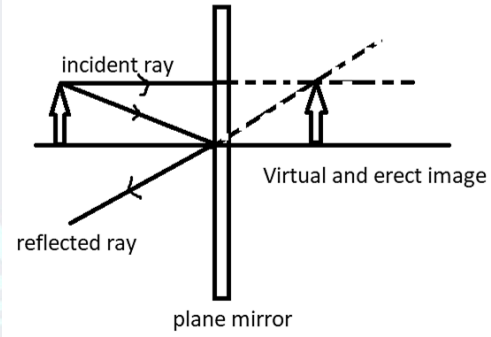
PHYSICS

Light Reflection and Refraction 1

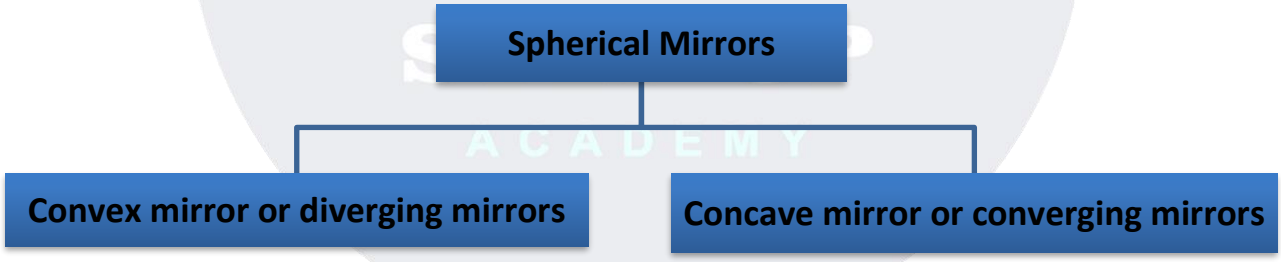
Reflection of Light

- Reflection is the phenomenon of bouncing back of light into the same medium on striking the surface of any object.
- **Laws of Reflection**
  - **First law:** The incident ray, the normal to the surface at the point of incidence and the reflected ray, all lie in the same plane.
  - **Second law:** The angle of reflection (r) is always equal to the angle of incidence(i).

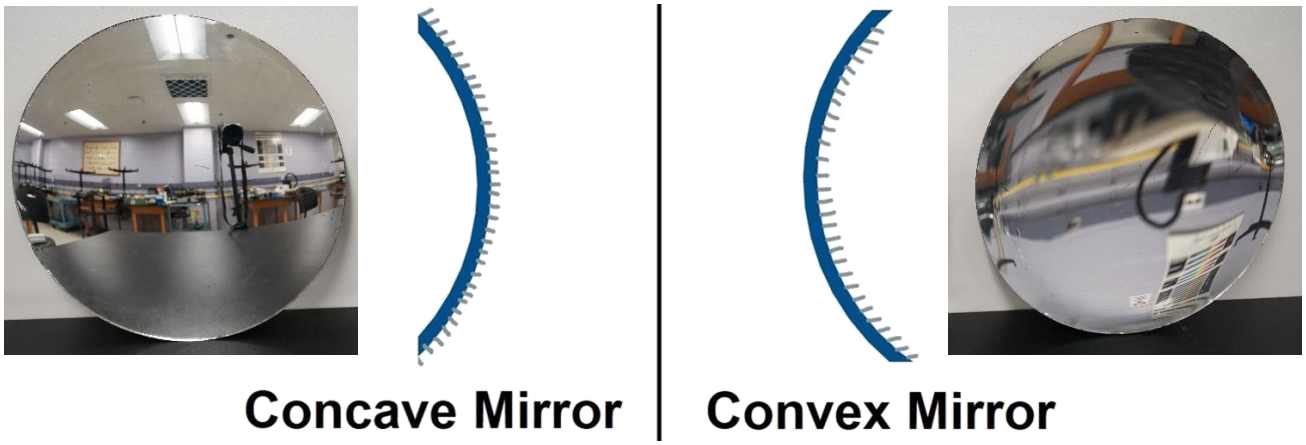
    ∠i = ∠r
- The image formed by a **plane mirror** is always
  - virtual and erect
  - of the same size as the object
  - as far behind the mirror as the object is in front of it
  - laterally inverted



Spherical mirrors are of two types:

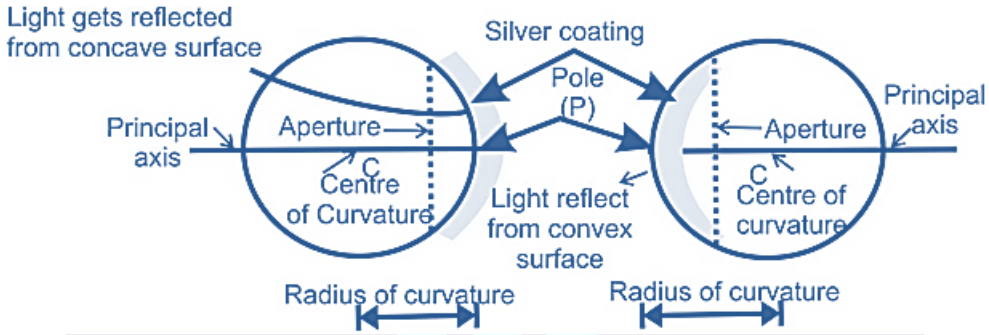


- **Convex mirrors or diverging mirrors** in which the reflecting surface is curved outwards.
- **Concave mirrors or converging mirrors** in which the reflecting surface is curved inwards.



Some terms related to spherical mirrors:

- The **center of curvature (C)** of a spherical mirror is the centre of the hollow sphere of glass, of which the spherical mirror is apart.
- The **radius of curvature (R)** of a spherical mirror is the radius of the hollow sphere of glass, of which the spherical mirror is apart.
- The **pole (P)** of a spherical mirror is the centre of the mirror.
- The **principal axis** of a spherical mirror is a straight line passing through the centre of curvature C and pole P of the spherical mirror.
- The **principal focus (F) of a concave mirror** is a point on the principal axis at which the rays of light incident on the mirror, in a direction parallel to the principal axis, actually meet after reflection from the mirror.



- The **principal focus (F) of a convex mirror** is a point on the principal axis from which the rays of light incident on the mirror, in a direction parallel to the principal axis, appear to diverge after reflection from the mirror.
- The **focal length (f)** of a mirror is the distance between its pole (P) and principal focus(F).
- For spherical mirrors of small aperture, **R =2f**.

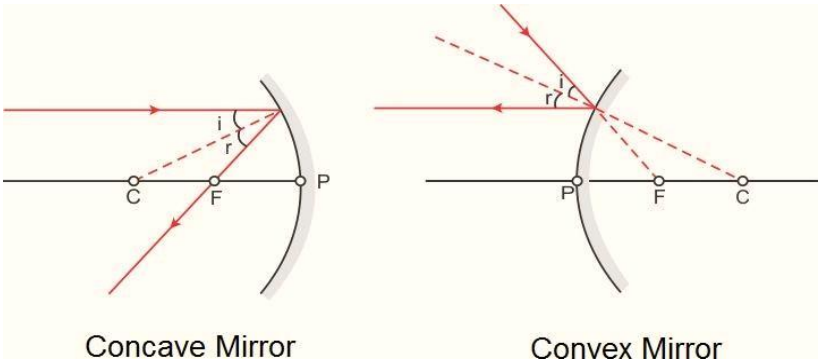
Sign Conventions for Spherical Mirrors

According to **New Cartesian Sign Conventions**,

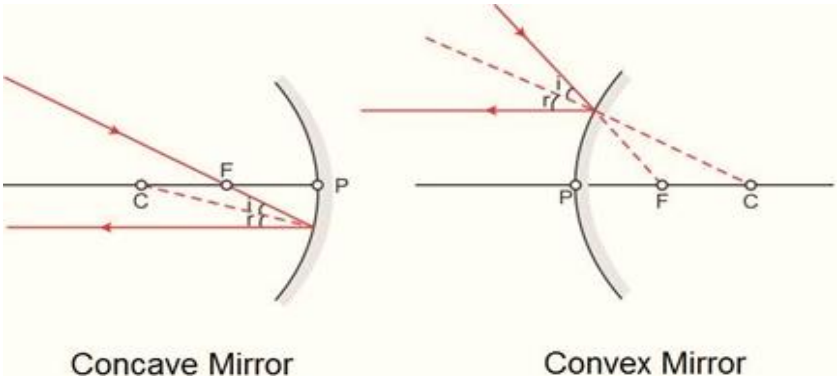
- All distances are measured from the pole of the mirror.
- The distances measured in the direction of incidence of light are taken as positive and *viceversa*.
- The heights above the principal axis are taken as positive and *viceversa*.

Rules for tracing images formed by Spherical Mirrors

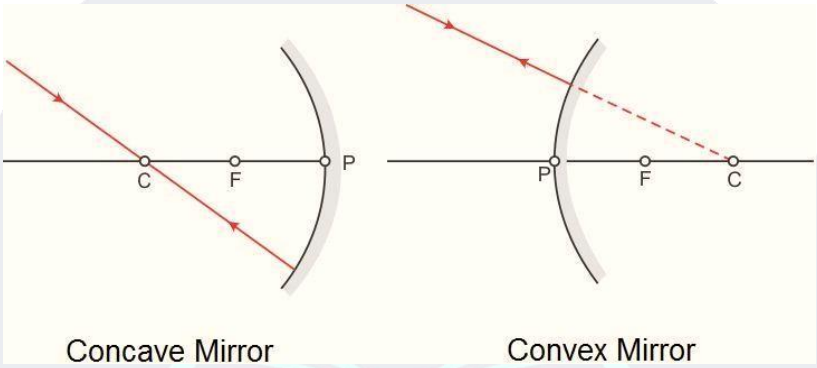
Rule 1: A ray which is parallel to the principal axis after reflection passes through the principal focus in case of a concave mirror or appears to diverge from the principal focus in case of a convex mirror.



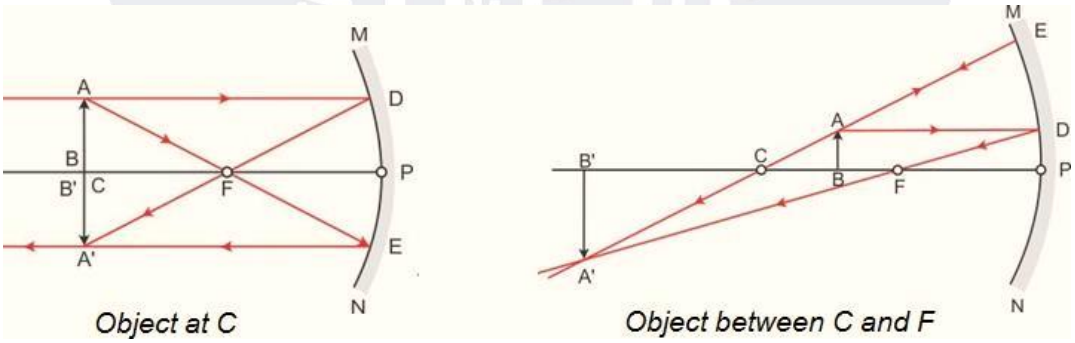
Rule 2: A ray passing through the principal focus of a concave mirror or a ray which is directed towards the principal focus of a convex mirror emerges parallel to the principal axis after reflection.



Rule 3: A ray passing through the centre of curvature of a concave mirror or directed towards the centre of curvature of a convex mirror is reflected back along the same path.



Rule 4: A ray incident obliquely towards the pole of a concave mirror or a convex mirror is reflected obliquely as per the laws of reflection.



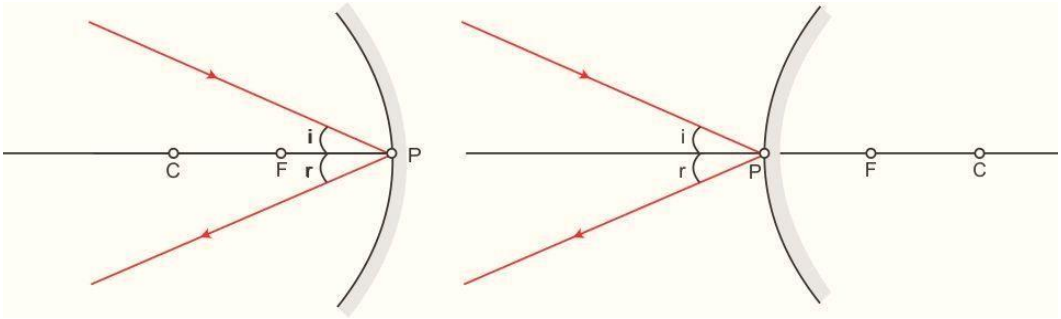
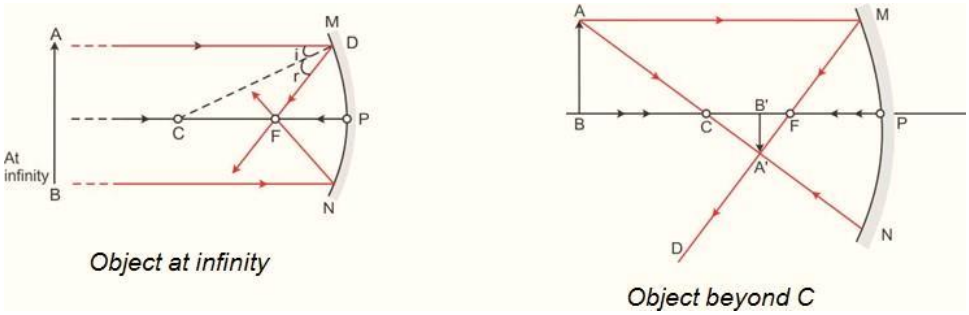
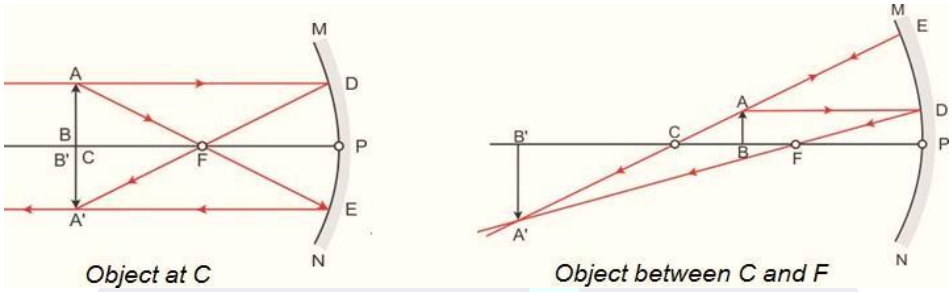
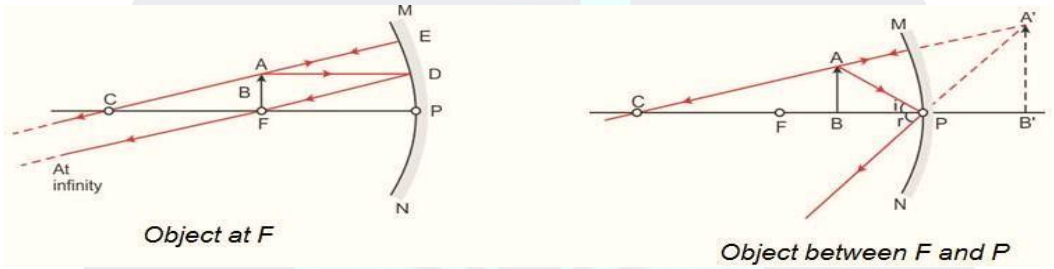


Image formation by a concave mirror

Ray Diagrams





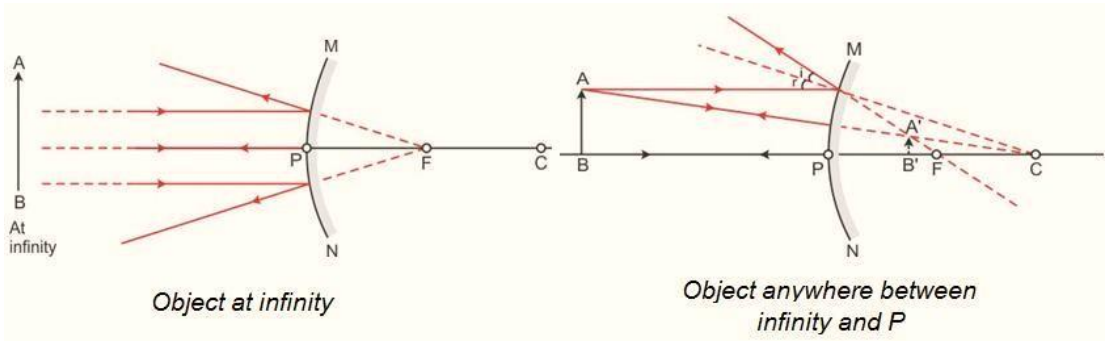


Characteristics of images formed

Position of object	Position of image	Size of image	Nature of image
At infinity	At focus F	Highly diminished	Real and inverted
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Equal to size of object	Real and inverted
Between C and F	Beyond C	Enlarged	Real and inverted
At F	At infinity	Highly enlarged	Real and inverted
Between F and P	Behind the mirror	Enlarged	Virtual and erect

Image formation by a convex mirror

Ray Diagrams



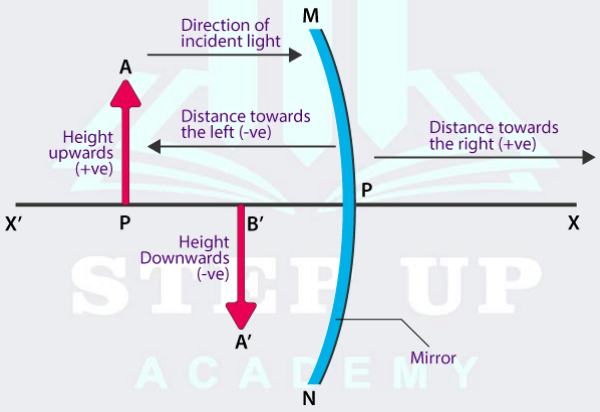
Characteristics of images formed

Position of object	Position of image	Size of image	Nature of image
At infinity	At focus F behind the mirror	Highly diminished, point sized	Virtual and erect
Anywhere between infinity and the pole of the mirror	Between P and F behind the mirror	Diminished	Virtual and erect

Sign Convention for Reflection by Spherical Mirrors

While dealing with the reflection of light by spherical mirrors, we shall follow a set of sign conventions called the New Cartesian Sign Convention. In this convention, the pole (P) of the mirror is taken as the origin. The principal axis of the mirror is taken as the x-axis (X'X) of the coordinate system. The conventions are as follows:

- The object is always placed to the left of the mirror. This implies that the light from the object falls on the mirror from the left-hand side.
- All distances parallel to the principal axis are measured from the pole of the mirror.
- All the distances measured to the right of the origin (along + x-axis) are taken as positive while those measured to the left of the origin (along – x-axis) are taken as negative.
- Distances measured perpendicular to and above the principal axis (along + y-axis) are taken as positive.
- Distances measured perpendicular to and below the principal axis (along –y-axis) are taken as negative.



The New Cartesian Sign Convention for spherical mirrors

- **Mirror Formula**

  The object distance (u), image distance (v) and focal length (f) of a spherical mirror are related as

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

- **Linear Magnification (m)**

  The magnification produced by a spherical mirror indicates the extent to which an object's image is magnified in relation to the object size.

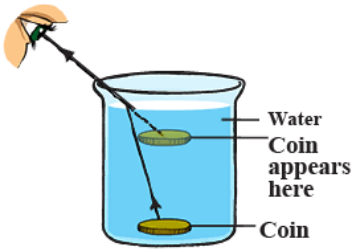
  Magnification is defined as the ratio of the image's height to the object's height. The letter m is commonly used to represent it.

  If h is the object's height and h' is the image's height, then the magnification m produced by a spherical mirror can be written as

$$m = \frac{\text{Height of the Image}}{\text{Height of the object}} = \frac{h'}{h}$$

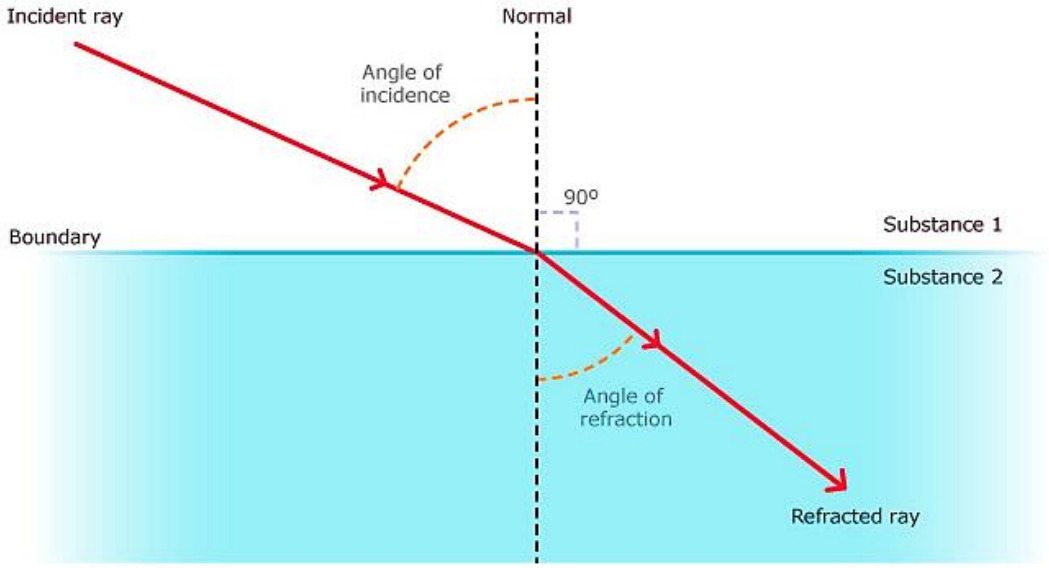
  m is **negative** for real images and **positive** for virtual images.

Refraction of Light



- The phenomenon of change in the path of a beam of light as it passes from one medium to another is called refraction of light.
- The **cause of refraction** is the change in the speed of light as it goes from one medium to another.

Refraction of light



Laws of Refraction

- **First Law:** The incident ray, the refracted ray and the normal to the interface of two media at the point of incidence, all lie in the same plane.
- **Second Law:** The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for a given pair of media.

$$\frac{\sin i}{\sin r} = \text{constant}$$

This law is also known as **Snell's law**.

The constant, written as n is called the **refractive index** of the second medium (in which the refracted ray lies) with respect to the first medium (in which the incident ray lies).

- **Absolute refractive index (n)** of a medium is given as

$$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in the medium}} = \frac{C}{V}$$

- When a beam of light passes from medium 1 to medium 2, the refractive index of medium 2 with respect to medium 1 is called the **relative refractive index**, represented by ${}^1n$, where

$${}^1n_2 = \frac{n_2}{n_1} = \frac{cv_2}{cv_1} = \frac{v_1}{v_2}$$

Similarly, the refractive index of medium 1 with respect to medium 2 is

$$^2n_1 = \frac{n_1}{n_2} = \frac{cv_1}{cv_2} = \frac{v_2}{v_1}$$

$$\Rightarrow {}^1n_2 \times {}^2n_1 = 1$$

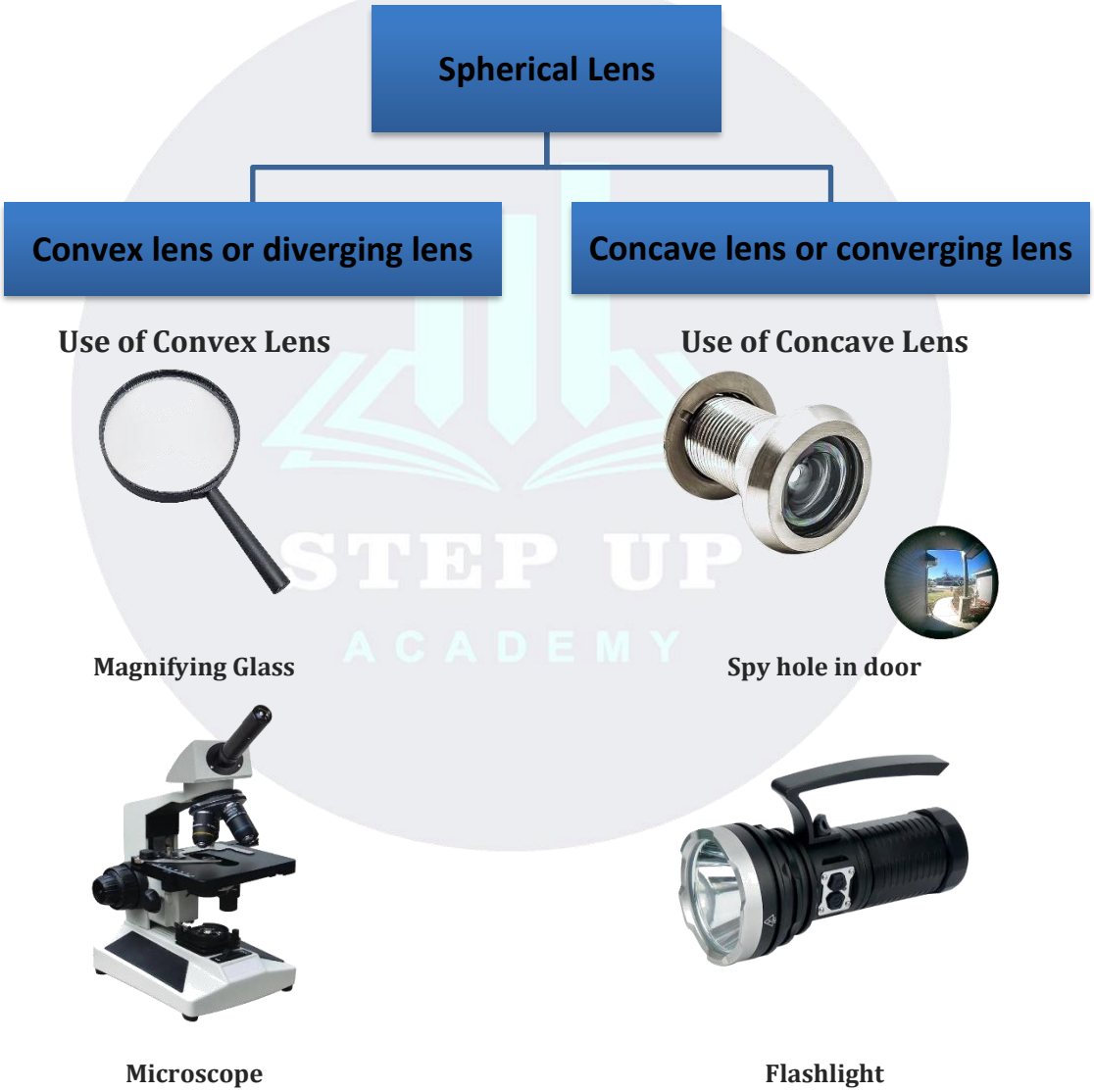
$$\text{or, } {}^1n_2 = \frac{1}{{}^2n_1}$$

- While going from **a rarer to a denser medium**, the ray of **light bends towards the normal**. While going from **a denser to a rarer medium**, the ray of **light bends away from the normal.**

Conditions for no refraction

- When light is incident normally on a boundary.
- When the refractive indices of the two media are equal.

- In the case of a **rectangular glass slab**, a ray of light suffers **two refractions**, one at the air–glass interface and the other at the glass–air interface. The emergent ray is **parallel** to the direction of the incident ray.



- **Convex lens or converging lens** which is thick at the centre and thin at the edges.
- **Concave lens or diverging lens** which is thin at the centre and thick at the edges.

- Some terms related to spherical lenses:
  - The central point of the lens is known as its **optical centre(O)**.
  - Each of the two spherical surfaces of a lens forms a part of a sphere. The centres of these spheres are called **centres of curvature** of the lens. These are represented as C_1 and C_2.

- The **principal axis** of a lens is a straight line passing through its two centres of curvature.
- The **principal focus of a convex lens** is a point on its principal axis to which light rays parallel to the principal axis converge after passing through the lens.
- The **principal focus of a concave lens** is a point on its principal axis from which light rays, originally parallel to the principal axis appear to diverge after passing through the lens.
- The **focal length (f)** of a lens is the distance of the principal focus from the optical centre.

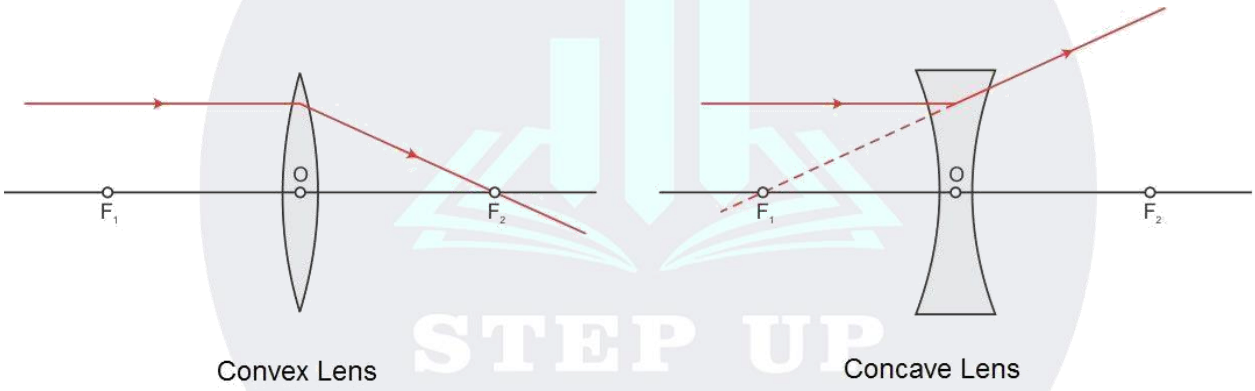
Sign Conventions for Spherical Lenses

According to **New Cartesian Sign Conventions**,

- All distances are measured from the optical centre of the lens.
- The distances measured in the direction of incidence of light are taken as positive and *viceversa*.
- The heights above the principal axis are taken as positive and *viceversa*.

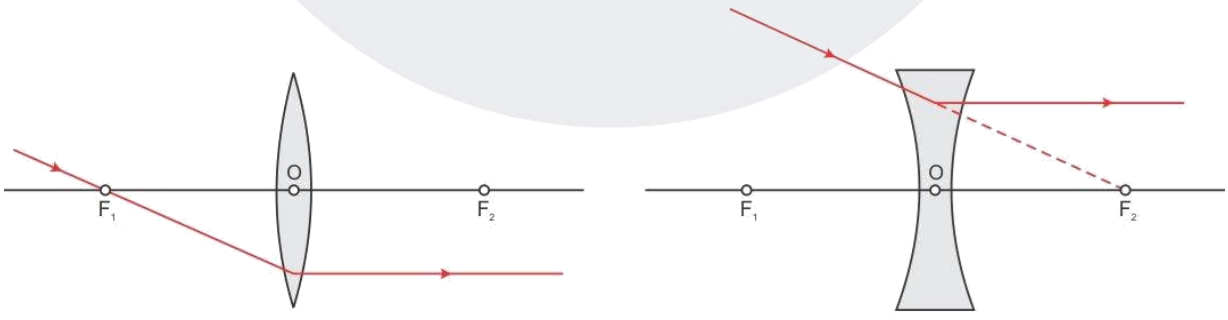
Rules for tracing images formed by spherical lens

Rule 1: A ray which is parallel to the principal axis, after refraction passes through the principal focus on the other side of the lens in case of a convex lens or appears to diverge from the principal focus on the same side of the lens in case of a concave lens.



Convex Lens Concave Lens

Rule 2: A ray passing through the principal focus of a convex lens or appearing to meet at the principal focus of a concave lens after refraction emerges parallel to the principal axis.

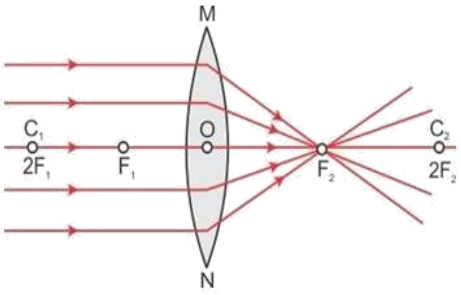


Convex Lens Concave Lens

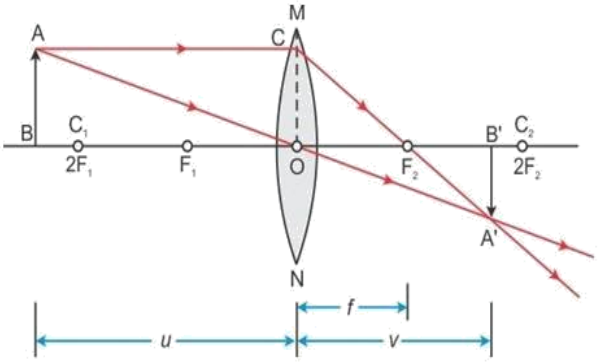
Rule 3: A ray passing through the optical centre of a convex lens or a concave lens emerges without any deviation.

Image formation by a convex lens

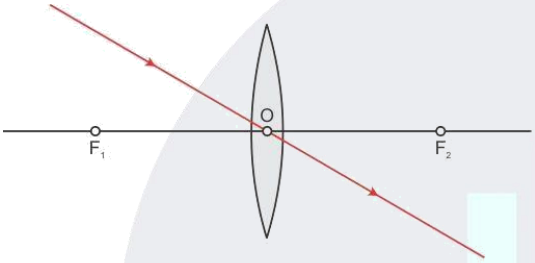
Ray Diagrams



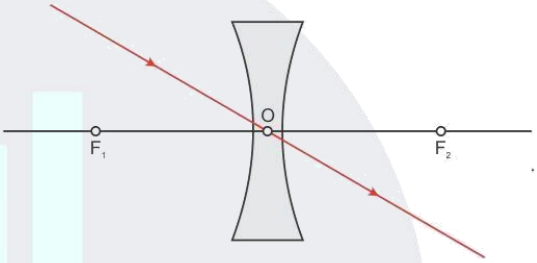
Object at infinity



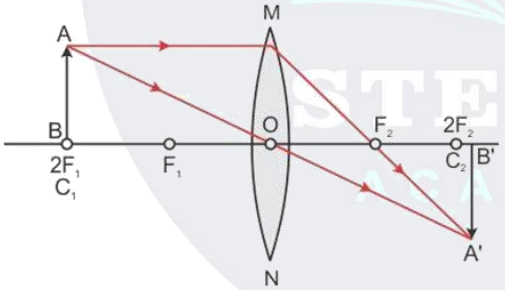
Object beyond $2F_1$



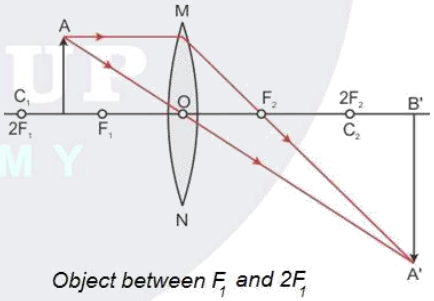
Convex Lens



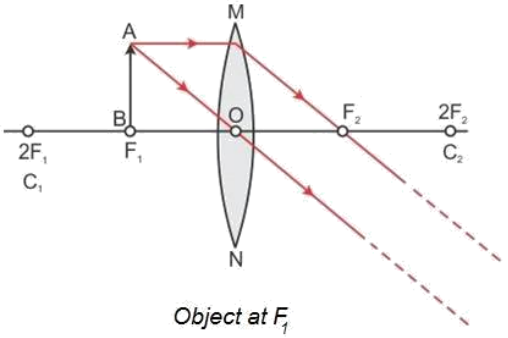
Concave Lens



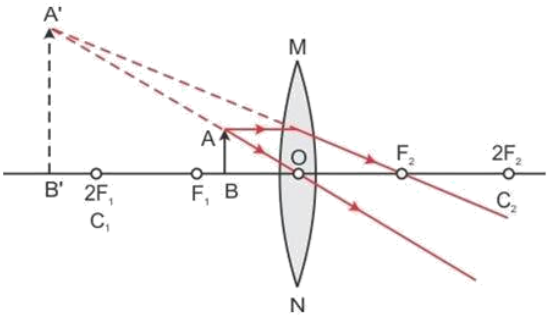
Object at $2F_1$



Object between F_1 and $2F_1$



Object at F_1



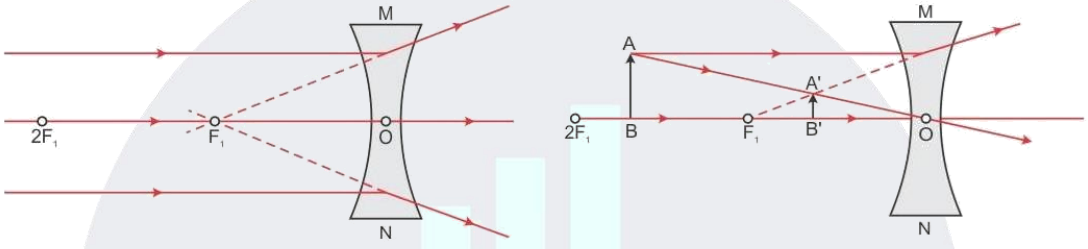
Object between F_1 and C

Characteristics of images formed

Position of object	Position of image	Size of image	Nature of image
At infinity	At focus F_2	Highly diminished	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Equal to size of object	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Highly enlarged	Real and inverted
Between F_1 and O	Beyond F_1 on the same side as the object	Enlarged	Virtual and erect

Image formation by a concave lens

Ray Diagrams



Object at infinity

Object between infinity and optical centre

Characteristics of images formed

Position of object	Position of image	Size of image	Nature of image
At infinity	At focus F_1	Highly diminished	Virtual and erect
Between infinity and O	Between focus F_1 and O	Diminished	Virtual and erect

Lens Formula

Object distance (u), image distance (v) and focal length (f) of a spherical lens are related as

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Linear Magnification (m) produced by a spherical lens is

$$m = \frac{\text{Height of the Image}}{\text{Height of the object}} = \frac{h'}{h}$$

m is **negative** for real images and **positive** for virtual images.

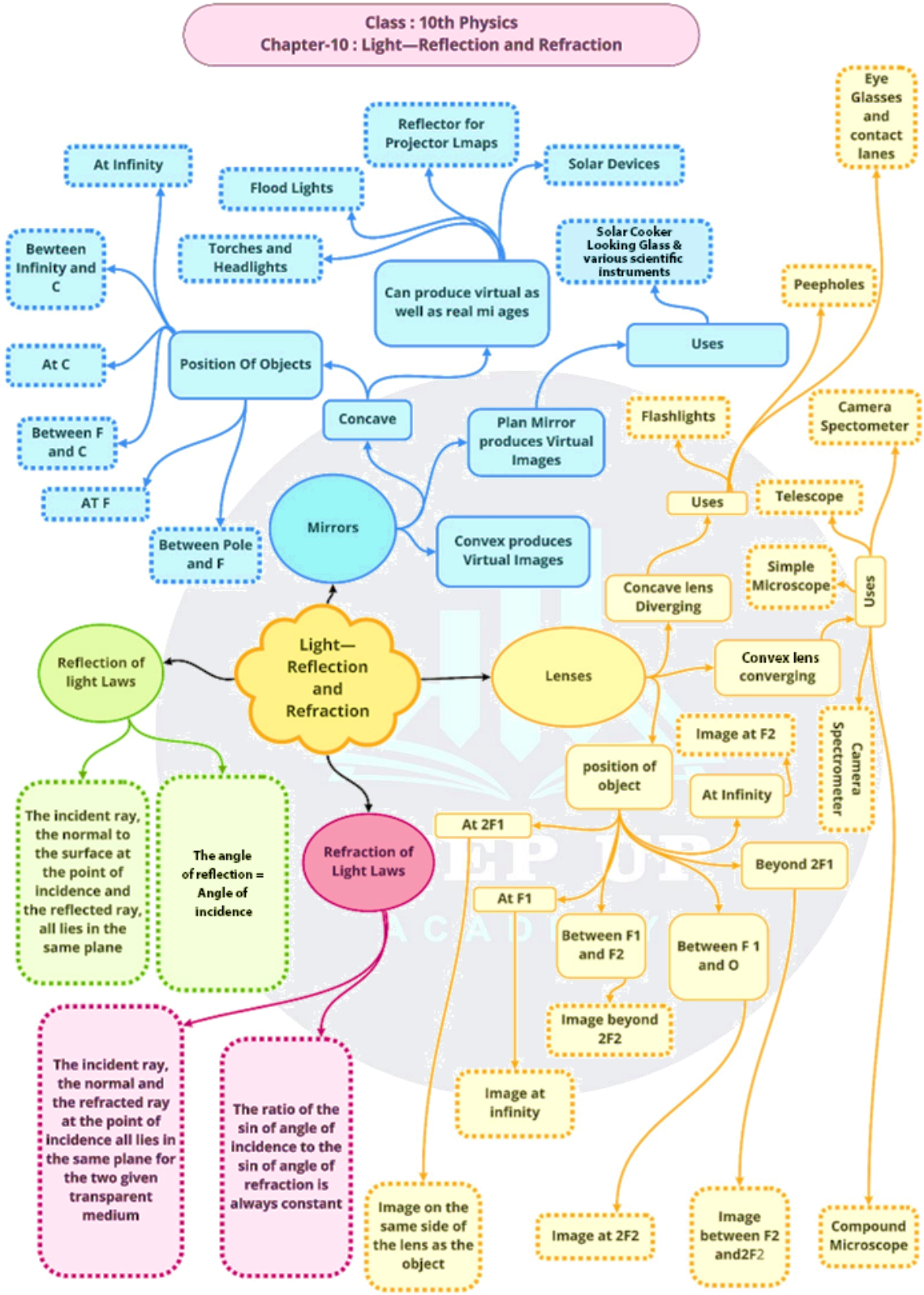
Power of a lens

Power of a lens is the reciprocal of the focal length of the lens. Its S.I. unit is **dioptre (D)**.

$$P\ (\text{dioptre}) = \frac{1}{f\ (\text{metre})}$$

- Power of a **convex lens** is **positive** and that of a **concave lens** is **negative**.
- When several thin lenses are placed in contact with one another, the **power of the combination of lenses** is equal to the algebraic sum of the powers of the individual lenses.

$$\mathbf{P = P_1 + P_2 + P_3 + P_4 + ...}$$


Class : 10th Physics
Chapter-10 : Light—Reflection and Refraction
Light—Reflection and Refraction
Reflection of light Laws
The incident ray, the normal to the surface at the point of incidence and the reflected ray, all lies in the same plane
The angle of reflection = Angle of incidence
Refraction of Light Laws
The incident ray, the normal and the refracted ray at the point of incidence all lies in the same plane for the two given transparent medium
The ratio of the sin of angle of incidence to the sin of angle of refraction is always constant
Mirrors
Concave
Position Of Objects
At Infinity
Bewteen Infinity and C
At C
Between F and C
AT F
Between Pole and F
Reflector for Projector Lmaps
Flood Lights
Torches and Headlights
Solar Devices
Can produce virtual as well as real mi ages
Plan Mirror produces Virtual Images
Convex produces Virtual Images
Solar Cooker Looking Glass & various scientific instruments
Uses
Flashlights
Uses
Concave lens Diverging
Lenses
Convex lens converging
position of object
At 2F1
At F1
Beyond 2F1
Between F1 and F2
Between F 1 and O
Image beyond 2F2
Image at infinity
Image on the same side of the lens as the object
Image at 2F2
Image between F2 and2F2
Image at F2
At Infinity
Eye Glasses and contact lanes
Peepholes
Camera Spectometer
Telescope
Simple Microscope
Uses
Camera Spectrometer
Compound Microscope

Important Questions

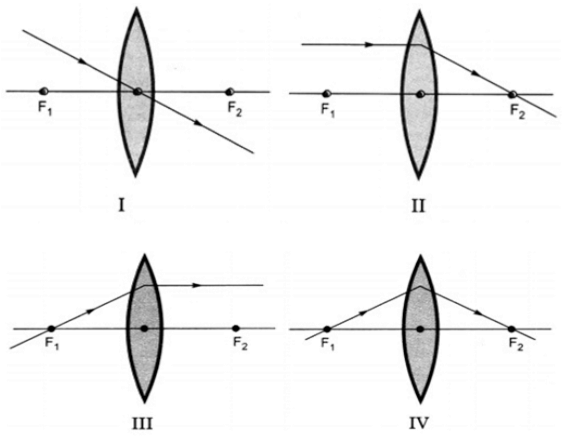
Multiple Choice Questions:

1. Which of the following can make a parallel beam of light when light from a point source is incident on it?
   (a) Concave mirror as well as convex lens
   (b) Convex mirror as well as concave lens
   (c) Two plane mirrors placed at 90° to each other
   (d) Concave mirror as well as concave lens

2. A 10 mm long awl pin is placed vertically in front of a concave mirror. A 5 mm long image of the awl pin is formed at 30 cm in front of the mirror. The focal length of this mirror is
   (a) -30 cm
   (b) -20 cm
   (c) -40cm
   (d) -60 cm

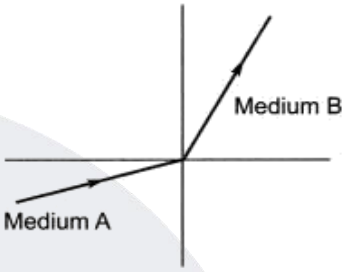
3. Under which of the following conditions a concave mirror can form an image larger than the actual object?
   (a) When the object is kept at a distance equal to its radius of curvature
   (b) When object is kept at a distance less than its focal length
   (c) When object is placed between the focus and center of curvature
   (d) When object is kept at a distance greater than its radius of curvature

4. The diagrams showing the correct path of the ray after passing through the



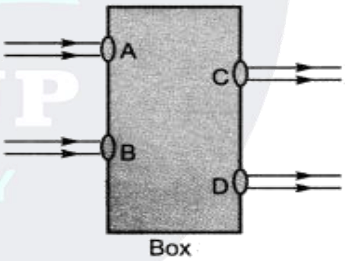
   (a) II and III only
   (b) I and II only
   (c) I, II and III
   (d) I, II and IV

5. A light ray enters from medium A to medium B as shown in figure. The refractive index of medium B relative to A will be



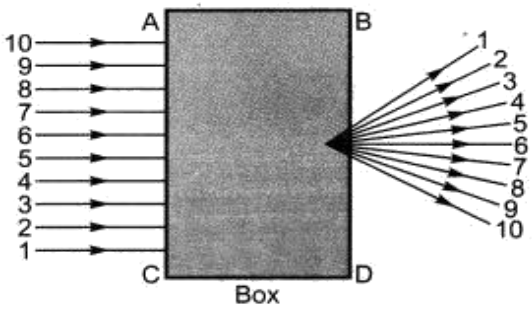
   (a) greater than unity
   (b) less than unity
   (c) equal to unity
   (d) zero

6. Beams of light are incident through the holes A and B and emerge out of box through the holes C and D respectively as shown in the figure. Which of the following could be inside the box?



   (a) A rectangular glass slab
   (b) A convex lens
   (c) A concave lens
   (d) A prism

7. A beam of light is incident through the holes on side A and emerges out of the holes on the other face of the box as show in the figure. Which of the following could be inside the box?



(a) Concave lens
(b) Rectangular glass slab
(c) Prism
(d) Convex lens

8. Which of the following statements is true?
(a) A convex lens has 4 dioptre power having a focal length 0.25 m
(b) A convex lens has -4 dioptre power having a focal length 0.25 m
(c) A concave lens has 4 dioptre power having a focal length 0.25 m
(d) A concave lens has -4 dioptre power having a focal length 0.25 m.

9. Magnification produced by a rear view mirror fitted in vehicles
(a) is less than one
(b) is more than one
(c) is equal to one
(d) can be more than or less than one depending upon the position of the object in front of it.

10. Rays from Sun converge at a point 15 cm in front of a concave mirror. Where should an object be placed so that size of its image is equal to the size of the object?
(a) 15 cm in front of the mirror
(b) 30 cm in front of the mirror
(c) between 15 cm and and 30 cm in front of the mirror
(d) more than 30 cm in front of the mirror

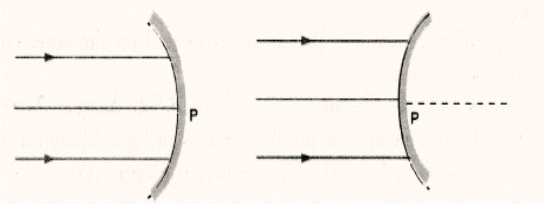
Very Short Question:

1. Define reflection of light?
2. What is a reflector?
3. State laws of reflection.
4. What are the values of angle of incidence ∠i and angle of reflection ∠r for normal incidence of light on a plane mirror?
5. What is real image?
6. What is virtual image?
7. Mention the nature of image produced by a plane mirror.
8. Define center of curvature of a spherical mirror.
9. Define radius of curvature of a spherical mirror.
10. Define aperture of a spherical mirror.

Short Questions:

1. List two differences between real and virtual images.
2. State the laws of reflection of light.
3. With the ray diagram show that angle of incidence is equal to the angle of reflection when a ray is incident on the concave mirror.
4. An object is placed at the following distances from a concave mirror of focal length 15 cm.
(a) 10 cm
(b) 20 cm
(c) 30 cm
(d) 40 cm
Which position of the object will produce
- Virtual image
- A diminished real image
- An enlarged real image
- An image of same size.

5. Draw ray diagram to show the formation of images when the object is placed in front of a concave mirror
(i) between its pole and focus point,
6. State three uses of a concave mirror.
7. State two uses of a convex mirror.
8. Parallel rays of light incident on a concave mirror and a convex mirror as shown in figure,
(i) Redraw the reflected rays in both the cases,
(ii) Name the points where the reflected rays meet or appear to meet on the principal axis.



Long Questions:

1. A thin converging lens forms a:
(i) real magnified image
(ii) virtual magnified image of an object placed in front of it.
(a) Write the positions of the objects in each case.
(b) Draw labelled diagrams to show the image formation in each case.
(c) How will the following be affected on cutting this lens into two halves along the principal axis?
- focal length,
- intensity of the image formed by half lens.

2. For the given data showing object distance and focal length of three concave mirrors, answer the following questions:

S.No.	Object distance (cm)	Focal length (cm)
1.	30	20
2.	10	15
3.	20	10

- Out of the three in which case the mirror will form the image having same size as the object?
- Which mirror is being used as a make-up-mirror?
- Draw the ray diagram for part (1) and part (2)

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Keeping a point object fixed, if a plane mirror is moved, the image will also move.

   Reason: In case of a plane mirror, distance of object and its image is equal from any point on the mirror.

2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

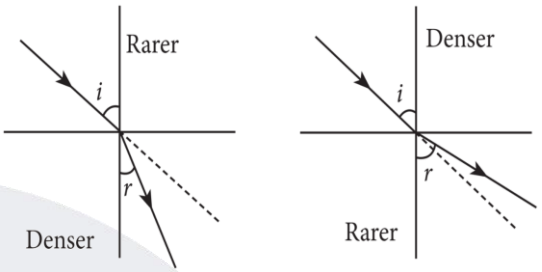
   Assertion: The size of the mirror affects the nature of the image.

   Reason: Small mirrors always form virtual images.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   When the rays of light travels from one transparent medium to another, the path of light is deviated. This phenomenon is called refraction of light. The bending of light depends on the optical density of medium through which the light pass.



   This speed of light varies from medium to medium. A medium in which the speed of light is more is optically rarer medium whereas in which the speed of light is less is optically denser medium. Whenever light goes from one medium to another, the frequency of light does not change however, speed and wavelength change. It concluded that change in speed of light is the basic cause of refraction.

   i. When light travels from air to glass, the ray of light bends:
      a. Towards the normal.
      b. Away from normal.
      c. Anywhere.
      d. None of these.

   ii. A ray of light passes from a medium A to another medium B. No bending of light occurs if the ray of light hits the boundary of medium B at an angle of:
      a. 0º
      b. 45º
      c. 90º
      d. 120º

   iii. When light passes from one medium to another, the frequency of light:
      a. Increases
      b. Decreases
      c. Remains same
      d. None of these

   iv. When light passes from glass to water, the speed of light:
      a. Increases.
      b. Decreases.
      c. Remains same.
      d. First increases then decrease.

v. The bottom of pool filled with water appears to be due to refraction of light:
   a. Shallower
   b. Deeper
   c. At same depth
   d. Empty

2. The lenses form different types of images when object placed at different locations. When a ray is incident parallel to the principal axis, then after refraction, it passes through the focus or appears to come from the focus. When a ray goes through the optical centre of the lens, it passes without any deviation. If the object is placed between focus and optical canter of the convex lens, erect and magnified image is fanned. As the object is brought closer to the convex lens from infinity to focus, the image moves away from the convex lens from focus to infinity. Also, the size of image goes on increasing and the image is always real and inverted. A concave lens always gives a virtual, erect, and diminished image irrespective to the position of the object.

i. The location of image fanned by a convex lens when the object is placed at infinity is
   a. At focus
   b. At 2F
   c. At optical center
   d. Between F and 2F

ii. When the object is placed at the focus of concave lens, the image formed is:
   a. Real and smaller
   b. Virtual and inverted
   c. Virtual and smaller
   d. Real and erect

iii. The size of image formed by a convex lens when the object is placed at the focus of convex lens is:
   a. Small
   b. Point in size
   c. Highly magnified
   d. Same as that of object

iv. When the object is placed at 2F in front of convex lens, the location of image is:
   a. At F
   b. At 2 F on the other side
   c. At infinity
   d. Between F and optical center

v. At which location of object in front of concave lens, the image between focus and optical centre is formed:
   a. Anywhere between centre and infinity
   b. At F
   c. At 2F
   d. Infinity

Answer Key

Multiple Choice Answers:

1. (a) Concave mirror as well as convex lens
2. (b) -20 cm
3. (c) When object is placed between the focus and centre of curvature
4. (c) I, II and III
5. (a) greater than unity
6. (a) A rectangular glass slab
7. (d) Convex lens
8. (a) A convex lens has 4 dioptre power having a focal length 0.25 m
9. (a) is less than one
10. (b) 30 cm in front of the mirror

Very Short Answers:

1. **Answer**: The process of returning or bouncing back the light to the same medium after striking the surface is called reflection of light.
2. **Answer**: A surface which reflects the light is called reflector.
3. **Answer**: Angle of incidence is equal to the angle of reflection. That is, $\angle i = \angle r$.

   Incident ray, reflected ray and normal to the reflecting surface at the point of incidence lie in the same plane.
4. **Answer**: For normal incidence, $\angle i = 0$. Therefore, according to law of reflection $\angle r = \angle i = 0$.
5. **Answer**: When rays of light from an object actually meet at a point after refraction, then image formed is real.
6. **Answer**: When rays of light from an object do not meet at a point but appears to meet at a point, then image formed is virtual.

7. **Answer**: Image is virtual, erect and of the same size as that of the object.

8. **Answer**: The center of a hollow sphere of which the spherical mirror forms a part is called the center of curvature of the spherical mirror.

9. **Answer**: The radius of a hollow sphere of which the spherical mirror forms a part is called radius of curvature of the spherical mirror.

10. **Answer**: The part of spherical mirror exposed to the incident light is called the aperture of the spherical mirror.

Short Answers:

1. **Answer**:

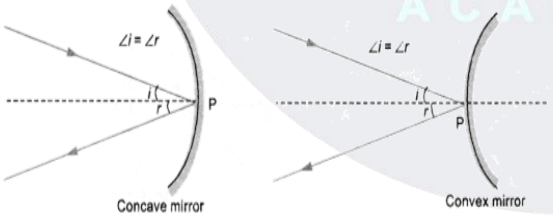
Real Image	Virtual Image
Real images are formed by a concave mirror	Convex mirror form a virtual image
Real images are formed due to the actual intersection of light rays	Virtual images are formed due to the imaginary intersection of light rays

2. **Answer**:

Angle of incidence is equal to the angle of reflection. That is, $\angle i = \angle r$.

Incident ray, reflected ray and normal to the reflecting surface at the point of incidence lie in the same plane.

3. **Answer**:



4. **Answer**:

Concave mirror forms virtual image if object is placed between the focus and pole of the mirror. Therefore, for the position of object at 10 cm mirror forms the required image.

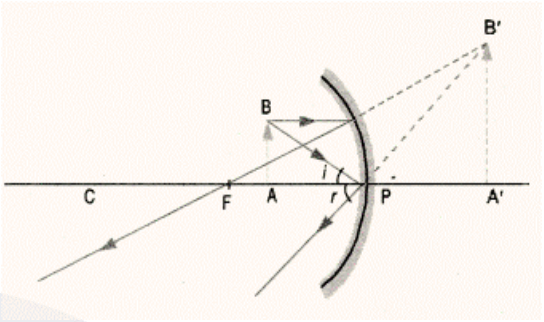
A real and diminished image is formed when object lies beyond C i.e., beyond 2F. So, for the position of object at 40 cm, mirror forms the required image.

An enlarged real image is formed when object lies between F and 2 F. So, for the position of object at 20 cm, mirror forms the required image.

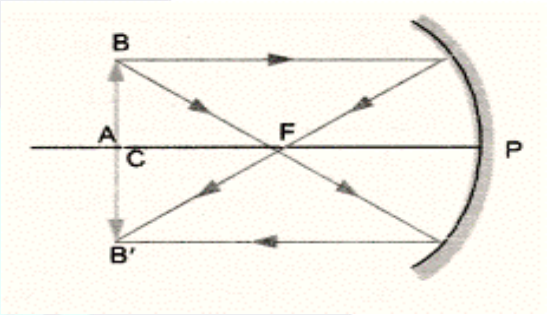
An image of same size of the object is formed when object lies at C or 2F. So, for the position of object at 30 cm, mirror forms the required image.

5. **Answer**:

(i)

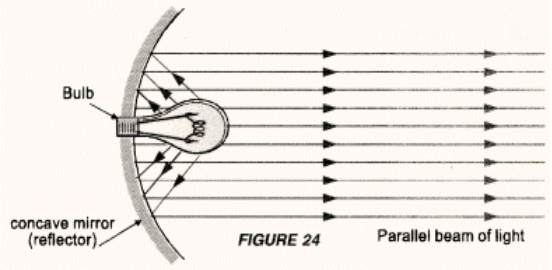


(ii)



6. **Answer**:

Reflector: Concave mirrors are used in motor head lights, search lights and torches etc. to produce an intense parallel beam of light. A bulb is placed at the focus of concave mirror or concave reflecting surface. The beam of light from the bulb after reflecting from the concave mirror goes as a parallel beam (figure 24).



This parallel beam of – light illuminates the road ahead of the vehicle.

Shaving and make up mirror: When an object is placed close to a concave mirror (i.e between the pole and focus of the concave mirror), an erect and enlarged (large in size) image of the object is formed. Because of this fact, concave mirror is used by men to see their enlarged faces while shaving. Similarly, a lady can see her face better with the help of a concave mirror while doing make up.

In solar cookers: When a parallel beam of sun light falls on a concave mirror, this beam is brought to the focus of the concave mirror. As a result of this, the temperature of an object (say a container containing un-cooked food) placed at this focus increases considerably. Hence the food in the container is cooked (figure 25).

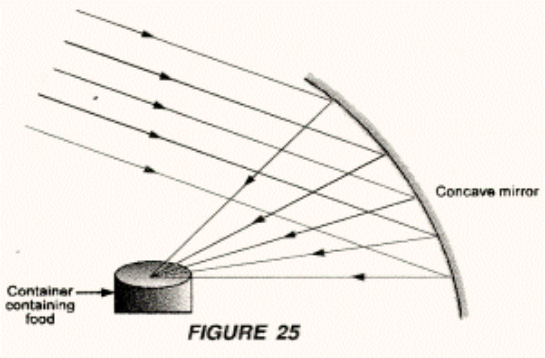
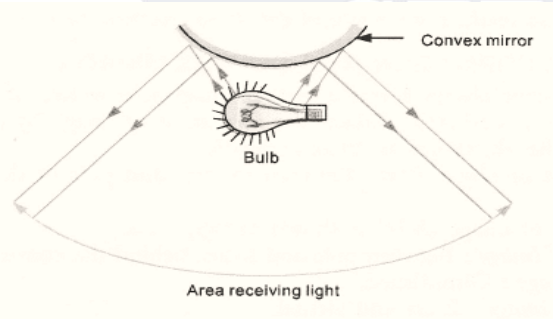


FIGURE 25

7. **Answer**:

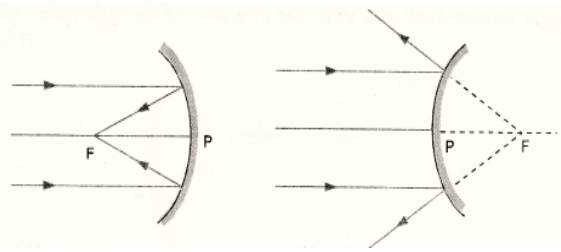
Rear view or driver's mirror. Convex mirror is used as a rear view mirror in vehicles because this mirror forms an erect and diminished image of an object behind the vehicle. Since the image of the object formed is small in size, so the field of view is increased. It means, the driver of a vehicle can see the traffic over large area behind his vehicle. This mirror is also known as driver's mirror.

In street lights. Convex mirror is used in street lights to diverge light over a large area.



8. **Answer**:

(i) Reflected rays are shown in figures.



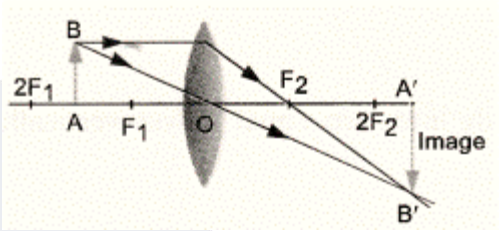
(ii) The point where the reflected rays of light meet or appear to meet on the principal axis is known as principal focus F of the concave mirror or convex mirror.

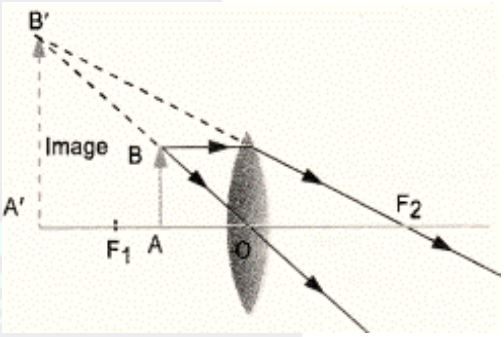
Long Answers:

1. **Answer**:

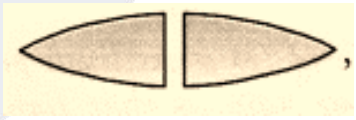
(a)
- A converging or convex lens forms real and magnified image of an object, when the object is placed between F1 and 2F1
- A converging lens forms a virtual magnified image of an object, when the object is placed between the focus and optical center of the converging lens.

(b)





(c) Focal length of each half will be equal to the focal length of the lens. If converging lens of focal length f is cut into two equal halves as shown in figure then the focal length of each half = f.



Intensity of the image formed ∝ (aperture of the lens)2. Aperture of each cut half of the lens is ½ times aperture of the lens. Hence, intensity of the image formed by half lens will decrease.

2. **Answer**:

i. Concave mirror forms the image having same size as the object if object is placed at the center of curvature of the mirror i.e. object distance = 2 f Therefore, for S.No. 3, concave mirror forms the required image.

ii. Concave mirror is used as a make-up mirror if the image of the face is magnified. This happens if the face or object is placed between F and 2 F. Therefore, for S. No. 2, concave mirror is

used as a make-up mirror.

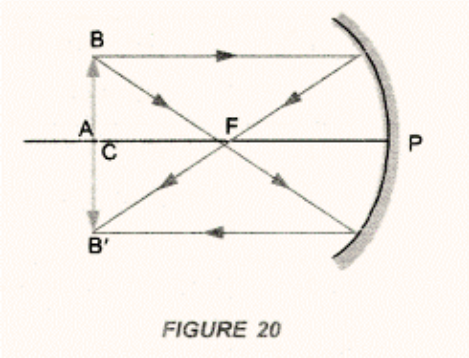


FIGURE 20

iii.

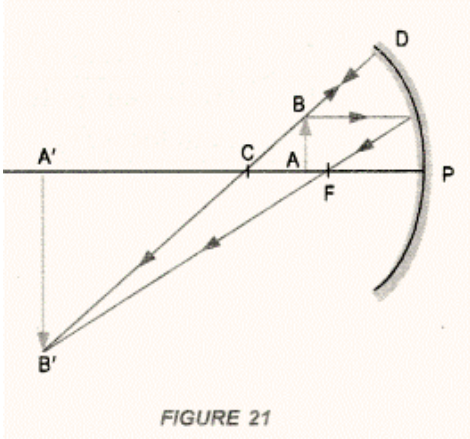


FIGURE 21

Assertion Reason Answer:

1. (a) Both A and R are true, and R is correct explanation of the assertion.

   Explanation:

   The image formed in a plane mirror is at the same distance behind the mirror as the object is in the front of the mirror. Image and the object are at equal distances from a plane mirror.

2. (d) A is false, but R is true.

   Explanation:

   The size of the image does not affect the nature of the image, except that a bigger image as it gathers more tight rays due to wider aperture.

Case Study Answer:

1. i. (a) Towards the normal.

   Explanation:

   When, a ray of light travels from air to glass, it bends towards the normal.

   ii. (c) 90º

   Explanation:

   No bending of light occurs when light is incident normally or perpendicularly on a boundary of two media since angle of incidence and angle of refraction both are zero.

   iii. (c) Remains same

   Explanation:

   When light goes from one medium to other medium, its frequency does not change.

   iv. (a) Increases.

   Explanation:

   The speed to light increases when light passes from glass to water as water is optically rarer medium.

   v. (a) Shallower

   Explanation:

   The bottom of a pool of water appears to be less deep than it actually is due to refraction.

2. i. (a) At focus

   Explanation:

   When an object is placed at infinity of convex lens, image will be formed at focus F.

   ii. (b)Virtual and inverted

   Explanation:

   Virtual and inverted image is formed, when object is placed at focus of the concave lens.

   iii. (c) Highly magnified

   Explanation:

   When object is placed at focus of a convex lens, highly enlarged or magnified image is formed.

   iv. (b) At 2 F on the other side

   Explanation:

   When an object is placed at distance 2F in front of a convex lens, then the image formed is at a distance 2F on the other of the lens.

   v. (a) Anywhere between centre and infinity

   Explanation:

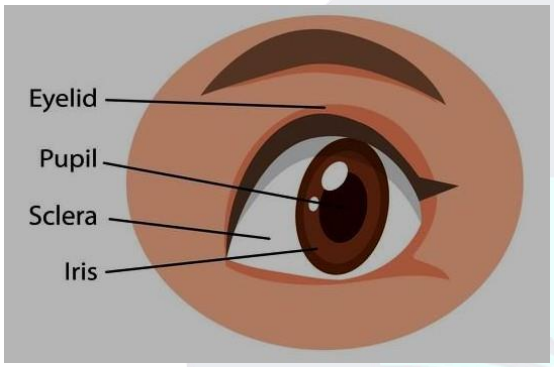
   Image if formed between focus and optical centre when the object is placed anywhere between optical centre and infinity.

The Human Eye and The Colourful World 2

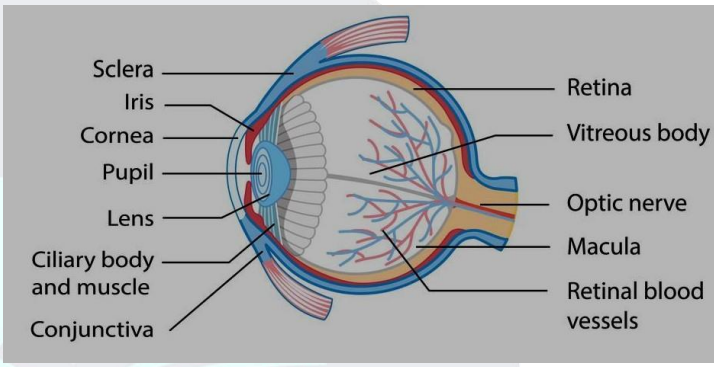
Human Eye

The human eye is an important and valuable sense organ which uses light and enables us to see the colourful world around us.

Structure of Human Eye



Human Eye Diagram (External Component)

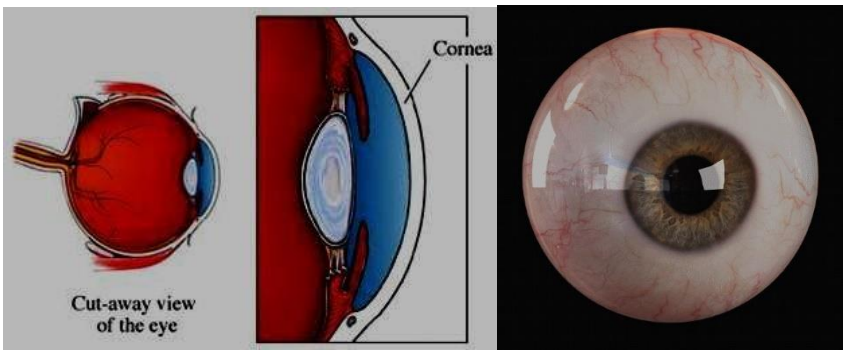


Human Eye Diagram (Internal Component)

The various parts of the human eye and their respective functions include

Part	Function
Cornea	Protective layer of the eye Refraction of light rays entering the eye
Eye lens	Adjust the focal length and form an inverted image of the object on the retina
Pupil	Regulates the amount of light entering the eye
Iris	Controls the size of the pupil
Retina	Acts as a screen for forming the image
Ciliary muscles	Adjust the thickness of the lens
Optic nerves	Send signals to the brain

1. Eyeball—The eyeball is approximately spherical in shape with a diameter of about 2.3 cm.



Cut Away View of Eye

I. Eyeball layers-

➢ The eyeball consists of three layers:

i. Fibrous layer (sclera, cornea)

ii. Vascular layer (choroid, ciliary body, iris)

iii. Nervous layer (retina)

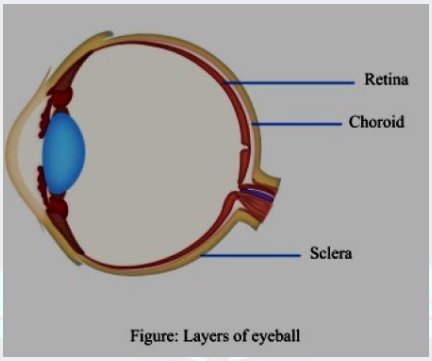
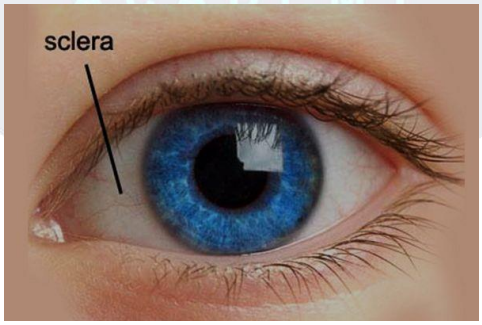


Figure: Layers of eyeball

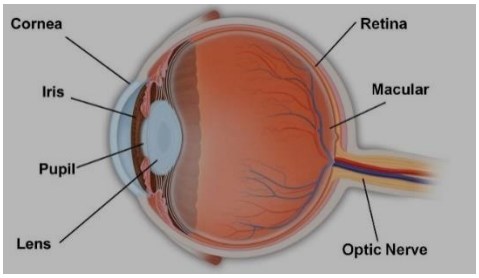
(i) Sclera:

The sclera functions as the supporting wall of the eyeball. It helps maintain eyeball shape, and protects it from injury. The sclera is covered by conjunctiva, which are clear mucus membranes that lubricate (moisturize) your eye.



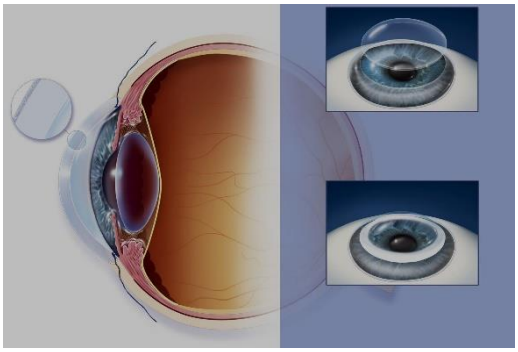
(ii) Cornea:

Light enters the eye through a thin membrane called the cornea.



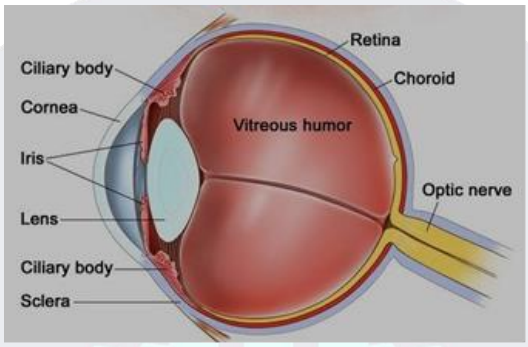
It forms the transparent bulge on the front surface of the eyeball.

Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea.



(iii) **Choroid:**

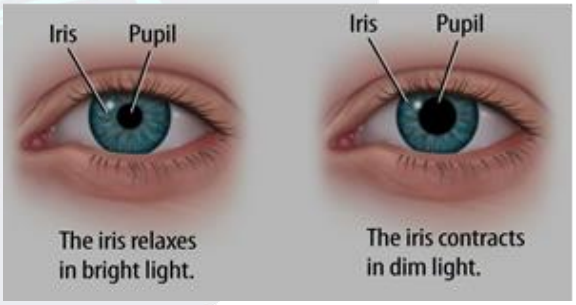
The choroid is filled with blood vessels that bring oxygen and nutrients to the eye.



2. Iris-

Iris is a thin, pigmented structure found in the eye that can regulate the amount of light that can enter the retina. Also, it determines the eye colour. Iris is present in the anterior part of the eye lens. It controls the size and diameter of the pupil and thus regulates the amount of light entering the eye.

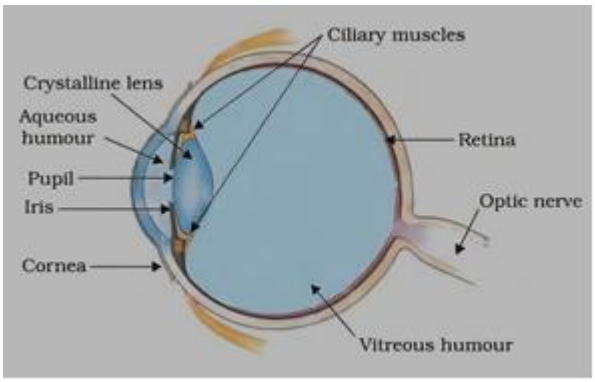
It controls the amount of light entering the eye by changing the size of the pupil.



- **Pupil-**

It is a hole in the middle of iris through which light enters the eye.

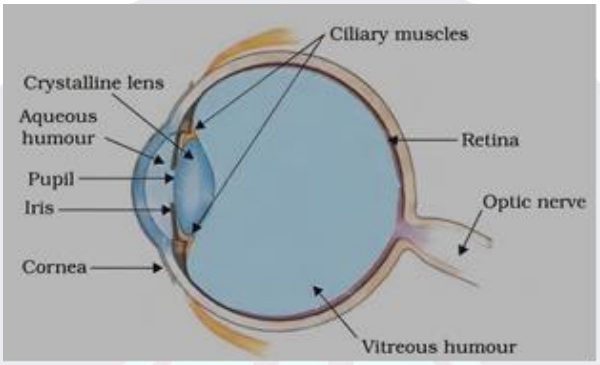
It appears black because light falling on it goes into the eye and does not come back.



- **Eye Lens-**

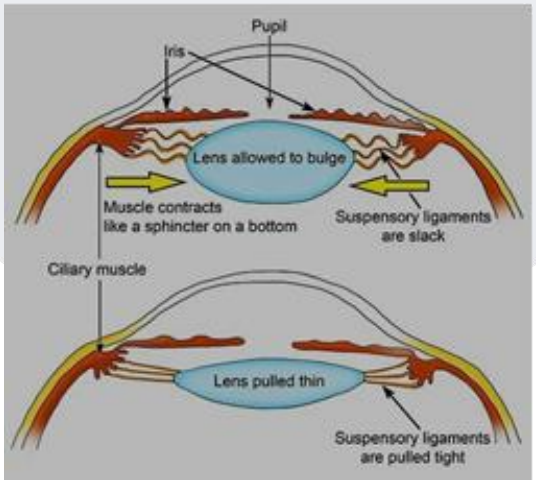
  It is a convex lens made of transparent and flexible jelly like material.

  Its curvature can be adjusted with the help of ciliary muscles.



- **Ciliary Muscles-**

  These are the muscles which are attached to eye lens and can modify the shape of eye lens which leads to the variation in focal lengths.



- **Retina-**

  The retina is a delicate membrane having enormous number of light-sensitive cells. The light-sensitive cells get activated upon illumination and generate electrical signals.

  These signals are sent to the brain via the optic nerves.

  The brain interprets these signals, and finally, processes the information so that we perceive objects as they are.

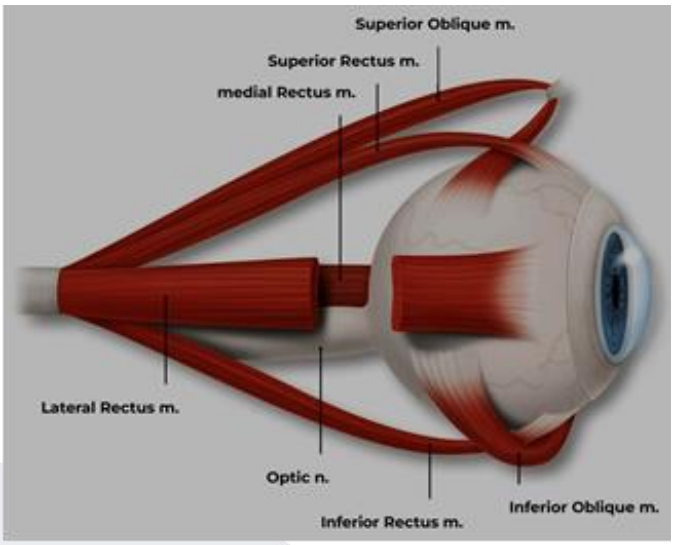
■ **Optical Nerve-**

These are the nerves which take the image to the brain in the form of electrical signals.

The image of any object seen persists on the retina for $\frac{1^{th}}{16}$ of a second, even after the removal of the object. This continuance of sensation on the eye for some time is called **persistence of vision**.

The numerous light-sensitive cells contained in the retina of the eye are of two types:

- **Rod-shaped cells** which respond to the **brightness or intensity** of light.
- **Cone-shaped cells** which respond to the **colour** of light.



Power of Accommodation of the Human Eye

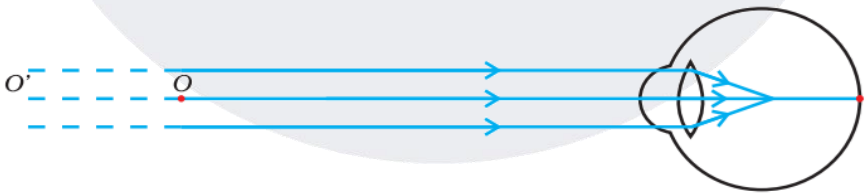
- Power of accommodation of the eye is the ability of the eye to observe distinctly the objects, situated at widely different distances from the eye, on account of change in the focal length of the eye lens by the action of the ciliary muscles holding the lens.
- The farthest point up to which the eye can see objects clearly is called the **far point (F)** of the eye. It is ideally **infinity** for a normal eye.
- The point of closest distance at which an object can be seen clearly by the eye is called the **near point (N)** of the eye. For a normal eye, the near point is 25 cm, which is called the **least distance of distinct vision (d)** of a normal eye.

  The distance between the far point (F) and near point (N) is called the **range of vision** of the eye.

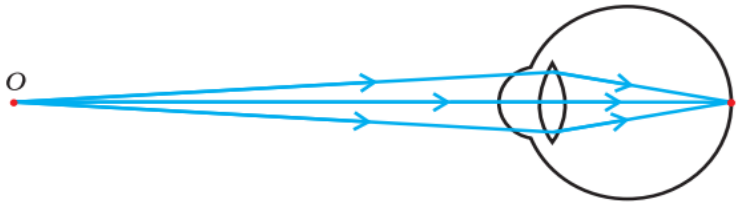
Defects of Vision

(a) Myopia or Short-Sightedness

A person with myopia can see nearby objects clearly but cannot see distant objects distinctly, as if the far point of the eye has shifted from infinity to some particular distance from the eye.



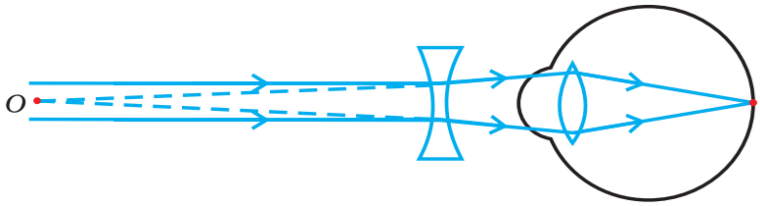
Myopic Eye



Far Point of a Myopic Eye

This defect may arise due to (i) excessive curvature of the eye lens or (ii) elongation of the eyeball.

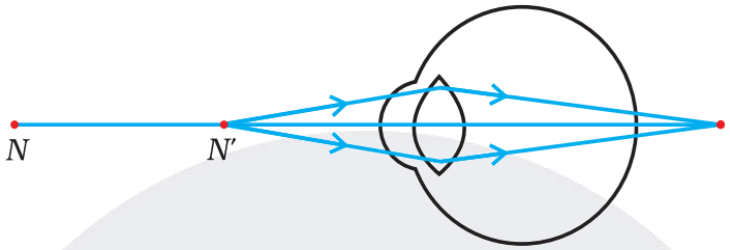
To correct myopia, the person has to wear spectacles with a **concave lens** of focal length equal to the distance of far point of the myopic eye.



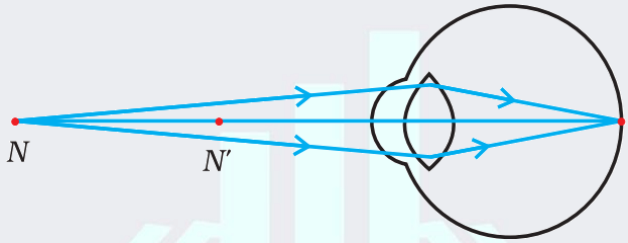
Correction for Myopia

(b) Hypermetropia or Long-Sightedness

A person with hypermetropia can see objects lying at large distances clearly but cannot see nearby objects clearly, as if the near point of the eye has shifted away from the eye.



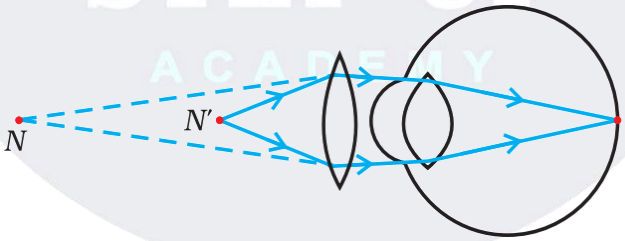
Hypermetropic Eye



Near Point of a Hypermetropic Eye

This defect may arise because (i) focal length of the eye lens is too long or (ii) the eyeball has become too small.

To correct hypermetropia, the person has to wear spectacles with a **convex lens** of focal length f, given by $f \frac{x' d}{x' - d}$, where d is the least distance of distinct vision and x′ is the distance of near point N of the hypermetropic eye.



Correction for Hypermetropia eye

(c) Presbyopia

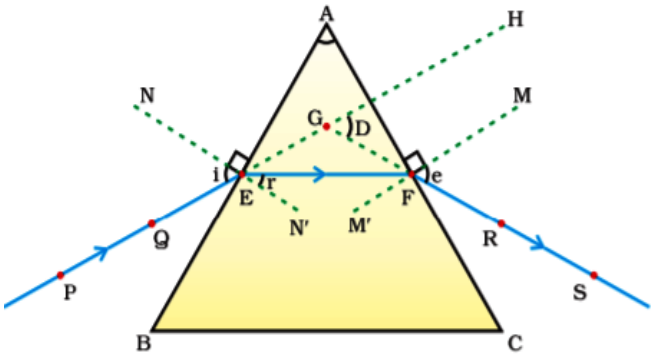
- Presbyopia is a human eye defect because of which an old person cannot read and write comfortably.
- It occurs in old age when the ciliary muscles holding the eye lens weaken and the eye lens loses some of its flexibility.
- To correct presbyopia, an old person has to wear spectacles with a **convex lens** of suitable focal length (as in hypermetropia).

Sometimes, a person may suffer from both myopia and hypermetropia. Such a person requires bi-focal lenses. The upper part of a bi-focal lens consists of concave lens facilitating distant vision, and the lower part consists of convex lens facilitating nearby vision.

Refraction through a glass prism

- If you take a glass prism, you can see that it has 2 triangular bases and three rectangular lateral surfaces, inclined at an angle. This angle is called the angle of the prism.

- Let's look at a top view of a triangular prism with a ray of light entering it.



PE – Incident ray
EF – Refracted ray
FS – Emergent ray
∠A – Angle of the prism
∠i – Angle of incidence
∠r – Angle of refraction
∠e – Angle of emergence
∠D – Angle of deviation

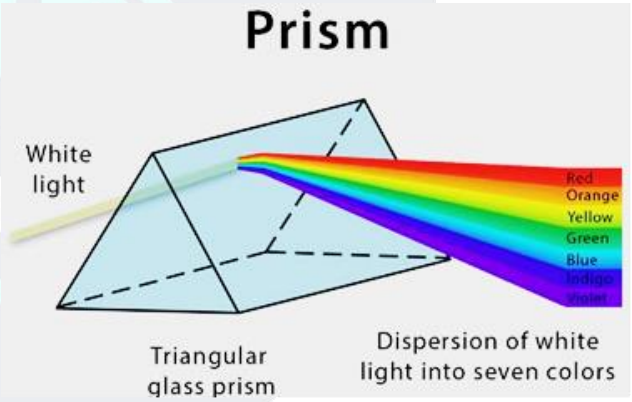
In the figure above, A is the angle of the prism.

- As per Snell's law, light travelling from a rarer medium to a denser medium bends towards the normal, and vice versa. Glass is denser than air, and thus, when a ray of light falls on the surface of the prism, it bends towards the normal. According to the diagram, ray PE falls on the surface of the prism and bends towards the normal NE.
- Then, while moving from the glass to air, the emergent ray FS bends away from the normal.
- ∠HDS is the angle of deviation which tells us how much the emergent ray has deviated from the incident ray. When the angle of incidence is equal to the angle of emergence, the angle of deviation is minimum.
- According to the figure, ∠PEN = ∠MES and ∠HDS is thus the angle of minimum deviation. The refracted ray EF is parallel to side BC in this case.

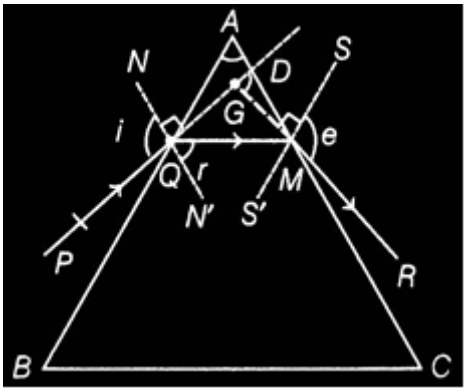
Dispersion of Light

Prism is a transparent refracting medium bounded by at least two lateral surfaces, inclined to each other at a certain angle. It has two triangular bases and three rectangular lateral surfaces. The angle between two lateral surfaces is called angle of prism (A).

In the given diagram, a ray of light PQ is entering from air to glass at the first surface AB. The light ray on refraction is bent towards the normal. At the second surface AC, the light ray enters from glass to air, so it bents away from the normal. The above diagram shows refraction through a prism,



where, PQ = incident ray, QM = refracted ray,
MR = emergent ray, ∠A = angle of prism,
∠i = angle of incidence, ∠r = angle of refraction,
∠e = angle of emergence, ∠D = angle of deviation



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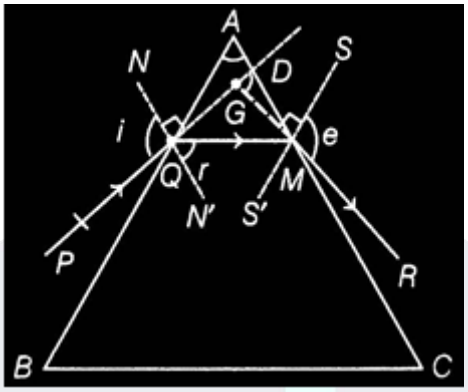
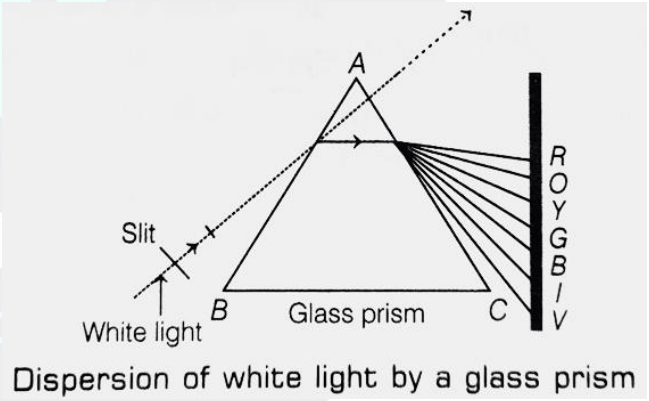


Dispersion of White Light by a Glass Prism

The phenomenon of splitting of white light into its constituent colours, when it passesthrough a prism is called dispersion.

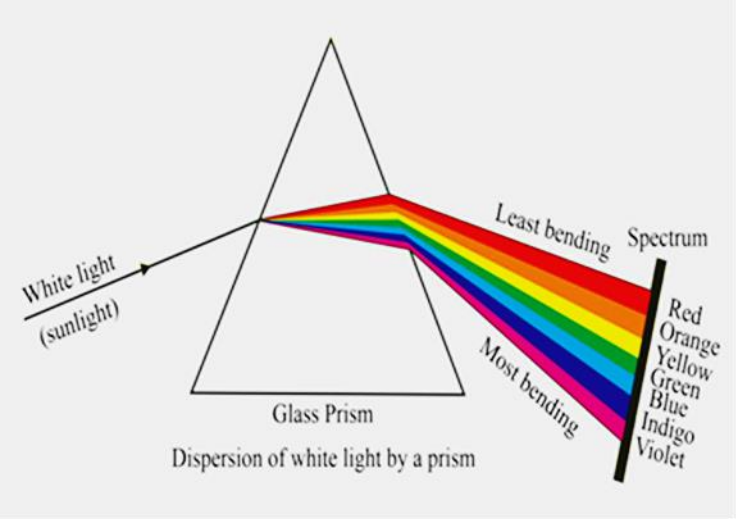
This band of seven colours so obtained, theVIBGYOR (V = violet, I = indigo, B = blue, G = green, Y = yellow, O = orange and R =red) is called spectrum.

Isaac Newton was the first one to use aglass prism to obtain the spectrum of light.



Dispersion of white light by a glass prism

- Dispersion of light is the phenomenon of splitting of a beam of white light into its seven constituent colours on passing through a glass prism.
- The band of coloured components of a light beam is called its **spectrum**.
- The sequence of colours given by the prism is Violet, Indigo, Blue, Green, Yellow, Orange and Red. **VIBGYOR** is the acronym for this sequence.
- The **cause of dispersion** is that different colours of white light with different wavelengths undergo different deviations on passing through a glass prism.
- If a second identical prism is placed in an inverted position with respect to the first prism, all the seven colours **recombine to form white light**.
- The **rainbow** is a beautiful example of dispersion of light in nature. Sunlight gets dispersed on passing through tiny droplets of water suspended in air during or after a shower.



Dispersion of white light by a prism

Isaac Newton was the first to use a glass prism to obtain the spectrum of sunlight. Hetried to split the colours of the spectrum of white light further by using another similar prism. However, he could not get any more colours. He then placed a second identical prism in an inverted position with respect to the first prism, allowed all the colours of the spectrum to pass through the second prism. He found a beam of white light emerging from the other side of the second prism. This observation gave Newton the idea that the sunlight is made up of seven colours.

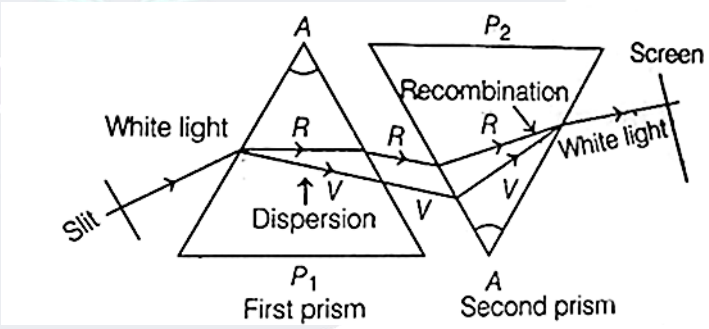
Cause of Dispersion

Light rays of different colours, travel with same speed in vacuum and air butin any other medium, they travel with different speeds and bend through different angles, which leads to the dispersion of light.

Red light has the maximum wavelength and violet light has the minimum wavelength. So in any medium, red light travels fastest and deviates least, while violet light travels slowest and deviatesmaximum, i.e.

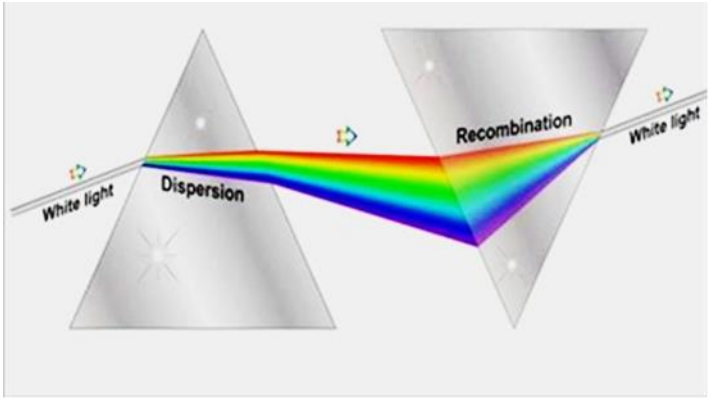
Recombination of White Light

Newton showed that the reverse of dispersion of light is also possible. He kept two prisms close to each other, onein erect position and the other in an inverted position. The light gets dispersed when passes through the firstprism.



Recombination of the spectrum of white light

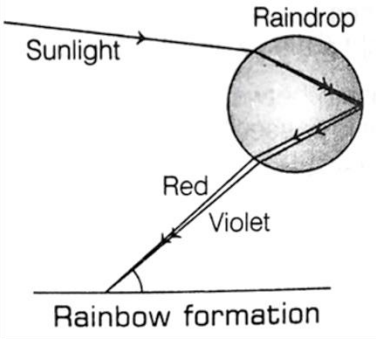
The second prism receives all the seven coloured rays from first prism and recombinesthem into original white light. This observation shows that sunlight is made up of seven colours. Any light that gives spectrum similar to that of sunlight is called white light.



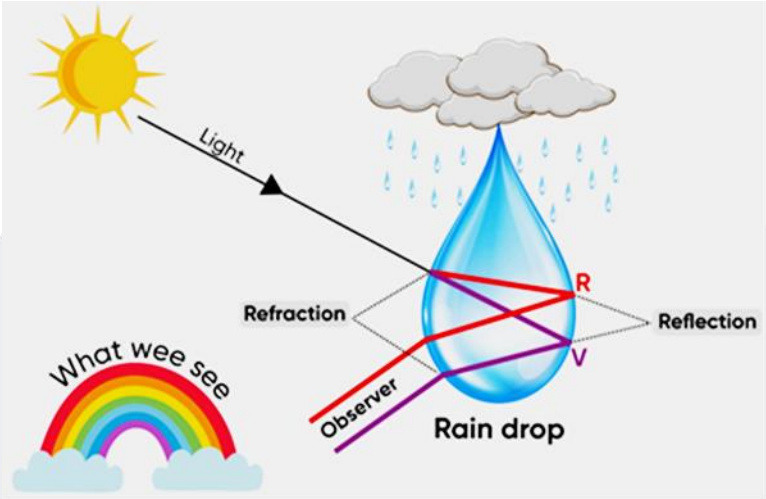
Dispersion of White Light: Rainbow Formation

Rainbow

A rainbow is a natural spectrum appearing in the sky after a rain shower.It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formedin a direction opposite to that of the Sun.



The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally and finally, refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye. A rainbow can alsobe seen on a sunny day by looking at the skythrough a waterfall or through a water fountain, with the Sun behind you.



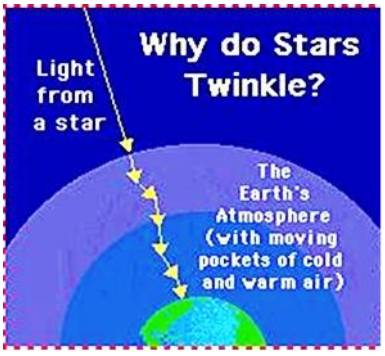
Atmospheric Refraction

The Earth's atmosphere is not uniform throughout, its density goes n changing as we move up or down. It can be considered to be consisting of layers of different densities, which act as rarer or denser medium with respect to each other. Due to this, when the light rays pass through the earth's atmosphere,they undergo refraction. The refraction of light caused by these layers is called atmospheric refraction.

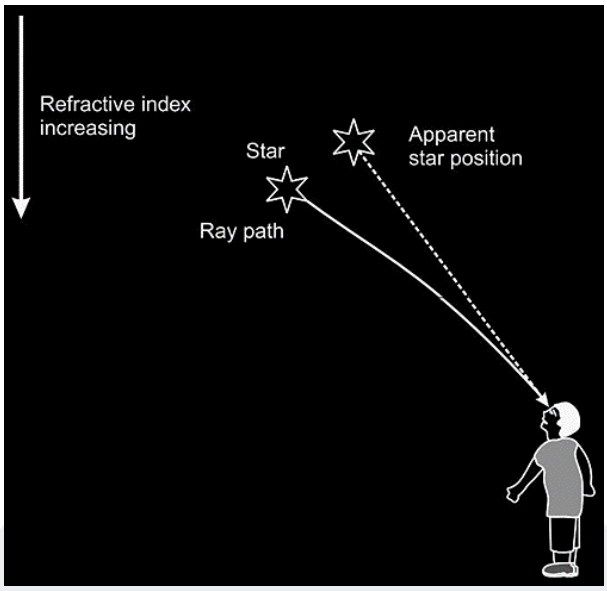
Some Phenomena Based on Atmospheric Refraction

Twinkling of Stars

The twinkling of a star is due to atmospheric refraction of starlight. As the light from the star enters the earth's atmosphere, it undergoes refraction dueto varying optical densities of air at various altitudes.

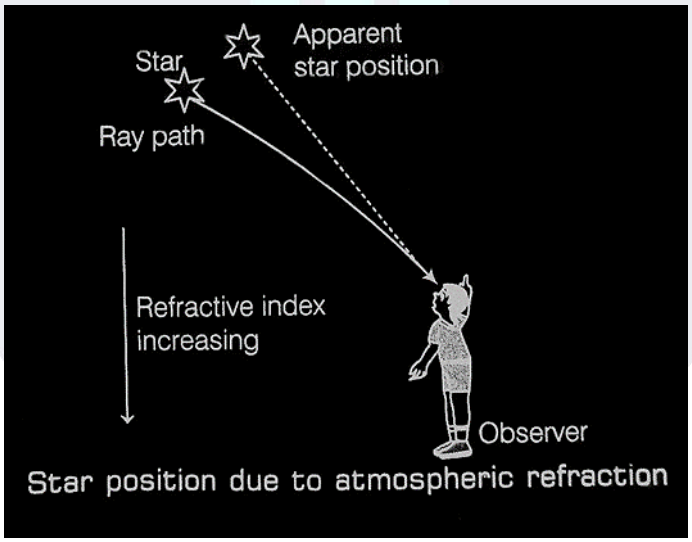


The continuously changing atmosphererefracts the light by different amounts.In this way, the starlight reaching our eyes increases and decreases continuously and the star appears to twinkle at night.



The Stars Seem Higher than They Actually Are

As the light from a star enters the Earth's atmosphere, it undergoes refraction and bends towards the normal each time due tothe atmospheric refraction. Therefore, the apparent position of the star is slightly different from its actual position. The star appears to be slightly higher than its actualposition, when viewed near the horizon.

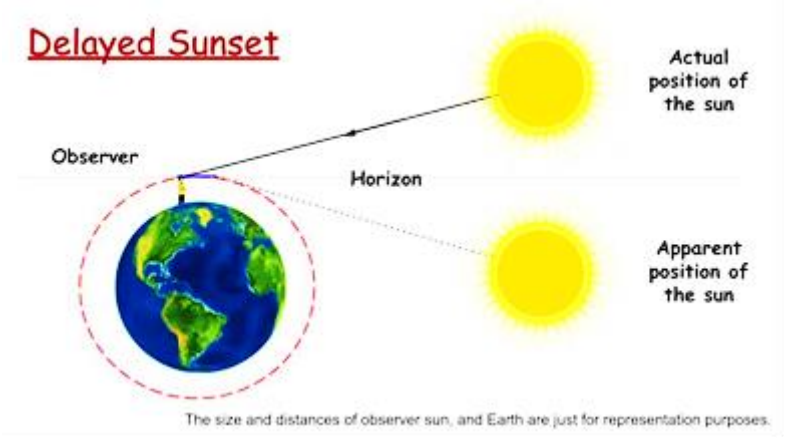


Planets do not Twinkle

As planets are of larger size and much closer tothe earth, then stars they can be considered asa collection of large number of point sized sources of light. The total variation in the amount of light entering our eye from all these individual point sized sources will average out to zero which nullify the twinkling effect of each other. Therefore, planets do not twinkle.

Advance Sunrise and Delayed Sunset

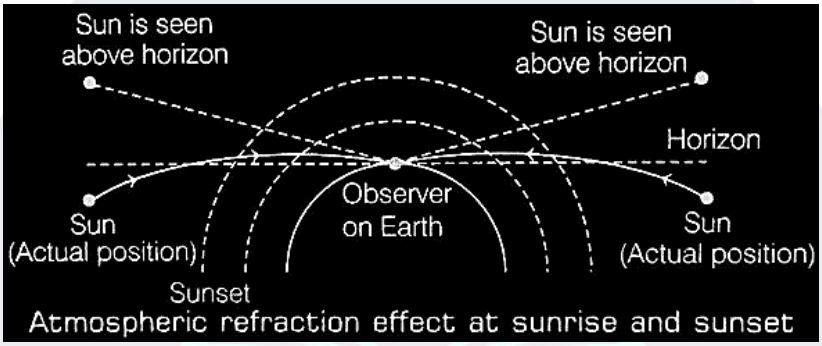
The Sun is visible to us about two minutesbefore the actual sunrise and about two minutes after the actual sunset. This is because of atmospheric refraction. When the Sun is slightly below the horizon, the sunlight coming from the less dense to more dense air, is refracted downwards.



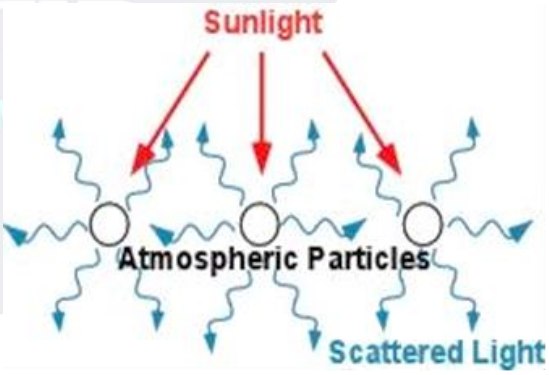
Advance Sunrise and Delayed Sunset

Because of this, the Sun appears to be raised above the horizon and so the Suncan be seen about two minutes before actual sunrise.

Similarly, due to atmospheric refraction, the Sun can be seen for about two minuteseven after the Sun has set below horizon.



Scattering of Light



The reflection of light from an object in all directions is called scattering of light. The colour of scattered light depends on the size ofscattering particles and wavelength of light.

Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelength (red light). If the size of the scattering particles is large enough, thenthe scattered light may even appear white.

The scattering of light is one of the most important phenomena in daily lives. This phenomenon has been seen by everyone from their childhood like the blue colour of the sky, the colour of the rainbow, etc. The scattering of light is completely different from the reflection and refraction of light. In reflection of light, the light goes in a straight line whereas in the scattering of light the light ray gets scattered in different directions by the medium through which it passes.

The process by which small particles are present in the atmosphere causes the scatter in the light which in turn gives rise to optical phenomena such as the blue colour of the sky in which we term as the scattering of light.

Example: When light strikes the particles in the air, the particles absorb some light and radiate the rest in all directions except the incident direction. This is called "scattering of light". The wavelength of the light and the size of the particle which scattered the light assists in determining the strength of the scattering.

Let p be considered as the probability of scattering and λ is the wavelength of radiation, then it is given as:

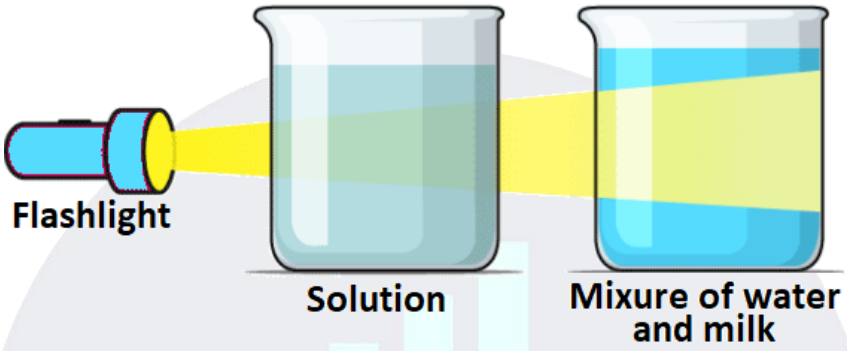
$$P = \frac{1}{\lambda^4}$$

The probability for scattering will give a high rise for shorter wavelength and it is inversely proportional to the fourth power of the wavelength of radiation.

Tyndall Effect

The Tyndall effect is the phenomenon in which the particles in a colloid scatter the beams of light that are directed at them. This effect is exhibited by all colloidal solutions and some very fine suspensions. Therefore, it can be used to verify if a given solution is a colloid. The intensity of scattered light depends on the density of the colloidal particles as well as the frequency of the incident light.

When a beam of light passes through a colloid, the colloidal particles present in the solution do not allow the beam to completely pass through. The light collides with the colloidal particles and is scattered (it deviates from its normal trajectory, which is a straight line). This scattering makes the path of the light beam visible, as illustrated below.



Generally, blue light is scattered to a greater extent when compared to red light. This is because the wavelength of blue light is smaller than that of red light. This is the reason why the smoke released by motorcycles sometimes appears blue.

The Tyndall effect was first discovered by (and is named after) the Irish physicist John Tyndall. The diameters of the particles that cause the Tyndall effect can range from 40 to 900 nanometers (1 nanometer = 10^{-9} meter). In comparison, the wavelength of the visible light spectrum ranges from 400 to 750 nanometers.

A beam of light passing through a true solution is not scattered. The scattering of light when it passesthrough a colloidal solution is called Tyndall effect. The earth's atmosphere is a heterogeneous mixtureof minute particles of smoke, tiny water droplets, suspended particles of dust and molecules of air which becomes visible due to scattering of light.

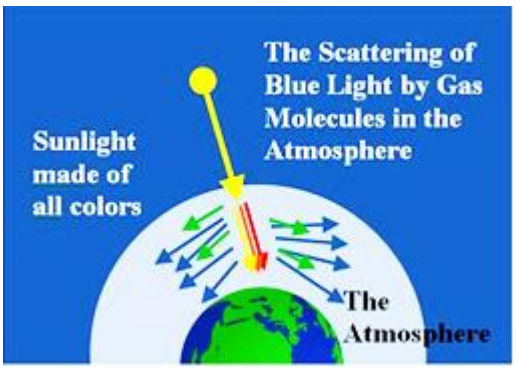
Examples of Tyndall Effect

We get to see Tyndall effect in our surroundings very often, some of the examples are

- When a beam of sunlight enters the dark room through small hole or window then its path become visible due to scattering of light by the dust particles present in the room.
- When a beam of light is projected on a screen from a projector in the cinema hall, it becomes visible.
- When sunlight passes through the canopy of a dense forest it get scattered by tiny water droplets.

The colour of the clear Sky Blue

During the day time, sky appears blue. This is because thesize of the particles in the atmosphere is smaller than the wavelength of visible light, so they scatter the light of shorter wavelengths.



The scattered blue light enters our eye. It should be noted that the sky appears black to the passengers flying at higher altitudes because scattering of light is not prominent at such height due to the absence of particles.

The molecules of air and other fine particles in the atmosphere have smaller size than the wavelength of visible light. These are

more effective in scattering light of shorter wavelengths at the blue end than the light of longer wavelength at the red end. Thus, the blue colour is due to the scattering of sunlight through fine particles in air.

Why does the sky appear dark instead of blue to an astronaut?

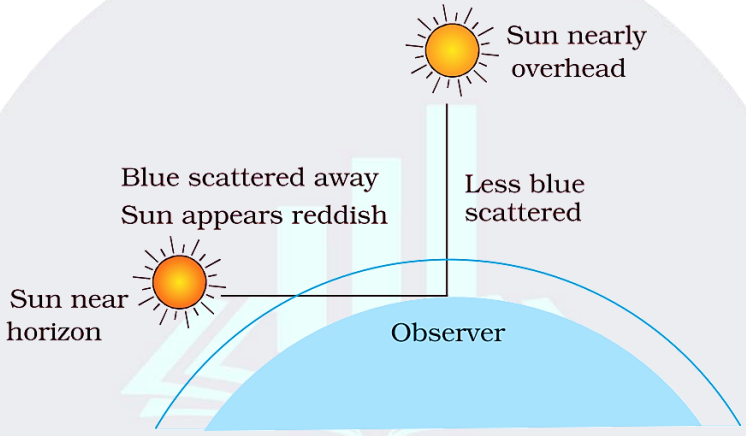
The sky appears dark instead of blue to an astronaut because there is no atmosphere in the outer space that can scatter the sunlight. As the sunlight is not scattered, no scattered light reaches the eyes of the astronauts and the sky appears black to them.

Colour of Sunrise and Sunset

At sunrise and sunset, the Sun and the skyappear red. Light from the S**u**n near the horizon passes through thicker layers of air and covers larger distance in the atmosphere before reaching our eyes.

Near the horizon, most of the blue light and shorter wavelengths light rays are scatteredaway by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun and the sky.

However at the noon, the light from the Sunoverhead would travel relatively shorter distance. So, it appears white as only a littleof the blue and violet colours are scattered.

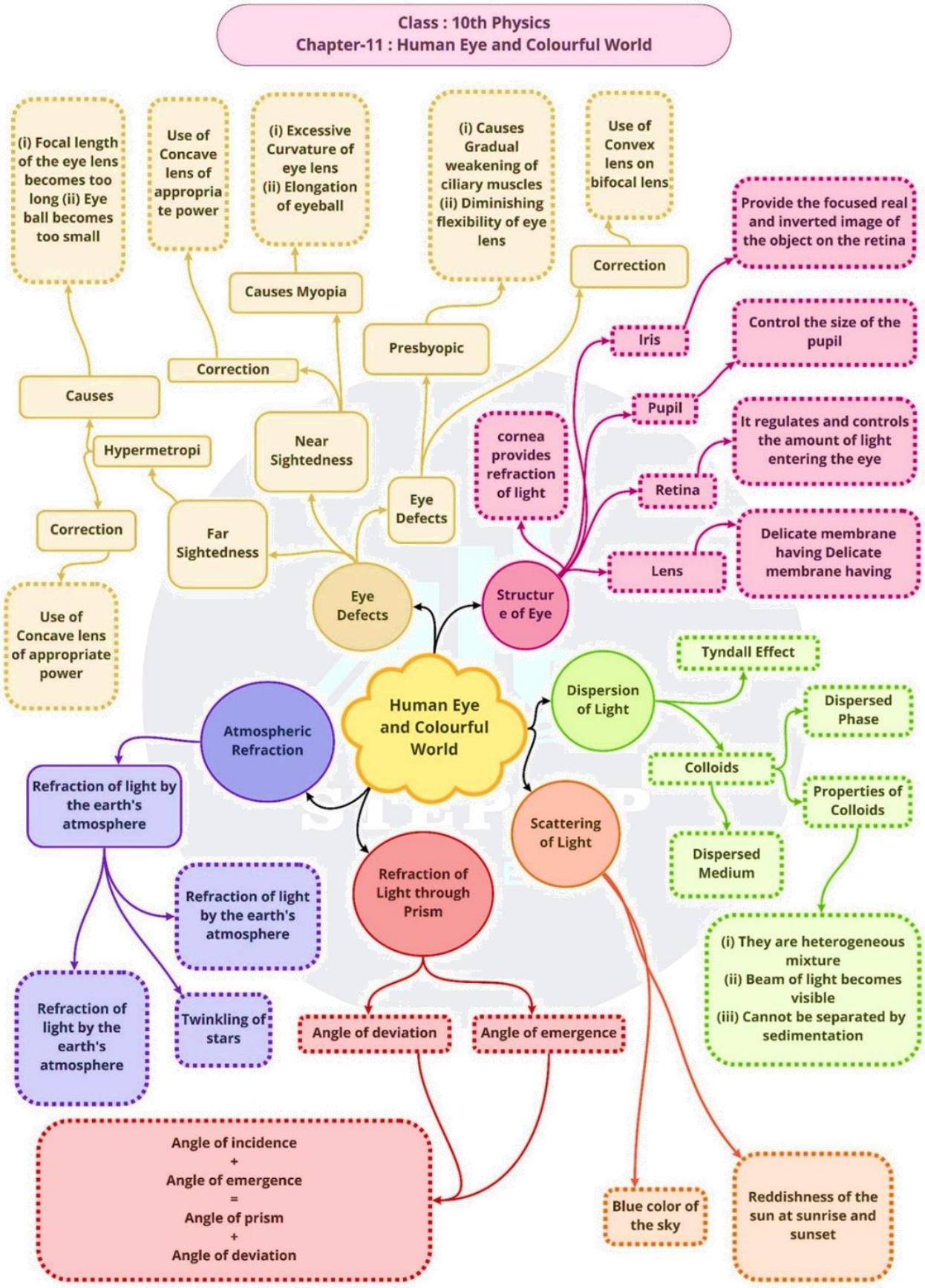


Reddening of the Sun at sunrise and sunset

DO YOU KNOW?

A human being has a horizontal field of view of about 150° with one eye and of about 180° with two eyes. So, two eyes give a wider field of view. The ability to detect faint objects is enhanced with two eyes.

Our eyes are separated by a few centimeters and each eye sees a slightly different image. Our brain combines the two images into one and tells us how close or far away things are. Thus, the two eyes enable to judge the distance more accurately/ keeping both the eyes open provides the third dimension of depth.


Class : 10th Physics
Chapter-11 : Human Eye and Colourful World
Human Eye and Colourful World
Eye Defects
Structure of Eye
Atmospheric Refraction
Dispersion of Light
Scattering of Light
Refraction of Light through Prism
Near Sightedness
Causes Myopia
(i) Excessive Curvature of eye lens (ii) Elongation of eyeball
Use of Concave lens of appropriate power
(i) Focal length of the eye lens becomes too long (ii) Eye ball becomes too small
Causes
Correction
Presbyopic
(i) Causes Gradual weakening of ciliary muscles (ii) Diminishing flexibility of eye lens
Use of Convex lens on bifocal lens
Correction
Far Sightedness
Hypermetropi
Causes
Correction
Use of Concave lens of appropriate power
Iris
Pupil
Retina
Lens
cornea provides refraction of light
Provide the focused real and inverted image of the object on the retina
Control the size of the pupil
It regulates and controls the amount of light entering the eye
Delicate membrane having Delicate membrane having
Tyndall Effect
Dispersed Phase
Colloids
Properties of Colloids
Dispersed Medium
(i) They are heterogeneous mixture (ii) Beam of light becomes visible (iii) Cannot be separated by sedimentation
Blue color of the sky
Reddishness of the sun at sunrise and sunset
Refraction of light by the earth's atmosphere
Refraction of light by the earth's atmosphere
Refraction of light by the earth's atmosphere
Twinkling of stars
Angle of deviation
Angle of emergence
Angle of incidence + Angle of emergence = Angle of prism + Angle of deviation

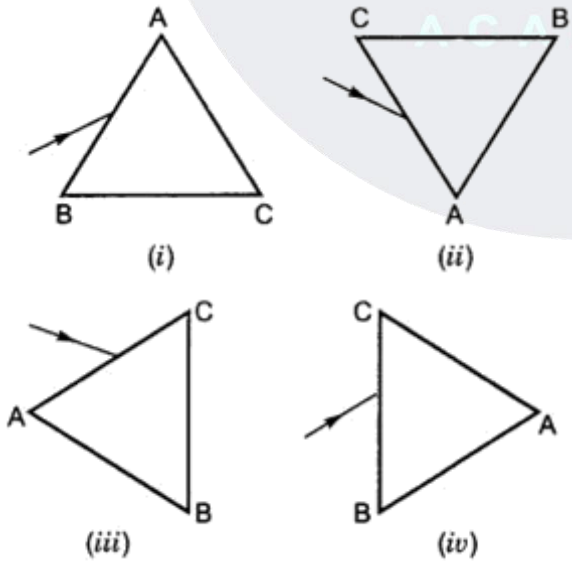
Important Questions

Multiple Choice Questions:

1. A person cannot see distinctly objects kept beyond 2 m. This defect can be corrected by using lens of power
   (a) +0.5 D
   (b) -0.5 D
   (c) +0.2 D
   (d) -0.2 D

2. A student sitting on the last bench can read the letters written on the blackboard but is not able to read / the letters written in his textbook. Which of the following statements is correct?
   (a) The near point of his eyes has receded away.
   (b) The near point of his eyes has come closer to him.
   (c) The far point of his eyes has come closer to him.
   (d) The far point of his eyes has receded away.

3. A prism ABC (with BC as base) is placed in different orientations. A narrow beam of white light is incident on the prism as shown in the Figures given below. In which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?



   (a) (i)
   (b) (ii)
   (c) (iii)
   (d) (iv)

4. At noon the sun appears white as
   (a) light is least scattered.
   (b) all the colours of the white light are scattered away.
   (c) blue colour is scattered the most.
   (d) red colour is scattered the most.

5. Which of the following phenomena of light are involved in the formation of a rainbow?
   (a) Reflection, refraction and dispersion
   (b) Refraction, dispersion and total internal reflection
   (c) Refraction, dispersion and internal reflection
   (d) Dispersion, scattering and total internal reflection

6. Twinkling of stars is due to atmospheric
   (a) dispersion of light by water droplets
   (b) refraction of light by different layers of varying refractive indices
   (c) scattering of light by dust particles
   (d) internal reflection of light by clouds

7. The clear sky appears blue because
   (a) blue light gets absorbed in the atmosphere.
   (b) ultraviolet radiations are absorbed in the atmosphere.
   (c) violet and blue lights get scattered more than lights of all other colours by the atmosphere.
   (d) light of all other colours is scattered more than the violet and blue colour lights by the atmosphere.

8. Which of the following statements is correct regarding the propagation of light of different colours of white light in air?
   (a) Red light moves fastest.
   (b) Blue light moves faster than green light.
   (c) All the colours of the white light move with the same speed.
   (d) Yellow light moves with the mean speed as that of the red and the violet light.

9. The danger signals installed at the top of tall buildings are red in colour. These can be easily seen from a distance because among all other colours, the red light

(a) is scattered the most by smoke or fog.

(b) is scattered the least by smoke or fog.

(c) is absorbed the most by smoke or fog.

(d) moves fastest in air.

10. Which of the following phenomena contributes significantly to the reddish appearance of the sun at sunrise or sunset?

(a) Dispersion of light

(b) Scattering of light

(c) Total internal reflection of light

(d) Reflection of light from the earth

Very Short Question:

1. Name the following part of human eye: A thin membrane through which light enters the eye.
2. Write the function of iris in the human eye.

Or

Mention the name of a structure formed in human eye that controls the size of the pupil.

3. What is the function of pupil in human eye?
4. Name the following part of human eye: A dark muscular diaphragm that controls the size of the pupil.
5. Name the type of lens in human eye.
6. Name the part of human eye that helps in changing the focal length of the eye lens.

Or

Name the part responsible for the power of accommodation of the human eye.

7. Name the ability of eye lens to adjust its focal length.
8. What is the nature of the image formed at the retina of human eye?
9. Name the part of human eye which acts as a screen to obtain the image of an object.
10. Mention the value of near point for normal eye.

Short Questions:

1. When we enter a dim-lit room from a bright light, we are not able to see the object in the room for some time.

Explain, why?

Or

Why does it take some time to see objects in a cinema hall when we just enter the hall from bright sun light? Explain.

2. The ciliary muscles of a normal eye are in their (i) most relaxed (ii) most contracted state. In which of the two cases is the focal length of the eye-lens more?
3. Why do we have two eyes instead of one eye?
4. A convex lens made of glass forms a sharp image on the screen for a particular position of an object with respect to the lens. A human eye lens is also a convex lens but it can form sharp images on the retina of eye for different positions of the objects. Explain, why?
5. How is a normal eye able to see distinctly distant as well as nearer objects? What is the distance of distinct vision?
6. What is short-sightedness? How can this defect be corrected?
7. What is long-sightedness? How can this defect be corrected?
8. What is presbyopia? State the cause of Presbyopia. How is presbyopia of a person be corrected?

Long Questions:

1. Write different parts of eye and explain their functions. Also explain, how an image of an object is formed on the retina of eye.
2. What is short-sightedness? List two causes for development of short-sightedness. Describe with a ray diagram, how this defect may be corrected using spectacles.

Or

What is myopia? State the two causes of myopia with a labelled ray diagram show

(i) the eye defect myopia,

(ii) correction of myopia using lens.

3. What is long-sightedness? List two causes for development of long-sightedness. Describe with a ray diagram, how this defect may be corrected using spectacles.

Or

What is hypermetropia? State the two causes of hypermetropia. With the help of a ray diagram, show (i) the eye defect hypermetropia, (ii) correction of hypermetropia by using a lens.

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

a. Both A and R are true, and R is correct explanation of the assertion.
b. Both A and R are true, but R is not the correct explanation of the assertion.
c. A is true, but R is false.
d. A is false, but R is true.

Assertion: There is no dispersion of light refracted through a rectangular glass slab.

Reason: Dispersion of light is the phenomenon of splitting of a beam of white light into its constituents' colours.

2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

a. Both A and R are true, and R is correct explanation of the assertion.
b. Both A and R are true, but R is not the correct explanation of the assertion.
c. A is true, but R is false.
d. A is false, but R is true.

Assertion: A beam of white light gives a spectrum on passing through a hollow prism.

Reason: Speed of light outside the prism is different as the speed of light inside the prism.

Case study Questions:

1. Read the following and answer any four questions from (i) to (v).

Atmospheric refraction is the phenomenon of bending of light on passing through earth's atmosphere. As we move above the surface of earth, density of air goes on decreasing. Local conditions like temperature etc. also affect the optical density of earth's atmosphere. On account of atmospheric refraction, stars seen appear higher than they actual are advanced sunrise; delayed sunset, oval appearance of the sun at sunrise and sunset; stars twinkle, planets do not.

i. Due to atmospheric refraction, apparent length of the day:
   a. Increases
   b. Decreases
   c. Remains the same
   d. All of these

ii. Apparent position of the star appears raised due to:
   a. Atmospheric refraction.
   b. Scattering of light.
   c. Both (a) and (b).
   d. None of these.

iii. The sun appears oval shaped or flattened due to:
   a. Dispersion.
   b. Scattering.
   c. Atmospheric refraction.
   d. Cannot say.

iv. Twinkling of stars and non-twinkling of planets is accounted for by:
   a. Scattering of light.
   b. Dispersion of light.
   c. Atmospheric refraction.
   d. None of these

v. In absence of atmosphere, the colour of sky appears:
   a. Blue
   b. Black
   c. Red
   d. Yellow

2. Read the following and answer any four questions from (i) to (v).

The spreading of light by the air molecules is called scattering of light. The light having least wavelength scatters more. The sun appears red at sunrise and sunset, appearance of blue sky it is due to the scattering of light. The colour of the scattered light depends on the size of particles. The smaller the molecules in the atmosphere scatter smaller wavelengths of tight. The amount of scattering of light depends on the wavelength of light. When light from sun enters the earth's atmosphere, it gets scattered by the dust particles and air molecules present in the atmosphere. The path of sunlight entering in the dark room through a fine hole is seen because of scattering of the sun light by the dust particles present in its path inside the room.

i. To an astronaut in a spaceship, the colour of earth appears:
   a. Red.
   b. Blue.
   c. White.
   d. Black.

ii. At the time of sunrise and sunset, the light from sun has to travel.
   a. Longest distance of atmosphere.
   b. Shortest distance of atmosphere.
   c. Both (a) and (b).
   d. Can't say.

iii. The colour of sky appears blue, it is due to the:
   a. Refraction of light through the atmosphere.
   b. Dispersion of light by air molecules.
   c. Scattering of light by air molecules.
   d. All of these.

iv. At the time of sunrise and sunset:
   a. Blue colour scattered and red colour reaches our eye.
   b. Red colour scattered and blue colour reaches our eye.
   c. Green and blue scattered and orange reaches our eye.
   d. None of these.

v. The danger signs made red in colour, because:
   a. The red light can be seen from farthest distance.
   b. The scattering of red light is least.
   c. Both (a) and (b).
   d. None of these.

Answer Key

Multiple Choice Answers:

1. (b) -0.5 D
2. (a) The near point of his eyes has receded away.
3. (b) (ii)
4. (a) light is least scattered.
5. (c) Refraction, dispersion and internal reflection
6. (b) refraction of light by different layers of varying refractive indices
7. (c) violet and blue lights get scattered more than lights of all other colours by the atmosphere.
8. (c) All the colours of the white light move with the same speed.
9. (b) is scattered the least by smoke or fog.
10. (b) Scattering of light

Very Short Answers:

1. **Answer**: Cornea.
2. **Answer**: Iris controls the size of the pupil.
3. **Answer**: It controls and regulates the light entering the eye.
4. **Answer**: Iris.
5. **Answer**: Convex lens.
6. **Answer**: Ciliary Muscles.
7. **Answer**: Accommodation.
8. **Answer**: Real and inverted image.
9. **Answer**: Retina.
10. **Answer**: 25 cm.

Short Answers:

1. **Answer**: In a bright light, the iris contracts the pupil of an eye to allow less light to enter the eye. When, we enter the dim-lit room, iris takes time to expand the pupil of an eye to allow more light to enter the eye so that the visible image of the object lying in the room are formed on the retina of the eye.
2. **Answer**: The focal length of eye-lens is more when the ciliary muscles of a normal eye are in their most relaxed state.
3. **Answer**: Two eyes are better than one eye because
   - the field of view with two eyes is more than with one eye.
   - two eyes give three dimensional picture of an object (i.e., the length, breadth and depth or height of an object) whereas one eye gives only two dimensional picture of an object.
4. **Answer**: A convex lens made of glass has a fixed focal length and hence it forms a sharp image on the screen for a particular position of an object. However, the focal length of human eye lens can be changed by the action of ciliary muscles. In other words, human eye lens has the ability to charge its focal length to form sharp images of objects at different positions. The process is known as accommodation of eye.

5. **Answer**: Eye has the ability known as accommodation of eye to see distant as well as nearer objects clearly. When objects is far away, the focal length of lens is increased due to the relaxed ciliary muscles. Hence sharp image of object is formed on the retina of eye. When object is nearer to the eye, the focal length of lens is decreased due to the contraction of ciliary muscles and hence sharp image of the object is formed on the retina of eye. The distance of distinct vision is 25 cm.

6. **Answer**: Short-sightedness or near-sightedness or Myopia

- A human eye is myopic if it can see the near objects clearly but unable to see far off objects or distant objects clearly.

  Causes of Myopia: This defect arises due to either by

- the elongation of the eye ball or
- the excessive curvature of the cornea.

7. **Answer**: A human eye which can see far off objects or distant objects clearly but can not see the near objects clearly is said to be suffered with a defect known as long sightedness or far sightedness or Hypermetropia.

   Causes of Hypermetropia: This defect arises due to either by

- the increase in the focal length of eye lens or
- the size of the eye ball becomes too small so that the light rays from the nearby points or objects are not brought to focus on the retina of the eye.

8. **Answer**: A human eye which cannot see the near objects and distant objects clearly is said to suffer from a defect known as Presbyopia. Eye suffering from Presbyopia cannot read and write comfortably.

   This defect arises due to the aging of a person. The ciliary muscles are weakened and the flexibility of the crystalline lens of the human eye decreases with age of the person. As a result, human eye is unable to focus on close as well as distant objects.

   This defect can be corrected by using a bi-focal lens. A bi-focal lens consists of a concave lens which forms the upper surface of the bi-focal lens and a convex lens which forms the lower surface of the bi-focal lens. The upper surface of bi-focal lens (i.e. the concave lens) enables the person to see distant objects clearly and the lower surface of bi-focal lens {i.e. convex lens) enables the person to see the near objects.

Long Answers:

1. **Answer**:

   The main parts of an eye and their functions are given below:

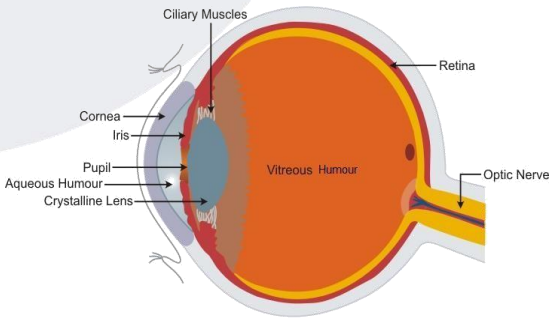
   Cornea is the outermost part of the eye. It is transparent part of eye and allows the light to enter in the eye.

   Iris: It is a circular dark diaphragm having a hole in its centre. This hole is called pupil. The circular dark diaphragm has muscles and coloured pigments. The colour of an eye depends upon the colour of these pigments.

   The function of iris is to control the size of the pupil. On the other hand, pupil controls and regulates the light entering the eye. The pupil becomes small when bright light falls on the eye. However, it becomes wide when there is dim light.

   Lens: The eye lens is a crystalline double convex lens and made of transparent and flexible tissues. It is behind the pupil and held by the muscles called ciliary muscles. It focuses the images of objects on the retina of the eye.

   Ciliary muscles: These muscles hold the eye lens in position. Ciliary muscles controls the focal length of the eye lens. When these muscles contracts, then the lens becomes thick and the focal length of the lens decreases. On the other hand, when ciliary muscles are relaxed, then the lens becomes thin and the focal length of the lens increases.



   Retina: It acts as a light-sensitive screen to obtain the image of the object. It contains number of cells in the form of rods and cones which are sensitive to light. These cells convert light energy into electrical impulses or signals.

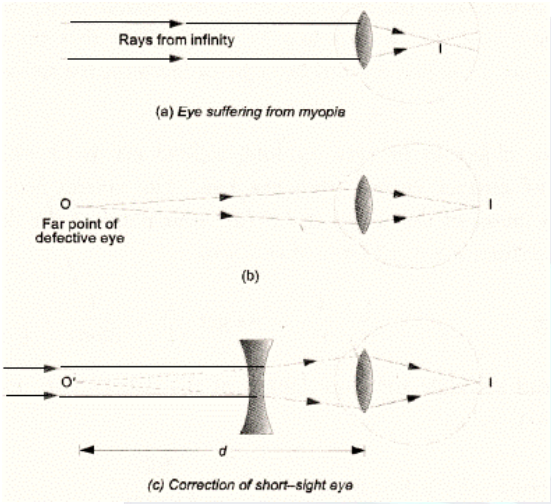
   Optic nerve: Optic nerve is formed by the nerve fibers coming from the retina. It carries nerve or electrical impulses or signals to the brain. The brain finally interprets the signal.

2. **Answer**:

A human eye is myopic if it can see the near objects clearly but unable to see far off objects or distant objects clearly.

Correction of short sightedness or Myopia

The image of a distant object (i.e., at infinity) is formed in front of the retina of eye suffering from myopia as shown in figure 5(a). As the image of the object lying at infinity is not formed on the retina of the eye, so such object cannot be seen clearly by the Myopic eye. The far point of such an eye is near to the eye as shown in figure 5(b).



This defect can be corrected by using a concave lens of suitable focal length (or power). So, a man suffering from this defect wears spectacles having concave lens of suitable focal length. The concave lens used diverges the rays of light entering the eye from infinity. Hence this lens makes the rays of light appear to come from the far point (O') of the defective eye as shown in figure 5(c).

Causes of Myopia: This defect arises due to either by:

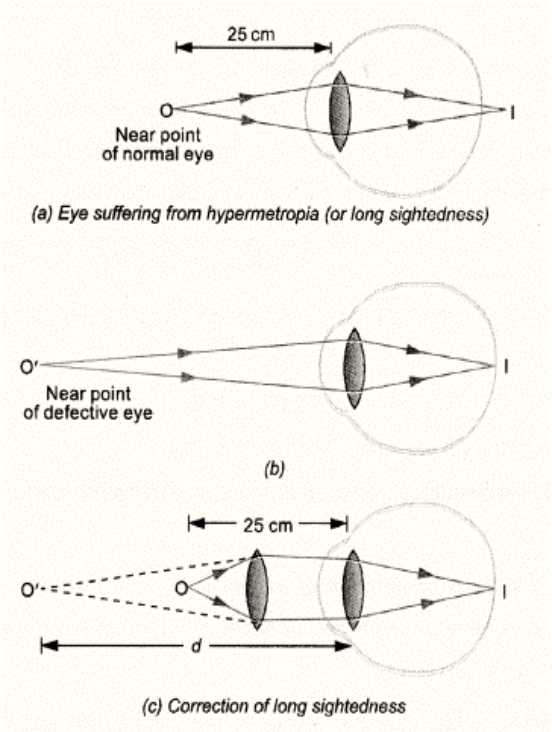
- the elongation of the eye ball or
- the excessive curvature of the cornea.

3. **Answer**:

A human eye which can see far off objects or distant objects clearly but can not see the near objects clearly is said to be suffered with a defect known as long sightedness or far sightedness or Hypermetropia.

Correction of long-sightedness (or Hypermetropia)

The image of a normal near point (which is 25 cm from the eye lens) is formed behind the retina of eye having long-sight defect as shown in figure 4(a). Hence, the image of the normal near point formed on the retina is blurred. The near point of such eye is little far from the near point of normal eye as shown in figure 4(b).



This defect can be corrected by using a convex lens of suitable focal length. So, a man suffering from this defect wears spectacles having convex lens of suitable focal length. The convex lens of spectacles reduces the divergence of rays of light entering the eye. Hence this lens makes the rays of light appear to come from the near point of the defective eye as shown in figure 4(c).

Causes of Hypermetropia: This defect arises due to either by:

- the increase in the focal length of eye lens or
- the size of the eye ball becomes too small so that the light rays from the nearby points or objects are not brought to focus on the retina of the eye.

Assertion Reason Answer:

1. (b) Both A and Rare true, but R is not the correct explanation of the assertion.

Explanation:

After refraction at two parallel faces of a glass slab, a ray of light emerges in a direction parallel to the direction of incidence of white light on the slab. As rays of all colours emerge in same direction, hence there is no dispersion only lateral displacement takes place.

2. (d) A is false, but R is true.

Explanation:

Dispersion of light cannot occur on passing through air contained in a hollow prism. Dispersion takes place because the refractive index of medium for different colours is different.

Case Study Answer:

1. i. (a)increases

Explanation:

Due to atmospheric refraction, apparent length of the day increases by 4 minutes.

ii. (a) Atmospheric refraction.

Explanation:

Apparent position of the star appears raised due to atmospheric refraction.

iii. Atmospheric refraction.

iv. Atmospheric refraction.

Explanation:

Twinkling of stars and non-twinkling of planets is on account of atmospheric refraction.

v. (b) Black

Explanation:

Due to no scattering of light.

2. i. (b) Blue.

Explanation:

Light is scattered by the air molecules present in atmosphere.

ii. (a) Longest distance of atmosphere.

Explanation:

As the distance between us and sun is more at the time of sunrise and sunset.

iii. (c) Scattering of light by air molecules.

Explanation:

Due to the more scattering of blue colour by molecules of air.

iv. (a) Blue colour scattered, and red colour reaches our eye.

Explanation:

Red light being of largest wavelength blue scatter more, red scattered least.

v. (c) Both (a) and (b).

Explanation:

Scattering is least but velocity of red light is more.

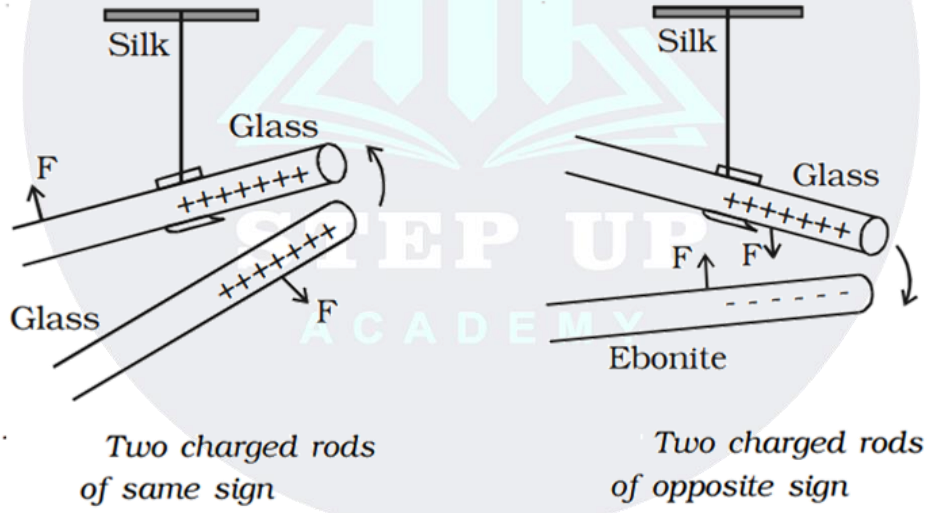
Electricity 3

A. **Electricity.** The branch of electricity was originated from the Greek words "Electrica" and "Elektron". Originally, it was a Greek philosopher named Thales who observed the attracting capacity of certain materials when rubbed on other materials. It was Gilbert who classified these materials under two heads Vitreous and Resinous. They are named later as positive and negative charge.

B. **Frictional Electricity.** When glass rod is rubbed on silk cloth, the charge acquired by glass rod is called positive and that by silk cloth is negative. When ebonite rod is rubbed with fur, the ebonite rod acquires negative charge while fur acquires positive charge. The following series of elements will give an idea about acquired charge :

Fur, flannel, Wax, Glass, Cotton, Paper, Silk, Human skin, Wood, Metals, Rubber, Resin, Amber, Sulphur, Ebonite.

When any two materials in this series are taken and rubbed with each other, the element occurring first in series will acquire positive charge while the element occurring later acquires negative charge.



C. **Fundamental Laws of Electrostatics.**

(i) There are two kinds of charges namely positive and negative.

(ii) Like charges repel each other and unlike charges attract each other.

D. **Coulomb's Law.** The electrostatic force of attraction or repulsion between a pair of charges is directly proportional to the product of the charges and inversely proportional to the square of the separation between them.

$$F \alpha \frac{q_1 q_2}{r^2} \text{ (or) } F = \frac{K q_1 q_2}{r^2}$$

Where K, the constant of proportionality has a value of 9×10^9 Nm^2/C^2 for free space.

This force acts along the line joining the two charges. If the charges are similar, then there will be repulsion and so force will be positive. If the charges are dissimilar, there will be attractive force and so the force will be negative.

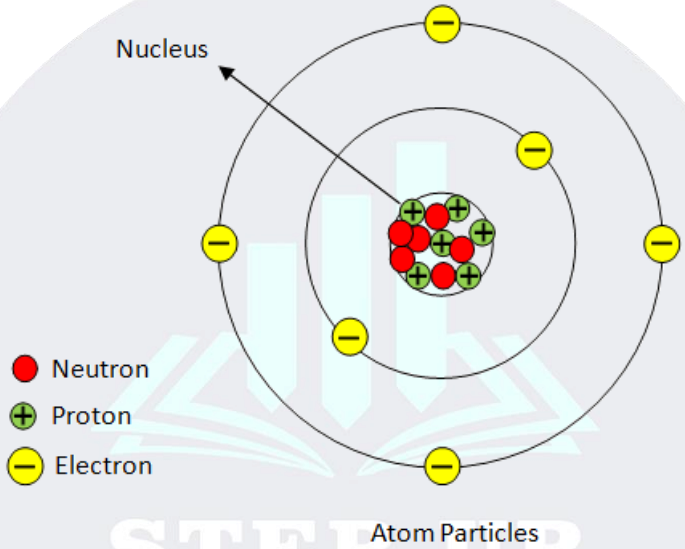
E. **Charge Conservation.** When a glass rod is rubbed on silk, we say that the glass rod acquires positive charge. But it is not created. The negative charges from glass rod are shifted to silk leaving a net positive charge on glass rod.

The net charge in them remains the same. So charges are not created or destroyed but can be transferred from one to another or remain conserved.

F. **Difference between Charge and Mass.**

Mass	Charge
1. Always remains positive. 2. Gravitation force of attraction exists between them. 3. Expressed in kilogram.	1. Can be negative or neutral also. 2. Electric force of attraction or repulsion. 3. Expressed in coulomb.

1. **Atom.** In general, atom is neutral. Any atom consists of a positively charged nucleus having protons and neutrons and negatively charged electrons moving around in circular orbits.



2. **Charge.** Electrons have a negative charge of 1.6×10^{-19} C, while protons have an equal positive charge of 1.6×10^{-19} C.

3. **Insulators.** Insulators do not conduct charges, they can be charged easily by friction. The charges remain localised in them.

4. **Conductors.** Substances in which charges can flow freely are called conductors while an insulator is one in which free motion is not possible.

5. **Charge Motion.** When charges move freely, it is said to constitute current. Charge motion can be possible only when we have energy sources. The conditions essential for the current flow are,

(i) the presence of a closed path and (ii) the presence of a source of energy.

Electric Current

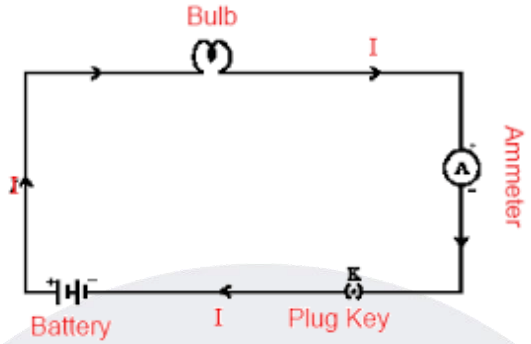
- **Electric current** is expressed as the amount of charge flowing through a particular area in unit time.
- Quantitatively, **electric current** is defined as the rate of flow of electric charge.

$$\text{Current, I} = \frac{\text{Charge flowing (Q)}}{\text{Time taken (t)}}$$

- The S.I. unit of current is **ampere (A)**, where 1 ampere = 1 coulomb/second.
- $1\ \text{mA} = 10^{-3}\ \text{A}, \quad 1\ \mu\text{A} = 10^{-6}\ \text{A}$
- The conventional direction of electric current is the one in which positive charges move orderly.
- An instrument called ammeter measures electric current in a circuit. It is always connected in series in a circuit through which the current is to be measured.

Electric circuit and circuit diagram

The electric circuits are closed loop or path which forms a network of electrical components, where electrons are able to flow. This path is made using electrical wires and is powered by a source, like a battery. The start of the point from where the electrons start flowing is called the source whereas the point where electrons leave the electrical circuit is called the return. Representation of an electric circuit through symbols is called a circuit diagram.



A schematic diagram of an electric circuit comprising – cell, electric bulb, ammeter and plug key

Example: A current of 1A is drawn by a filament of an electric bulb for 20 minutes. Find the amount of electric charge that flows through the circuit.

Ans: The given data is,

I = 1A and

t = 20 minutes

t = 20 × 60

t = 1200 seconds

Therefore,

$$I = \frac{Q}{t}$$

Electric charge is $q = It$

$q = 1 \times 1200$

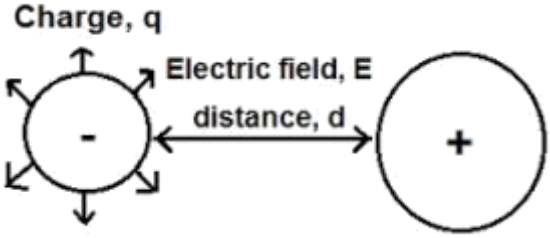
$q = 1200$ C

Coulomb's Law

According to Coulomb's law, the force of attraction or repulsion between two charged bodies is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. It acts along the line joining the two charges considered to be point charges. $F \propto \frac{q_1 q_2}{d^2}$

Electric Potential

Electric potential is the work done per unit charge in bringing the charge from infinity to that point against electrostatic force. In a conductor, electrons flow only when there is a difference in electric pressure at its ends. This is also called potential difference.



Electric Potential Difference

- Electric potential difference (pd) between two points in an electric circuit, carrying some current, is the amount of work done to move a unit charge from one point to another.

$$\text{Potential difference (pd)} = \frac{\text{Work done (W)}}{\text{Quanity of charge moved (Q)}}$$

- The S.I. unit of pd is **volt (V)**, where 1 volt $= \frac{1 \text{ joule}}{1 \text{coulomb}}$

Example: How much work is done in moving a charge of 2 C across two points having a potential difference 12 V?

Ans: The amount of charge Q, that flows between two points at potential difference V (= 12 V) is 2 C. Thus, the amount of work W, done in moving the charge [from Eq. (12.2)] is

W = VQ

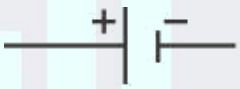
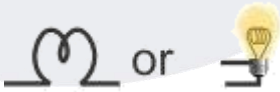
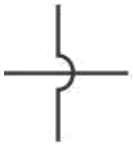
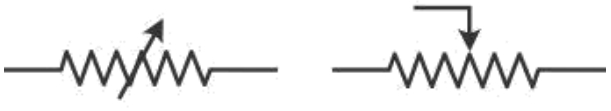
= 12 V × 2 C

= 24 J.

Electric Circuit

- A continuous conducting path between the terminals of a source of electricity is called an **electric circuit.**
- A drawing showing the way various electric devices are connected in a circuit is called a **circuit diagram**.

Some commonly used circuit elements are given below:

Sr. No.	Element	Symbol
1	An electric cell	
2	A battery	
3	Plug key or switch (open)	
4	Plug key or switch (closed)	
5	A wire joint	
6	Bulb	
7	Wires crossing without joining	
8	Resistor	
9	Variable resistor or Rheostat	

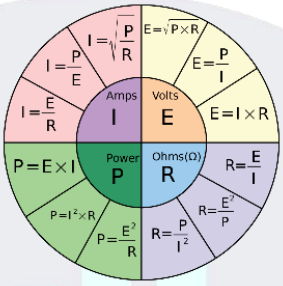
10	Ammeter	
11	Voltmeter	

Ohm's law

- According to Ohm's law, the current (I) flowing through a conductor is directly proportional to the potential difference (V) across its ends, provided its physical conditions remain the same.

$$V \propto I$$

$$\frac{V}{I} = Constant$$



$$\frac{V}{I} = R$$

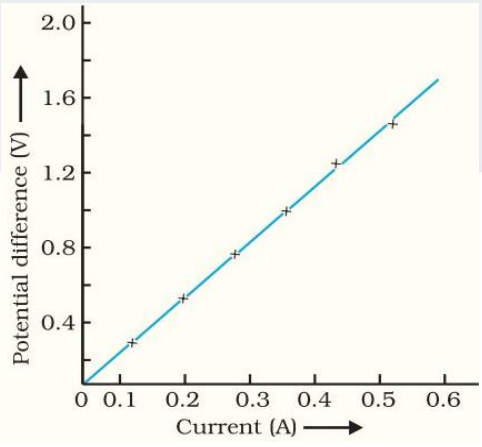
$$V = IR$$

where R is a constant of proportionality called **resistance** of the conductor.

- **Resistance** is the property of a conductor to resist the flow of charges through it.
- The S.I. unit of resistance is **ohm (Ω).**

$$\text{From } R \propto \frac{V}{l} \; 1 \text{ ohm} = 1 \frac{volt}{ampere}$$

Potential difference across the two points of a metallic conductor is directly proportional to current passing through the circuit provided that temperature remains constant.

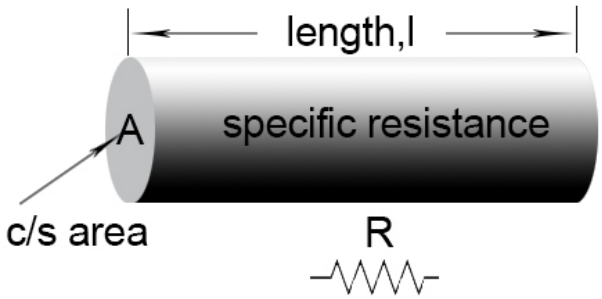


V–I graph for a nichrome wire. A straight line plot shows that as the current through a wire increases, the potential difference across the wire increases linearly – this is Ohm's law.

Factors Affecting Resistance

A conducting wire's resistance is determined by:

a) Nature of the material of the wire [Resistivity (Ω)]



b) Length of the wire (l)

c) Cross-sectional area of the wire (A)

Factors on which the Resistance of a Conductor depends

Resistance of a uniform metallic conductor is:

a) directly proportional to the length of conductor,

b) inversely proportional to the area of cross-section,

c) directly proportional to the temperature and

d) depend on nature of material.

Resistivity

- The resistance of a conductor is directly proportional to its length (l) and inversely proportional to its area of cross section (A).

$$R \propto \frac{l}{A}$$

$$R = \rho \frac{l}{A}$$

where ρ is a constant of proportionality called **specific resistance** or **resistivity** of the material of the conductor.

- The S.I. unit of resistivity is **ohm metre (Ω m).**
- Resistivity does not change with change in length or area of cross-section but it changes with change in temperature.
- Range of resistivity of metals and alloys is 10-8 to 10-6 Ωm.
- Range of resistivity of insulators is 1012 to 1017 Ωm.
- Resistivity of alloy is generally higher than that of its constituent metals.
- Alloys do not oxidize (burn) readily at high temperature, so they are commonly used in electrical heating devices.
- Copper and aluminum are used for electrical transmission lines as they have low resistivity.

Semiconductors and Superconductors

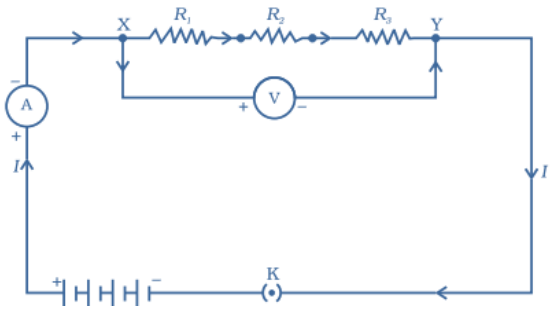
- **Semiconductors** are materials with resistivity that fall between those of an insulator and a conductor.
- Materials which lose their resistivity at low temperatures are called **super conductors**.

Combination of Resistances

Resistances in Series

- The current flowing through each resistance is the same.
- The potential difference across the ends of the series combination is distributed across the resistances.

- The equivalent resistance (R_s) of a series combination containing resistances R_1, R_2, R_3... is **$R_s + R_1 + R_2 + R_3 + ...$**
- The equivalent resistance is greater than the greatest resistance in the combination.



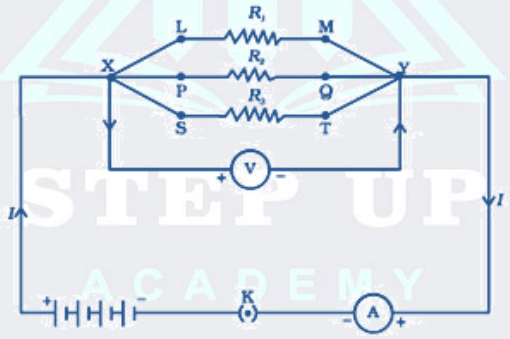
$I_1 = I_2 = I_3$

$V_T = V_1 + V_2 + V_3$

and, $R_T = R_1 + R_2 + R_3$

Resistances in Parallel

- The potential difference across each resistance is the same and is equal to the potential difference across the combination.
- The main current divides itself, and a different current flows through each resistance.
- The equivalent resistance (R_p) of a parallel combination containing resistances R_1, R_2, R_3... is given by $\frac{1}{R_\rho} =$ $\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} ... =$
- The equivalent resistance is lesser than the least of all the resistances in the combination.



Advantages of Parallel Combination over Series Combination

- In series circuit, when one component fails, the circuit is broken and none of the component works.
- Different appliances have different requirement of current. This cannot be satisfied in series as current remains same.
- The total resistance in a parallel circuit is decreased.

Heating Effect of Electric Current

- The effect of electric current due to which heat is produced in a conductor, when current passes through it, is called the heating effect of electric current.
- The total work (W) done by the current in an electric circuit is called **electric energy** and is given as

$$W = VIt = I^2Rt$$

$$W = \frac{V^2t}{R}$$

This energy is exhibited as heat. Thus, we have $H = VIt = I^2Rt$.

This is called **Joule's Law of Heating**, which states that the heat produced in a resistor is directly proportional to the:

- Square of the current in the resistor, $H \propto I^2$
- Resistance of the resistor $H \propto R$
- Time for which current flows through the conductor, $H \propto t$. So, $H = I^2Rt$
- Heating effect is desirable in devices like electric heater, electric iron, electric bulb, electric fuse, etc.
- Heating effect is undesirable in devices like computers, computer monitors (CRT), TV, refrigerators etc.
- In electric bulb, most of the power consumed by the filament appears a heat and a small part of it is radiated in form of light.

Filament of electric bulb is made up of tungsten because:

- it does not oxidize readily at high temperature.
- it has high melting point (3380º C).

The bulbs are filled with chemically inactive gases like nitrogen and argon to prolong the life of filament.

Practical Applications of the Heating Effects of Electric Current

- Electrical appliances like laundry iron, toaster, oven, kettle and heater are some devices based on Joule's Law of Heating.
- The concept of electric heating is also used to produce light, as in an electric bulb.
- Another application of Joule's Law of Heating is the fuse used in electric circuits.

Electric Fuse

It is a safety device that protects our electrical appliances in case of short circuit or overloading.

- Fuse is made up of pure tin or alloy of copper and tin.
- Fuse is always connected in series with live wire.
- Fuse has low melting point.
- Current capacity of fuse is slightly higher than that of the appliance.s

Electric Power

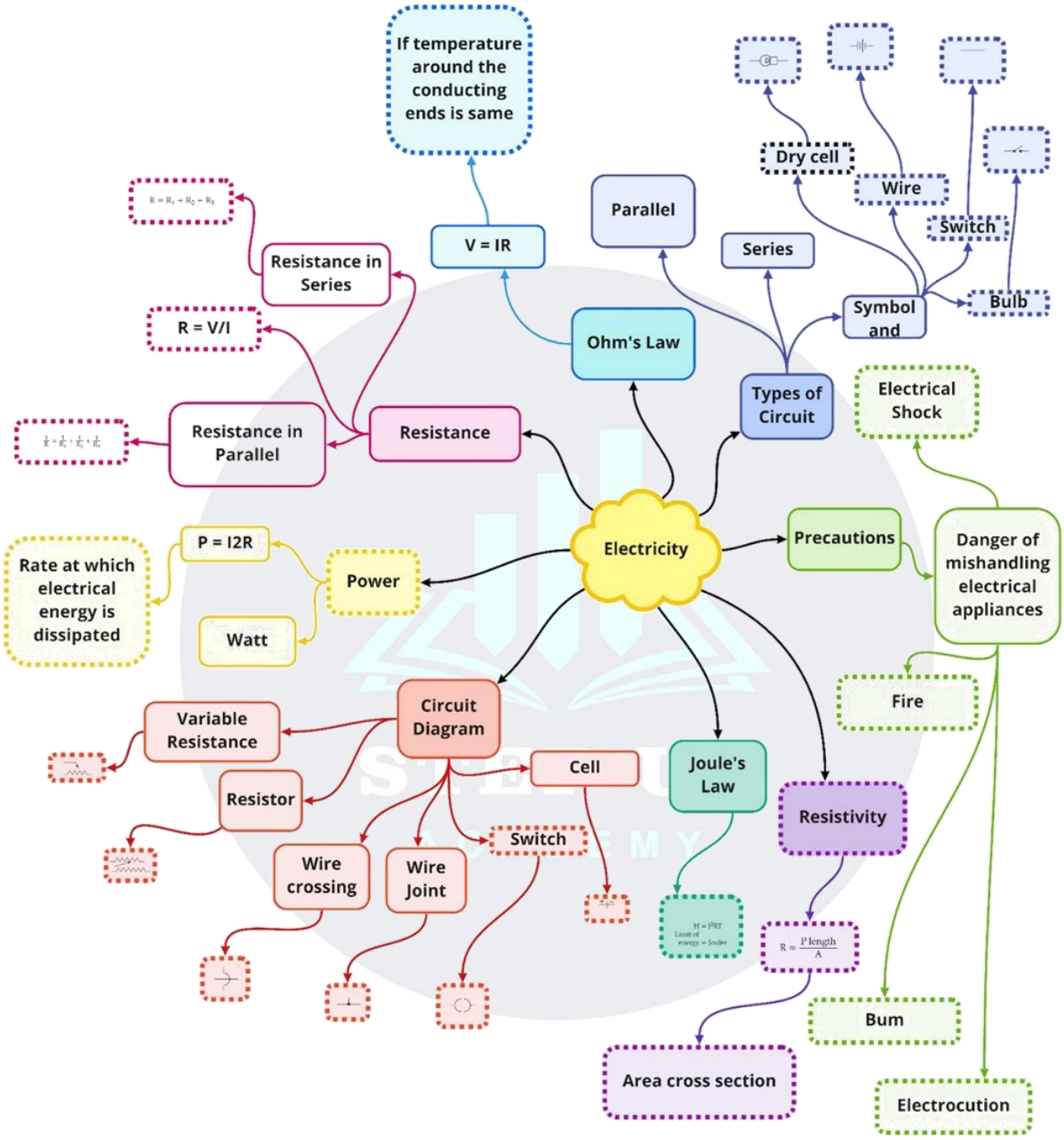
- Electric power is the rate at which electrical energy is produced or consumed in an electric circuit

$$\mathbf{P = VI = I^2R}$$

$$\mathbf{P = \frac{V^2}{R}}$$

- The **S.I. unit** of power is **watt (W).**
- One watt of power is consumed when 1 A of current flows at a potential difference of 1 V. The commercial unit of electric energy is **kilowatt hour (kWh)**, commonly known as a **unit**. **1 kWh = 3.6 MJ**

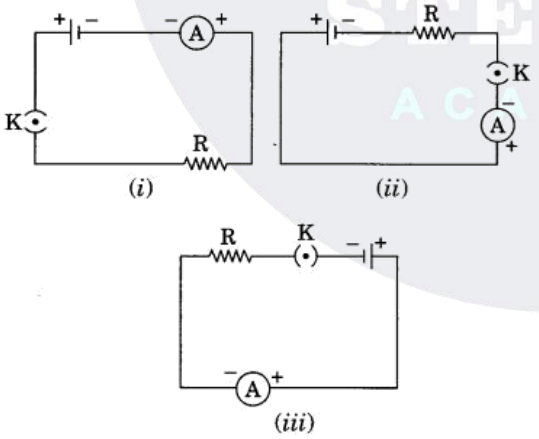
Class : 10th Physics
Chapter-12 : Electricity



Important Questions

Multiple Choice Questions:

1. Which of the following represents voltage?
   (a) $\frac{\text{Work done}}{\text{Current} \times \text{Charge}}$
   (b) Work done × Charge
   (c) $\frac{\text{Work done} \times \text{Time}}{\text{Current}}$
   (d) Work done × Charge × Time
2. Unit of electric power may also be expressed as
   (a) volt ampere
   (b) kilowatt hour
   (c) watt second
   (d) Joule second
3. Electrical resistivity of a given metallic wire depends upon
   (a) its length
   (b) its thickness
   (c) its shape
   (d) nature of the material
4. A cell, a resistor, a key and ammeter are arranged as shown in the circuit diagrams of Figure (i), (ii) and (iii). The current recorded in the ammeter will be



   (a) maximum in (i)
   (b) maximum in (ii)
   (c) maximum in (iii)
   (d) the same in all the cases
5. The unit of e.m.f. of a cell is
   (a) dyne
   (b) volt
   (c) ampere
   (d) joule
6. Kilowatt hour is the unit of
   (a) power
   (b) energy
   (c) impulse
   (d) force
7. 1 kWh is equal to
   (a) 3.6×10^6 MJ
   (b) 3.6×10^5 MJ
   (c) 3.6×10^2 MJ
   (d) 3.6 MJ
8. Materials which allow larger currents to flow through them are called
   (a) insulators
   (b) conductors
   (c) semiconductors
   (d) alloys
9. Conventionally, the direction of the current is taken as
   (a) the direction of flow of negative charge
   (b) the direction of flow of atoms
   (c) the direction of flow of molecules
   (d) the direction of flow of positive charge
10. The unit of specific resistance is
   (a) ohm
   (b) ohm
   (c) ohm-meter
   (d) ohm per meter

Very Short Question:

1. Define electric potential.
2. State the relation between work (W), change (q) and electric potential (V).
3. What is the S.I. unit of electrical potential?
4. Define 1 volt electric potential.
5. Is electric potential a scalar or a vector physical quantity?
6. What is meant by potential difference between two points?
7. Name the instrument used to measure the electric potential difference.
8. Write down the relation between the potential difference between two points A and B in a conductor, work done W in moving a unit charge from point B to A and the charge q.

Or

State the relation between work, charge and potential difference for an electric circuit.

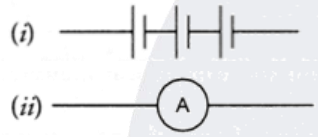
Or

Express work done in an electric field in terms of charge and potential difference.

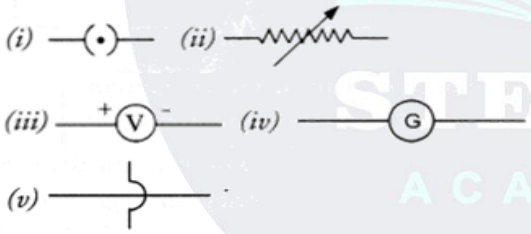
9. Mention the factor that maintains the flow of charge through a conductor.
10. Define electric current.

Short Questions:

1. Define electric current. State and define its SI unit.
2. List two differences between a voltmeter and ammeter.
3. What is an electric circuit? Distinguish between an open and a closed circuit.
4. What do the following symbols represent in a circuit? Write the name and one function of each.



5. What do the following symbols represent in a circuit? Write the name and one function of each?



6. Express Ohm's law both by a mathematical formula and by a graph line.
7. List the factors on which the resistance of a conductor depends. Write the expression to show the relation of resistance with these factors.
8. What is likely to happen and how it would affect the value of resistance if we pass the current for a longer time?

Long Questions:

1. State Ohm's law. How can this law be verified experimentally? Does Ohm's law hold good under all conditions?
2. How will you infer with the help of an experiment that same voltage or potential difference exists across three resistors connected in parallel arrangement to a battery?

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: A current carrying wire should be charged.

   Reason: The current in a wire is due to flow of free electrons in a definite direction.

2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Good conductors of heat are also good conductors of electricity and vice versa.

   Reason: Mainly electrons are responsible for conduction.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   The rate of flow of charge is called electric current. The SJ unit of electric current is Ampere (A). The direction of flow of current is always opposite to the direction of flow of electrons in the current. The electric potential is defined as the amount of work done in bringing a unit positive test charge from infinity to a point in the electric field. The amount of work done in bringing a unit positive test charge from one point to another point in an electric field is defined as potential difference.

$$V_{AB} = V_B - V_A = \frac{W_{BA}}{q}$$

The SJ unit of potential and potential difference is volt.

i. The 2C of charge is flowing through a conductor in 100ms, the current in the circuit is:
   a. 20A
   b. 2A
   c. 0.2A
   d. 0.02A

ii. Which of the following is true?
   a. Current flows from positive terminal of the cell to the negative terminal of the cell outside the cell.
   b. The negative charge moves from lower potential to higher potential.
   c. The direction of flow of current in same as the direction of flow of positive charge.
   d. All of these.

iii. The potential difference between the two terminals of battery, if 100 joules of work is required to transfer 20 coulombs of charge from one terminal of the battery to other is:
   a. 50V
   b. -5V
   c. 0.5V
   d. 500V

iv. The number of electrons flowing per second in a conductor if I A current is passing through it:
   a. 6.25×10^{20}
   b. 6.25×10^{19}
   c. 6.25×10^{18}
   d. 6.25×10^{-19}

v. The voltage can be written as:
   a. Work done × charge × time
   b. $\frac{\text{Work done}}{\text{Current} \times \text{Charge}}$
   c. $\frac{\text{Work done} \times \text{Time}}{\text{Current}}$
   d. Work done × Charge

2. Read the following and answer any four questions from (i) to (v).

The electrical energy consumed by an electrical appliance is given by the product of its power rating and the time for which it is used. The SI unit of electrical energy is Joule. Actually, Joule represents a very small quantity of energy, and therefore it is inconvenient to use where a large quantity of energy is involved. So, for commercial purposes we use a bigger unit of electrical energy which is called kilowatt-hour. 1 kilowatt-hour is equal to 3.6×10^6 joules of electrical energy.

i. The energy dissipated by the heater is E. When the time of operating the heater is doubled, the energy dissipated is:
   a. Doubled
   b. Half
   c. Remains same
   d. Four times

ii. The power of a lamp is 60W. The energy consumed in 1 minute is:
   a. 360J
   b. 36J
   c. 3600J
   d. 3.6J

iii. The electrical refrigerator rated 400W operates 8 hours a day. The cost of electrical energy is ₹ 5 per kWh. Find the cost of running the refrigerator for one day?
   a. ₹ 32
   b. ₹ 16
   c. ₹ 8
   d. ₹ 4

iv. Calculate the energy transformed by a 5A current flowing through a resistor of 2Ω for 30 minutes?
   a. 90kJ
   b. 80kJ
   c. 60kJ
   d. 40kJ

v. Which of the following is correct?
   a. 1 watt h our = 3600J
   b. $1kWh = 36 \times 10^6 J$
   c. Energy (in kWh) = power (in W) × time (ih hr)
   d. Energy (inkWh) = $\frac{V_{(volt)} \times I_{(ampere)} \times t_{(sec)}}{100}$

Answer Key

Multiple Choice Answers:

1. (a)
2. (a) volt ampere
3. (d) nature of the material
4. (d) the same in all the cases
5. (b) volt
6. (b) energy
7. (d) 3.6 MJ
8. (b) conductors
9. (d) the direction of flow of positive charge
10. (c) ohm-meter

Very Short Answers:

1. **Answer**: Electric potential at a point in an electric field is defined as the work done in moving a unit positive charge from infinity to that point in the electric field.
2. **Answer**: V = W/q.
3. **Answer**: volt.
4. **Answer**: Electric potential is said to be 1 volt if 1 Joule of work is done in moving 1 coulomb charge from infinity to a point in the electric field.
5. **Answer**: Electric potential is a scalar physical quantity.
6. **Answer**: Work done per unit charge in moving a unit positive charge from one point to another point in an electric field is called potential difference between two points.
7. **Answer**: Voltmeter.
8. **Answer**: $V_A - V_B = dV = \frac{W}{q}$.

   That is, potential difference = $\frac{\text{Work}}{\text{Charge}}$
9. **Answer**: Potential difference across the ends of the conductor.
10. **Answer**: Electric current is defined as the amount of electric charge flowing through any cross-section of a conductor per unit time.

Short Answers:

1. **Answer**: Electric current is defined as the amount of charge flowing through a cross-section of a conductor in unit time.

   $I = \frac{\text{Charge}}{\text{Time}} = \frac{Q}{t}$.

   SI unit of electric current is ampere (A).

   Electric current through a conductor is said to be 1 ampere if one coulomb charge flows through a cross-section of the conductor in one second.
2. **Answer**:

Ammeter	Voltmeter
1. Ammeter measures electric current in the circuit.	1. Voltmeter measures the potential difference between two points on a conductor.
2. Ammeter is connected in series in an electric circuit.	2. Voltmeter is connected in parallel across the ends of a conductor or resistor.

3. **Answer**: electric circuit:

   An electric circuit is a closed conducting path containing a source of electric energy (i.e., a cell or a battery) and a device or element or load (say, an electric bulb) utilizing the electric energy.

   The direction of electric current is opposite to the direction of the flow of electrons in the conductor.

   Open electric circuit: An electric circuit through which no electric current flows is known as open electric circuit.

   The electric circuit shown in figure 10 (A) will be open circuit if the plug of the key is taken out or if the connecting wire breaks from any point.

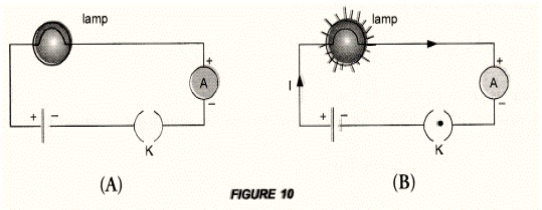


FIGURE 10

   Closed circuit: An electric circuit through which electric current flows continuously is known as closed circuit (Figure 10 (B)).

4. **Answer**:

   (i) It represents a battery. It maintains a potential difference across the circuit element for the flow of current in the circuit.

   (ii) It represents an ammeter. Ammeter is used to measure the electric current in the circuit.

5. **Answer**:

   (i) It represents a closed plug key. It is used to make the closed electric circuit.

   (ii) It represents a variable resistance. It is used to increase or decrease the electric current in the circuit.

   (iii) It represents a voltmeter. It is used to measure the potential difference across a resistor in the circuit.

   (iv) It represents a galvanometer. It is used to detect the presence of small current in the circuit.

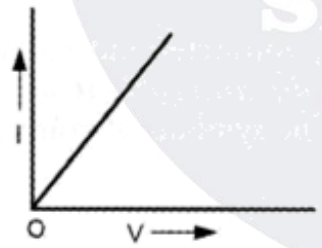
   (v) It represents wire crossing (not connected with each other). The wires are used to connect various components in the circuit.

6. **Answer**:

   Mathematical formula of Ohm's law is

   $$V = IR$$

   For a graph line,



7. **Answer**: Resistance of a factor depends on its length (l) and area of cross section (A).

8. **Answer**: When current passes through a conductor for a longer time, the conductor is heated due to Joule's heating effect. Resistance of conductor increases with increase in temperature due to heating effect.

Long Answers:

1. **Answer**:

   For Ohm's law: Ohm's law states that the electric current flowing through a conductor is directly proportional to the potential difference across the ends of the conductor, provided the temperature and . other physical conditions of the conductor remain the same.

   For experimental verification: Verify Ohm's law

   Apparatus: A conductor of resistance R, an ammeter, a voltmeter, a battery, a variable resistance (or rheostat used to change the current in the circuit), connecting wires, a key and sand paper.

   Procedure:

   Connect the various components as shown in figure 12.

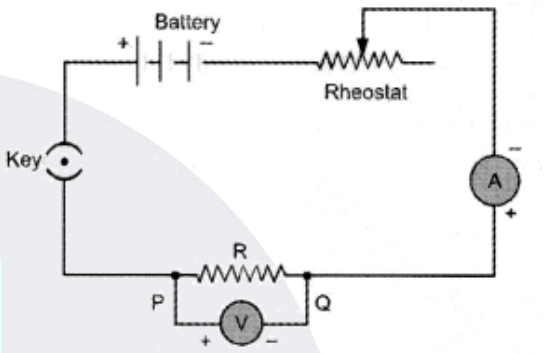


FIGURE 12

- Close the key, so that current begins to flow in the circuit.
- Note down the potential difference (V) across the conductor PQ of resistance R shown by the voltmeter and the corresponding current (I) shown by the ammeter.
- Now move the knob of rheostat so that the current in the circuit increases.
- Again note down the potential difference (V) across the conductor PQ of resistance R in the voltmeter and current in the circuit shown by ammeter.
- Repeat the experiment at least five times by increasing the current in the circuit by moving the knob of the rheostat in steps.

Observations:

S.No.	Potential Difference (V)	Current (I)	V/I
1.			
2.			
3.			
4.			
5.			
6.			
7.			

Plot a graph between V and I by taking V along X-axis and I along Y-axis. We get a straight line passing through origin as shown in figure 11.

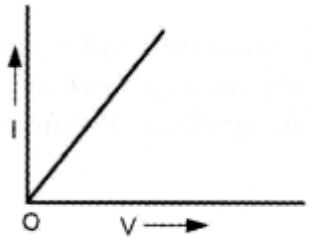


FIGURE 11

Conclusion: From the graph between V and I, we conclude that I x V, which is Ohm's law. Hence Ohm's law is verified experimentally.

Precautions: While verifying Ohm's law experimentally, the following precautions should be taken:

- Current should not be allowed to pass through the circuit continuously for a long time, which may cause the increase in temperature of the conductor. Therefore, the plug of the key must be taken out every time after noting the readings of ammeter and voltmeter.
- Connections should be tight.
- The conductor used in the experiment should be such that its resistance is not changed with increase in temperature of the conductor.

Ohm's law holds good if the temperature of the conductor remains the same.

2. **Answer**:

Perform an activity to investigate the relation between potential difference across parallel combination of resistors and the potential difference across each individual resistors,

- Connect three resistors of resistances R1, R2 and R3 in parallel. One end of each resistor is joined at a common point 'a' and the other end of each resistor is connected at another common point 'b'.
- Connect the parallel combination of resistors with a battery, a plug key K and an ammeter A as shown in figure 22(A).

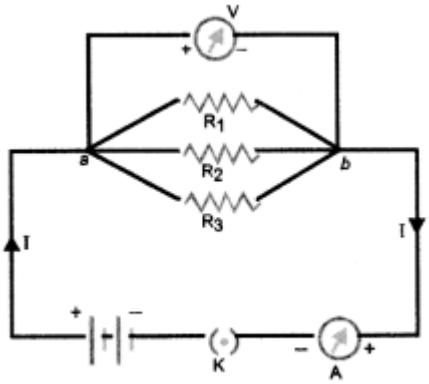


FIGURE 22(A)

- Now connect a voltmeter across the parallel combination of resistors between a and b points.
- Note the reading of voltmeter. Let it be V. This is the potential difference across the parallel combination of resistors.
- Now, disconnect the voltmeter and connect it across R_1 as shown in figure 22(B).

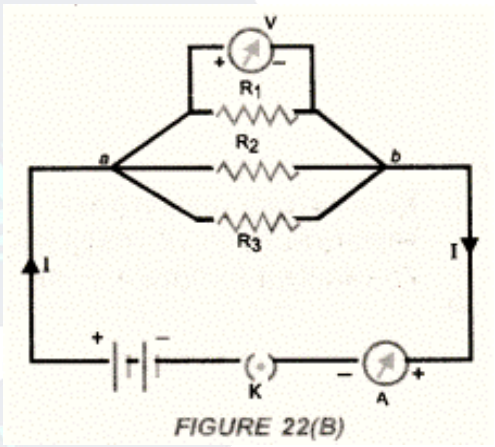


FIGURE 22(B)

- Note the reading of voltmeter. It is found to be V.
- Disconnect the voltmeter and connect it across R_2. Note the reading of voltmeter. It is found to be V.
- Again, disconnect the voltmeter and connect it across R_3. Note the reading of voltmeter. It is found to be V.

Conclusion : When resistors are connected in parallel to each other, potential difference across each resistor is equal to the potential difference across the parallel combination of resistors.

Assertion Reason Answer:

1. (d) A is false, but R is true.

Explanation:

The current in a wire is due to flow of free electrons in a definite direction. But the number

of protons in the wire at any instant is equal to number of electrons, and charge on electrons is equal and opposite to that of proton. Hence, net charge on the wire is zero.

2. (a) Both A and R are true, and R is correct explanation of the assertion.

Explanation:

Metals are good conductors of electricity. It is because of the presence of a large number of free electrons in metals. And for metals, electrons are the main cause for thermal conduction. That's why all good conductors of heat are also good conductors of electricity.

Case study Answer:

1. (i) (a) 20 A

Explanation:

q = 2C.t = 100ms = 0.1s

$$I = \frac{q}{r} = \frac{2}{0.1} = 20A$$

(ii) (d) All of these.

(iii) (b) –5V

Explanation:

W = 100J, q = 20C

$$V = \frac{W}{q} = \frac{100}{20} = 5V$$

(iv) (c) 6.25×10^{18}

Explanation:

I = 1A, t = 1s

q = It = 1 × 1 = 1C

$$n = \frac{q}{e} = \frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$$

(v) (c) $\frac{\text{Work done} \times \text{Time}}{\text{Current}}$

Explanation:

$$V = \frac{W}{q} = \frac{W}{It}$$

2. i. (a) Doubled

Explanation:

$E \propto t$

ii. (c) 3600J

Explanation:

Given: P = 60W, t = 1 min

E = 60 × 1 × 60 = 3600J

iii. (b) ₹ 16

Explanation:

Given: P = 400 Ω , t = 8 hour

E = 400 × 8 = 3200Wh = 3.2kWh.

Cost= 3.2 × 5 = ₹ 16

iv. (a) 90kJ

Explanation:

Given: I = 5A,

R = 2 Ω , t = 30 min

$E = I^2Rt = 5 \times 5 \times 2 \times 30 \times 60$

E = 90000J = 90kJ

v. (a) 1 watt hour = 3600J

Explanation:

1 watt hr = 3600J.

Magnetic Effects of Electric Current 4

Magnet

A magnet is a material that produces a field that attracts or repels other such materials of magnetic nature.

Lodestone (Fe_3O_4) is a naturally occurring magnet. It attracts materials like Iron, Nickel, Cobalt, etc.

A magnet is always bipolar with poles named north and south **poles**. These two poles always exist together and can not be separated. North pole of a magnet is the side which points to Earth's geographic north when it is freely suspended.

Bar magnet: A bar magnet is a rectangular object, composed of iron, steel or any form of a ferromagnetic substance, that shows permanent magnetic properties. It has two different poles, a north and a south pole such that when suspended freely, the north pole aligns itself towards the geographic north pole of the Earth.

Magnetic Field and Field Lines

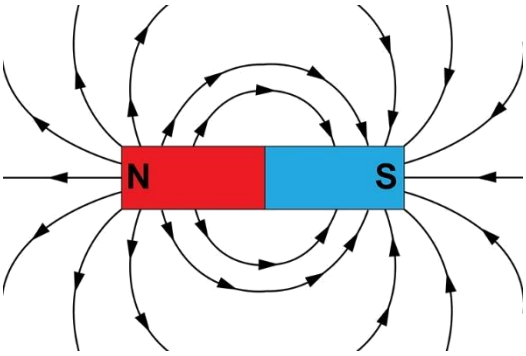
- The space around a magnet in which the force of attraction and repulsion caused by the magnet can be detected is called the **magnetic field**.
- The curved paths along which iron filings arrange themselves due to the force acting on them in the magnetic field of a bar magnet are called **magnetic field lines**.

Iron filings near the bar magnet align themselves along the field lines

- The direction of the magnetic field at any point is obtained by drawing a tangent to the field line at that point.

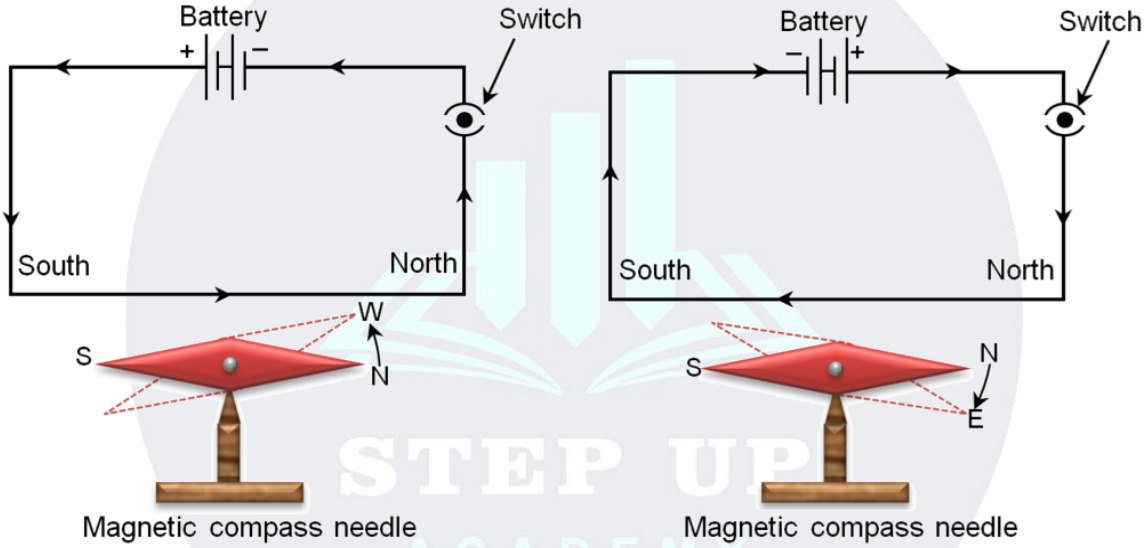
Properties of Magnetic Field Lines

- A magnetic field line is directed from the North Pole to the South Pole outside the magnet.
- A magnetic field line is a closed and continuous curve.
- The magnetic field lines are closer where the magnetic field is strong and farther apart where the magnetic field is weak.
- The magnetic field lines never intersect each other.
- Parallel and equidistant field lines represent a uniform magnetic field.

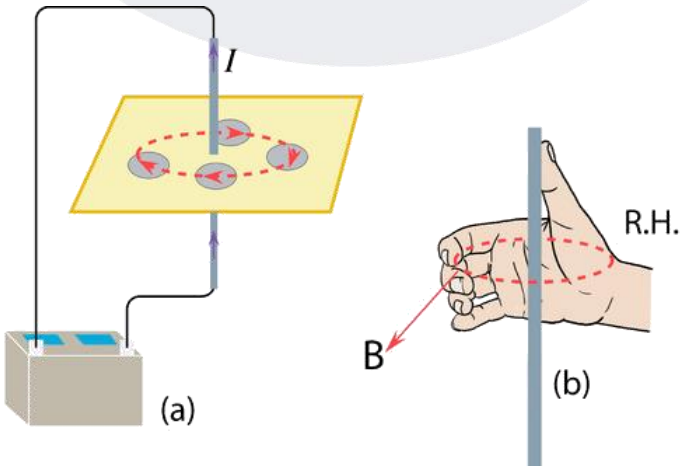


Magnetic Field Due to a Current Carrying Conductor

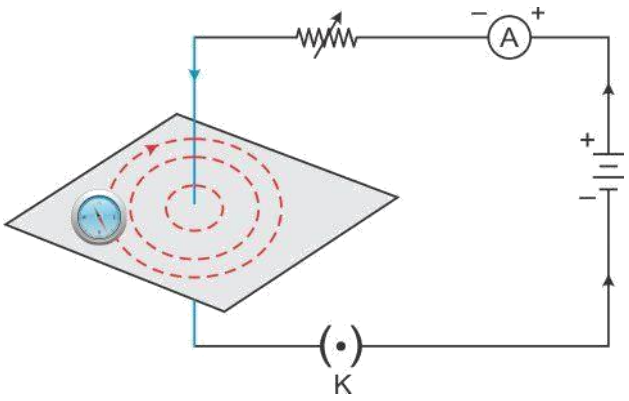
Oersted's experiment: When electric current flows through a current carrying conductor, it produces a magnetic field around it. This can be seen with the help of a magnetic needle which shows deflection. The more the current, the higher the deflection. If the direction of current is reversed, the direction of deflection is also reversed.



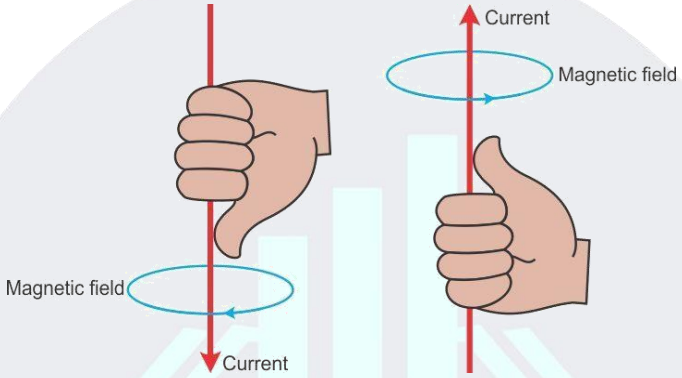
Magnetic Field due to a Straight Current-carrying Conductor



- The magnetic field lines around a straight conductor carrying a current are concentric circles.



- The direction of a magnetic field is given by the **Right-Hand Thumb Rule.**



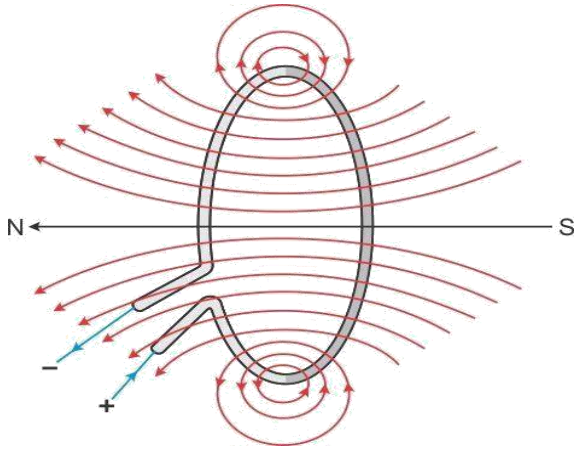
Right-Hand Thumb Rule:

Imagine that you are holding a straight current-carrying conductor in your right hand such that the thumb points towards the direction of the current. Then, your curved fingers wrapped around the conductor point in the direction of the field lines of the magnetic field.

The **magnitude of the magnetic field** due to a straight current-carrying conductor at a given point is

- Directly proportional to the current flowing through the conductor
- Inversely proportional to the distance of that point from the conductor

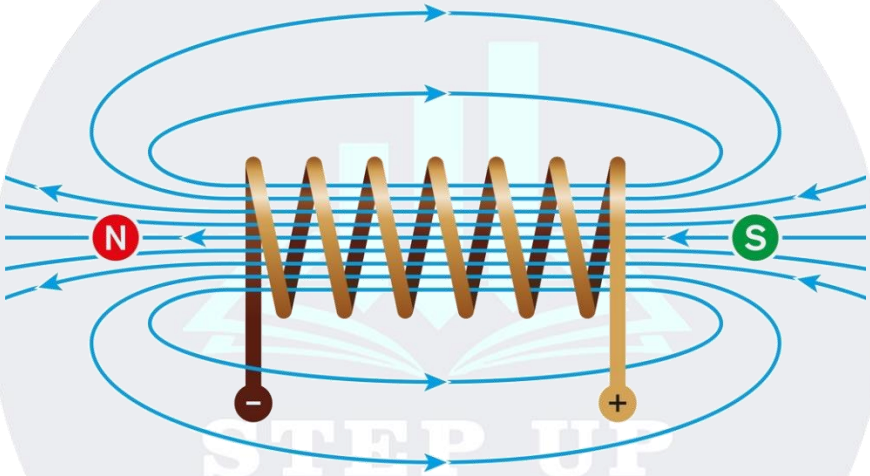
Magnetic Field due to a Current-carrying Circular Coil



- The magnetic field lines near the coil are nearly circular or concentric.
- The magnetic field at the centre of the coil is maximum and almost uniform.
- Looking at the face of a coil, if the current around it is in the clockwise direction, then it faces the South Pole. If the current around it is in the anticlockwise direction, then it faces the North Pole. This is called the **Clock rule.**
- The **magnitude of a magnetic field** at the centre of the coil is
  - Directly proportional to the current flowing through it
  - Inversely proportional to the radius of the coil
  - Directly proportional to the number of turns of the coil

Magnetic Field due to a Current-carrying Solenoid

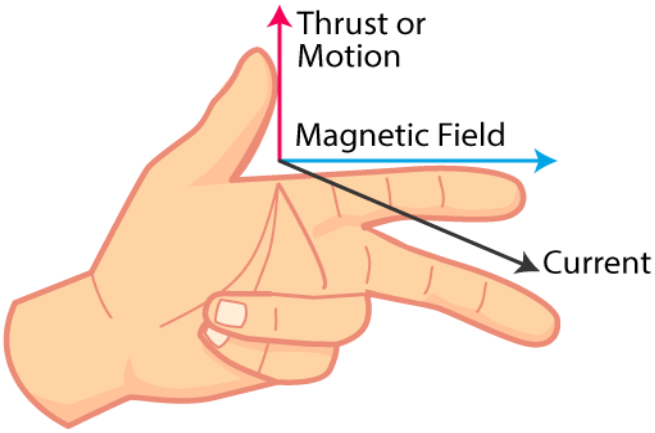
- The pattern of the magnetic field lines around a current-carrying solenoid is similar to that produced by a bar magnet as shown in the figure below.
- The magnetic field inside a solenoid is uniform.



- In accordance with the **Clock rule**, the end of the solenoid at which the current flows in the anticlockwise direction behaves as a North Pole, while the end at which the current flows in the clockwise direction behaves as a South Pole.
- The **magnitude of the magnetic field** inside the solenoid is directly proportional to the
  - Current flowing through it
  - Number of turns per unit length of the solenoid

Force on a Current-carrying Conductor in a Magnetic Field

- A current-carrying conductor when placed in a magnetic field experiences a force.
- The direction of the force gets reversed when the direction of the current is reversed or when the direction of the magnetic field is reversed.
- The force acting on a conductor is found to be maximum when the current and magnetic field are at right angles to each other.
- When the conductor is placed parallel to the magnetic field, no force acts on it.
- **Fleming's Left-Hand Rule** gives the direction of the magnetic force acting on the conductor.



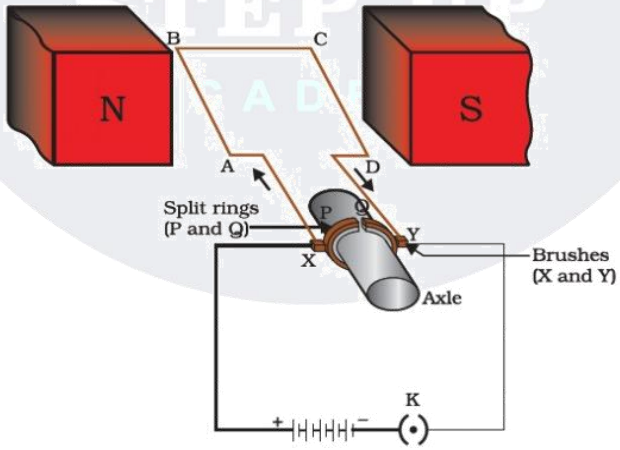
Fleming's Left-Hand Rule:

Stretch the thumb, forefinger and middle finger of the left hand such that they are mutually perpendicular to each other. If the forefinger points in the direction of the field, and the middle finger in the direction of the current, then the thumb gives the direction of motion or the force acting on the conductor.

- The force experienced by a current-carrying conductor in a magnetic field is the underlying principle of an **electric motor** where electric energy is converted into mechanical energy. Such motors are used to run many electrical appliances, including fans, toys etc.

Electric motor

- An electric motor is a rotating device that converts electrical energy to mechanical energy.
- An electric motor consists of a rectangular coil ABCD of insulated copper wire. The coil is placed between the two poles of a magnetic field such that the arm AB and CD are perpendicular to the direction of the magnetic field.



- The ends of the coil are connected to the two halves P and Q of a split ring. The inner sides of these halves are insulated and attached to an axle.
- The external conducting edges of P and Q touch two conducting stationary brushes X and Y, respectively.
- Current in the coil ABCD enters from the source battery through conducting brush X and flows back to the battery through brush Y.
- The force acting on arm AB pushes it downwards while the force acting on arm CD pushes it upwards.
- Thus the coil and the axle O, mounted free to turn about an axis, rotate anti-clockwise.

- At half rotation, Q makes contact with the brush X and P with brush Y. Therefore the current in the coil gets reversed and flows along the path DCBA.
- The split ring acts as a commutator which reverse the direction of current and also reverses the direction of force acting on the two arms AB and CD.
- Thus the arm AB of the coil that was earlier pushed down is now pushed up and the arm CD previously pushed up is now pushed down.
- Therefore the coil and the axle rotate half a turn more in the same direction. The reversing of the current is repeated at each half rotation, giving rise to a continuous rotation of the coil and to the axle.

Commutator: A device that reverses the direction of flow of current through a circuit is called a commutator.

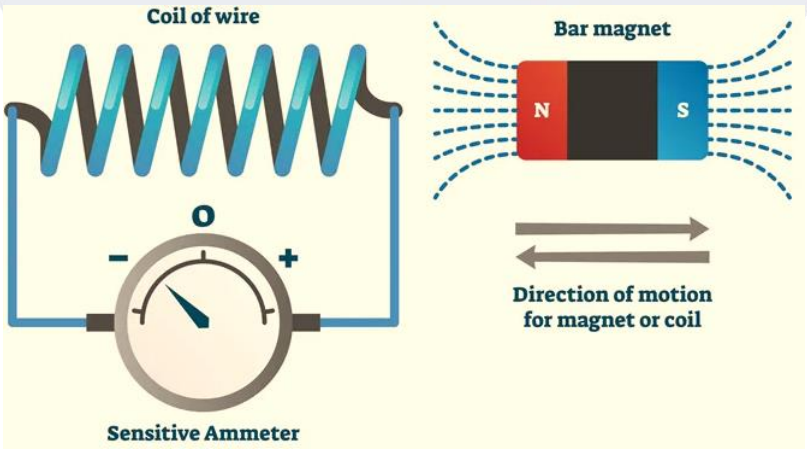
Armature: The soft iron core, on which the coil is wound including the coils is called armature. It enhances the power of the motor.

Electromagnetic Induction (EMI)

- The phenomenon of generating an electric current in a circuit (coil) by changing the magnetic flux linked with it is called **electromagnetic induction**.
- The change in magnetic flux in a coil may be due to the
  - Relative motion between the coil and the magnet placed near it.
  - Relative motion between the coil and a current-carrying conductor placed near it
  - Change of current in the conductor placed near the coil
- This either happens when a conductor is set in a moving magnetic field (when utilizing AC power source) or when a conductor is always moving in a stationary magnetic field.

This law of electromagnetic induction was found by **Michael Faraday**. He organized a leading wire according to the setup given underneath, connected to a gadget to gauge the voltage over the circuit. So when a bar magnet passes through the snaking, the voltage is measured in the circuit. The importance of this is a way of producing electrical energy in a circuit by using magnetic fields and not just batteries anymore. The machines like generators, transformers also the motors work on the principle of electromagnetic induction.

Faraday's law of Electromagnetic Induction



- **First law:** Whenever a conductor is placed in a varying magnetic field, EMF induces and this emf is called an induced emf and if the conductor is a closed circuit than the induced current flows through it.
- **Second law:** The magnitude of the induced EMF is equal to the rate of change of flux linkages.

Based on his experiments we now have Faraday's law of electromagnetic induction according to which the amount of voltage induced in a coil is proportional to the number of turns and the changing magnetic field of the coil.

So now, the induced voltage is as follows:

$$e = N \times d\Phi/dt$$

where,

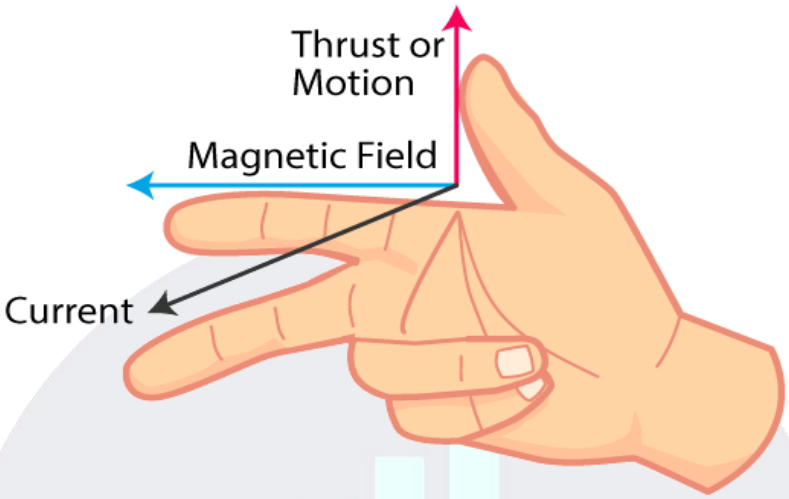
e is the induced voltage

N is the number of turns in the coil

Φ is the magnetic flux

t is the time

Fleming's Right-Hand Rule is used to find the direction of induced current.

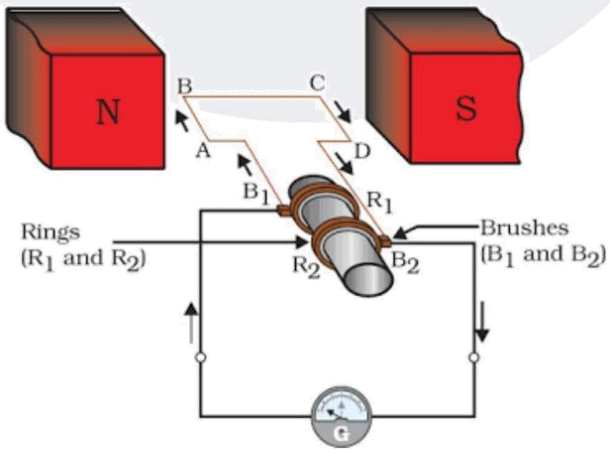


Fleming's Right-Hand Rule:

Stretch the thumb, forefinger and middle finger of the right hand such that they are mutually perpendicular to each other. If the forefinger points in the direction of the field and the thumb in the direction of the motion of the conductor, then the middle finger gives the direction of the induced current in the conductor.

Electric Generator

- An electric generator, mechanical energy is used to rotate a conductor in a magnetic field to produce electricity.
- An electric generator consists of a rotating rectangular coil ABCD placed between the two poles of a permanent magnet.



- The two ends of this coil are connected to the two rings R1 and R2. The inner side of these rings are made insulated.
- The inner side of these rings are made insulated. The two conducting stationary brushes B1 and B2 are kept pressed separately on the rings R1 and R2, respectively.

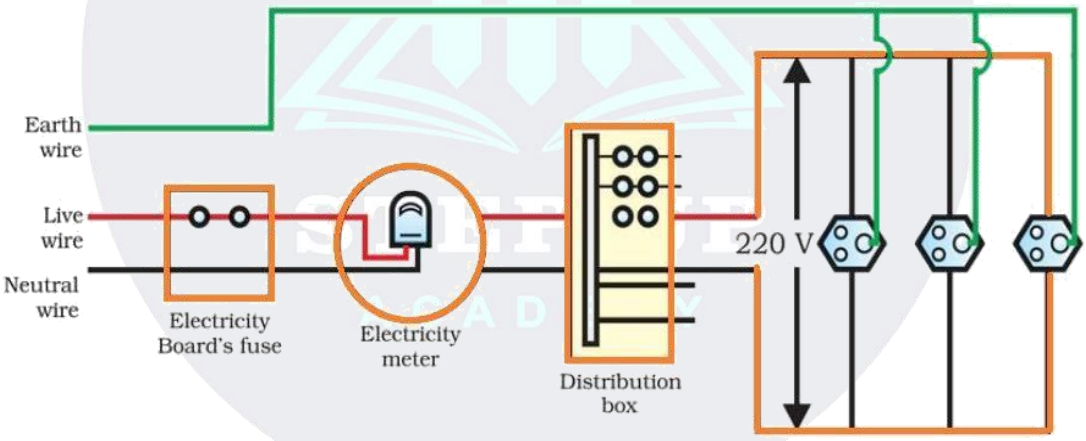
- The two rings R1 and R2 are internally attached to an axle. The axle may be mechanically rotated from outside to rotate the coil inside the magnetic field.
- Outer ends of the two brushes are connected to the galvanometer to show the flow of current in the given external circuit.
- When the axle attached to the two rings is rotated such that the arm AB moves up (and the arm CD moves down) in the magnetic field produced by the permanent magnet.
- After half a rotation, arm CD starts moving up and AB moving down. As a result, the directions of the induced currents in both the arms change, giving rise to the net induced current in the direction DCBA.
- The current in the external circuit now flows from B1 to B2. Thus after every half rotation the polarity of the current in the respective arms changes.

To get a direct current (DC), a split-ring type commutator must be used. With this arrangement, one brush is at all times in contact with the arm moving up in the field, while the other is in contact with the arm moving down.

The direct current always flows in one direction, whereas the alternating current reverses its direction periodically.

Domestic Electric Circuits

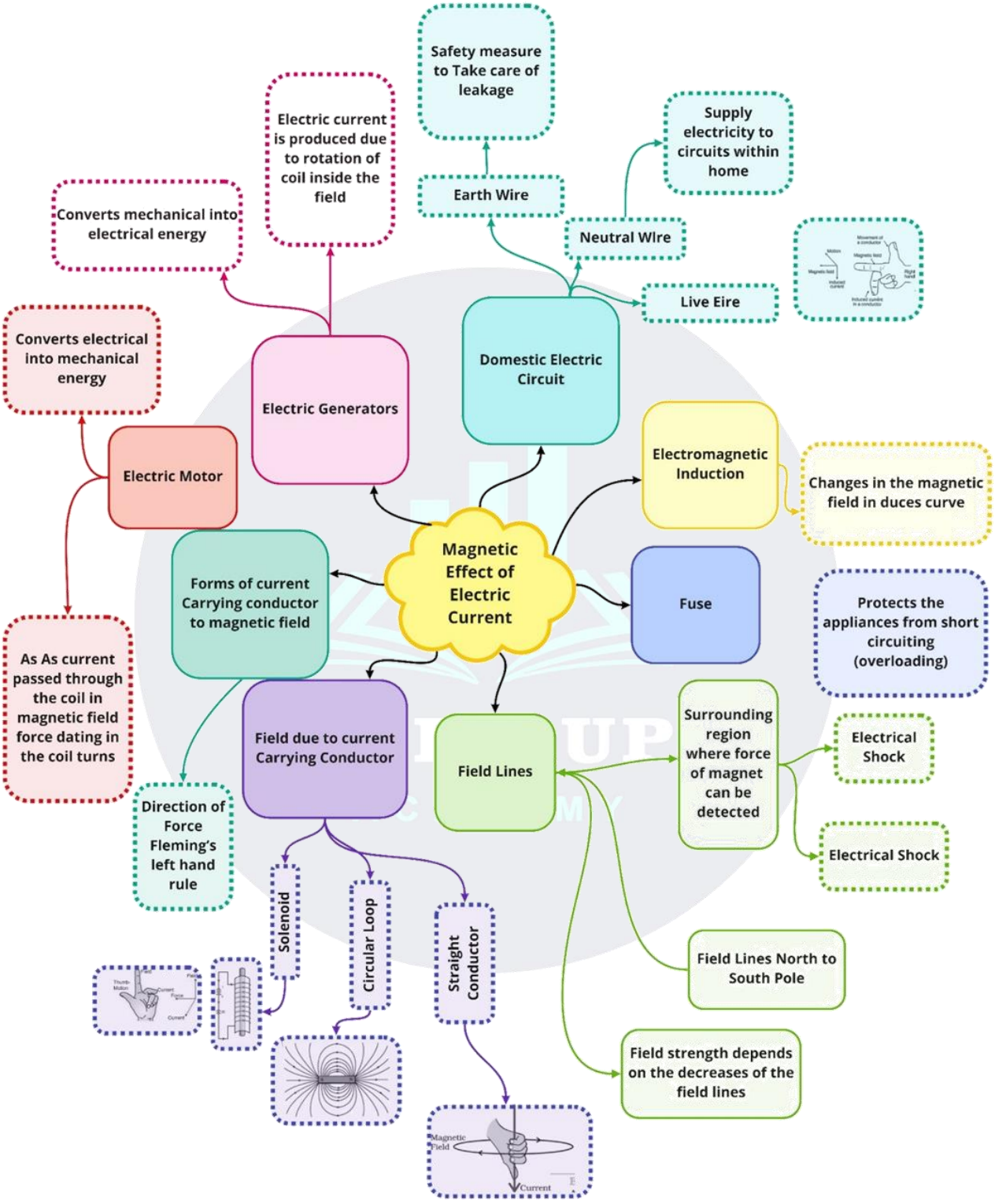
- In our homes, we receive electric power through a main supply called the **mains**. We receive an AC electric power of 220 V with a frequency of 50 Hz.
- One of the wires in the electricity wiring of houses has a red insulation and is called the **live wire**. The other, of black insulation is called the **neutral wire**. The third is the **earth wire** which has green insulation and is connected to a metallic plate deep inside the Earth.



The earth wire in wiring is used as a safety measure to ensure that any leakage of current in the metallic body does not give the user a severe shock.

A **fuse** is an important safety device used to protect circuits and appliances from **short-circuiting** (which occurs when a live wire and a neutral wire come in contact) or **overloading** (which occurs when an electric circuit draws more current than the permitted value).

Class : 10th Physics
Chapter-13 : Magnetic Effect of Electric Current



Important Questions

Multiple Choice Questions:

1. Choose the incorrect statements from the following regarding magnetic lines of field.

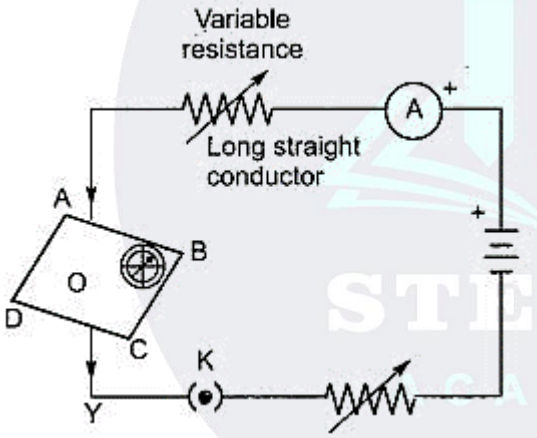
   (a) the direction of magnetic field at a point is taken to be the direction in which the north pole of a magnetic compass needle points

   (b) magnetic field lines are closed curves

   (c) if magnetic field lines are parallel and equidistant, they represent zero field strength

   (d) relative strength of magnetic field is shown by the degree of closeness of the field lines.

2. If the key in the arrangement figure given below is taken out (the circuit is made open) and magnetic. field lines are drawn over the horizontal plane ABCD, the lines are



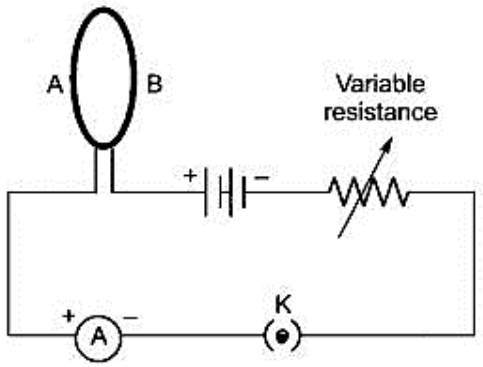
   (a) concentric circles

   (b) elliptical in shape

   (c) straight lines parallel to each other (Due to earth's magnetic field)

   (d) concentric circles near the point O but of elliptical shapes as we go away from it.

3. A circular loop placed in a plane perpendicular to the plane of paper carries a current when the keys is ON. The current as seen from points A and B (in the plane of paper and on the axis of the coil) is anticlockwise and clockwise respectively. The magnetic field lines point from B to A. The N-pole of the resultant magnet is on the faces close to.



   (a) A

   (b) B

   (c) A if the current is small, and B if the current is large

   (d) B if the current is small and A if the current is large.

4. For a current in a long straight solenoid, N- and S-poles are created at the two ends. Among the following statements, the incorrect statement is

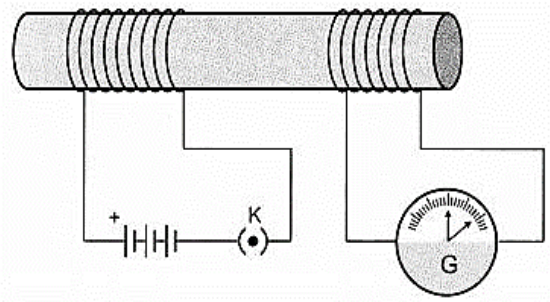
   (a) the field lines inside the solenoid are in the form of straight lines which indicates that the magnetic field is the same at all points inside the solenoid

   (b) the strong magnetic field produced inside the solenoid can be used to magnetize a piece of magnetic material like soft iron, when placed inside the coil

   (c) the pattern of the magnetic field associated with the solenoid is different from the pattern of the magnetic field around a bar magnet

   (d) the N- and S-poles exchange position when the direction of current through the solenoid is reversed.

5. In the arrangement shown in the figure there are two coils wound on a non-conducting cylindrical rod. Initially the key is not inserted. Then the key is inserted and later removed. Then



(a) the deflection in the galvanometer remains zero throughout.

(b) there is a momentary deflection in the galvanometer, but it dies out shortly and there is no effect when the keys is removed.

(c) there are momentary galvanometer deflections that die out shortly; the deflections are in the same direction.

(d) there are momentary galvanometer deflections that die out shortly; the deflection are in opposite directions.

6. Choose the incorrect statement

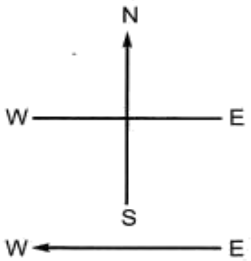
(a) Fleming's right-hand rule is a simple rule to know the direction of induced current.

(b) The right-hand thumb rule is used to find the direction of magnetic fields due to current carrying conductors.

(c) The difference between the direct and alternating currents is that the current always flows in one direction, whereas the alternating current reverses its direction periodically.

(d) In India, the AC changes direction after every 150 second.

7. A constant current flows in a horizontal wire in the plane of the paper from east to west as shown in the figure. The direction of magnetic field at a point will be North to South.



(a) directly above the wire

(b) directly below the wire

(c) at a point located in the plane of the paper, on the north side of the wire

(d) at a point located in the plane of the paper, on the south side of the wire.

8. The strength of magnetic field inside a long current carrying straight solenoid is

(a) more at the ends than at the center

(b) minimum in the middle

(c) same at all points

(d) found to increase from one end to the other

9. The most important safety method used for protecting home appliances from short circuiting or overloading is by

(a) earthing

(b) use of fuse

(c) use of stabilizers

(d) use of electric meter.

10. Select the incorrect statement

(a) Magnetic field lines are closed curves

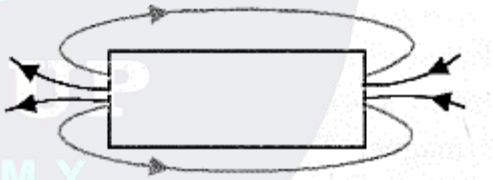
(b) No two field lines can cross each other

(c) Field lines can cross each other

(d) The relative strength of the magnetic field is shown by degree of closeness of the field lines.

Very Short Question:

1. Identify the poles of a magnet in the figure.



2. What is the direction of magnetic field lines outside a bar magnet?

3. What does crowding of magnetic field lines indicate?

Or

What does the degree of closeness of magnetic field lines near the poles signify?

4. At what place of the magnet are the magnetic field lines denser ?

5. What is meant by magnetic field?

6. How is the direction of magnetic field at a point determined?

7. What is SI unit of magnetic field?

8. What is the direction of magnetic field lines inside a bar magnet?

9. Define a magnetic field line?

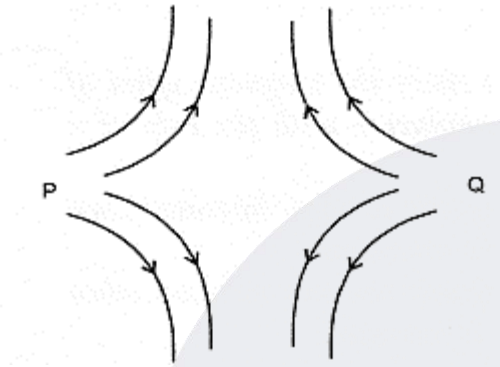
Or

What are magnetic field lines?

10. Give two uses of a magnetic compass.

Short Questions:

1. In the figure below, identify the poles marked P and Q as North Pole or South pole. Give reason for your answer.



2. State the factors on which the strength of magnetic field at a point due to a current carrying conductor depends. State the rule which gives the direction of magnetic field.

3. Describe an activity to show that magnetic field is generated around straight current carrying wire.

Or

With the help of a labelled circuit diagram describe an activity to illustrate the pattern of the magnetic field lines around a straight current carrying long conducting wire.

4. A horizontal power line carries current in east to west direction. What is the direction of the magnetic field due to the current in the power line at a point above and at a point below the power line?

5. A magnetic compass is placed near a current carrying wire. What will you observe?

- When current in the wire is increased,
- When the magnetic compass is displaced away from the wire?

Or

A magnetic compass shows a deflection near a current carrying wire. How will the deflection of the compass get affected if current in the wire is increased? Support your answer with reason.

6. Draw a diagram to show how a magnetic needle deflects when it is placed above or below a straight conductor carrying current depending on the direction of the current in the conductor.

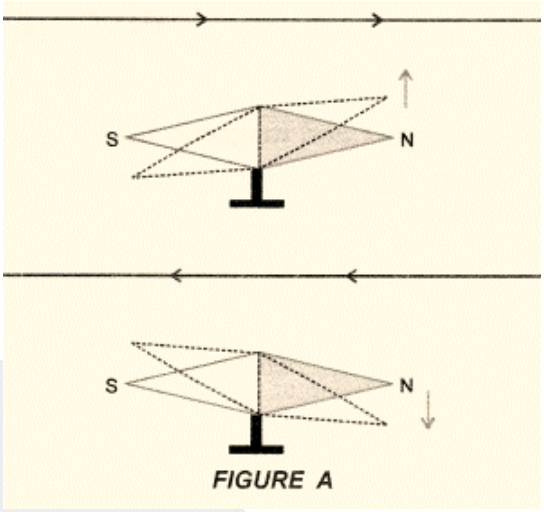


FIGURE A

7. A student performs an experiment to study the magnetic effect of current around a current carrying conductor with the help of a magnetic compass. He reports that:

- The degree of deflection of the magnetic compass increases when the compass is moved away from the conductor.
- The degree of deflection of the magnetic compass increases when the current through the conductor is increased

Which of the above observations of the student appears to be wrong and why?

8. With the help of a diagram describe an activity to show that an electric current can affect a magnet.

Long Questions:

1. Explain, the construction and working of an electric motor using a well labelled diagram.

2. Describe the construction and working of A.C. generator with the help of a labelled diagram. How can you convert AC generator to DC generator?

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

b. Both A and R are true, but R is not the correct explanation of the assertion.

c. A is true, but R is false.

d. A is false, but R is true.

Assertion: In a conductor, free electrons keep on moving but no magnetic force acts on a conductor in a magnetic field.

Reason: Force on free electron due to magnetic field always acts perpendicular to its direction of motion.

2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

a. Both A and R are true, and R is correct explanation of the assertion.

b. Both A and R are true, but R is not the correct explanation of the assertion.

c. A is true, but R is false.

d. A is false, but R is true.

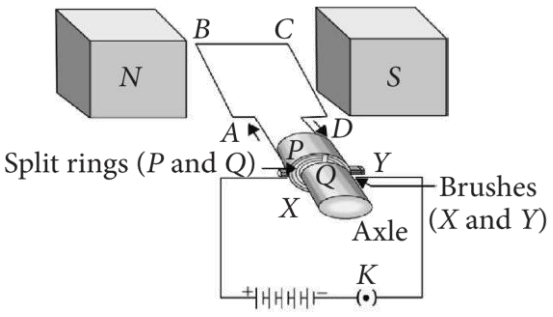
Assertion: No net force acts on a rectangular coil carrying a steady current when suspended freely in a uniform magnetic field.

Reason: Forces acting on each pair of the opposite sides of the coil are equal and opposite.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

An electric motor is a rotating device that converts electrical energy into mechanical energy. Electric motor is used as an important component in electric fans, refrigerators, mixers, washing machines, computers, MP3 players, etc.



An electric motor consists of a rectangular coil ABCD of insulated copper wire. The coil is placed between the two poles of a magnetic field such that the arm AB and CD are perpendicular to the direction of the magnetic field. The ends of the coil are connected to the two halves P and Q of a split ring. The inner sides of these halves are insulated and attached to an axle. The external conducting edges of P and Q touch two conducting stationary bushes X and Y, respectively, as shown in the figure. Commercial motors use an electromagnet in place of a permanent magnet, a large number of turns of conducting wire in the current carrying coil and a soft iron core on which the coil is wound.

i. Choose incorrect statement from the following regarding split rings.

a. Split rings are used to reverse the direction of current in coil.

b. Split rings are also known as commutator.

c. Split ring is a discontinuous or a broken ring.

d. Both (a) and (b).

ii. Which of the following has no effect on the size of the turning effect on the coil of an electric motor?

a. The amount of the current in the coil.

b. The direction of the current in the coil.

c. The number of turns in the coil.

d. The strength of the magnetic field.

iii. When current is switched ON, an electric fan converts?

a. Mechanical energy to chemical energy.

b. Electrical energy to mechanical energy.

c. Chemical energy to mechanical energy.

d. Mechanical energy to electrical energy.

iv. In an electric motor, device that makes contact with the rotating rings and through them to supply current to coil is:

a. Axle.

b. Brushes.

c. Coil.

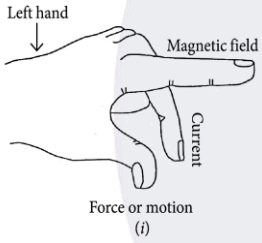
d. Split rings.

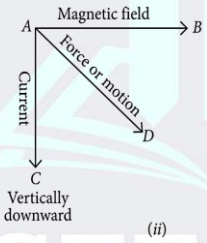
v. In an electric motor, the direction of current in the coil changes once in each:

a. Two rotations.
b. One rotation.
c. Half rotation.
d. One-fourth rotation.

2. Read the following and answer any four questions from (i) to (v).

Andre Marie Ampere suggested that a magnet must exert an equal and opposite force on a current carrying conductor, which was experimentally found to be true. But we know that current is due to charges in motion. Thus, it is clear that a charge moving in a magnetic field experience a force, except when it is moving in a direction parallel to it. If the direction of motion is perpendicular to the direction of magnetic field, the magnitude of force experienced depends on the charge, velocity (v), strength of magnetic field (B), and sine of the angle between v and B. Direction of magnetic force is given by Fleming's left-hand rule.





i. If an electron is travelling horizontally towards east. A magnetic field in vertically downward direction exerts a force on the electron along:

a. East.
b. West.
c. North.
d. South.

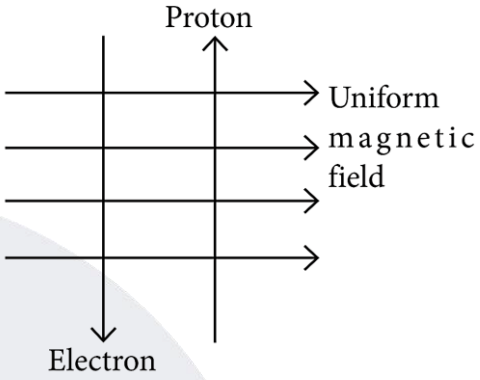
ii. If a charged particle is moving along a magnetic field line. The magnetic force on the particle is:

a. Along its velocity.
b. Opposite to its velocity.
c. Perpendicular to its velocity.
d. Zero.

iii. A magnetic field exerts no force on:

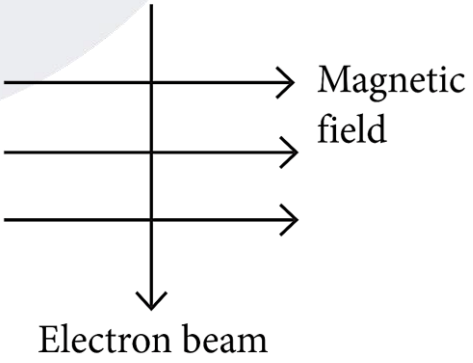
a. A stationary electric charge.
b. A magnet.
c. An electric charge moving perpendicular to its direction.
d. An unmagnetised iron bar.

iv. A uniform magnetic field exists in the plane of paper pointing from left to right, as shown in figure. In the field, an electron and a proton move as shown. The electron and the proton experience:



a. Forces both pointing into the plane of paper.
b. Forces both pointing out of the plane of paper.
c. Forces pointing into the plane of paper and out of the plane of paper, respectively.
d. Force pointing opposite and along the direction of the uniform magnetic field respectively.

v. An electron beam enters a magnetic field at right angles to it as shown in the figure. The direction of force acting on the electron beam will be:



a. To the left.
b. To the right.
c. Into the page.
d. Out of the page.

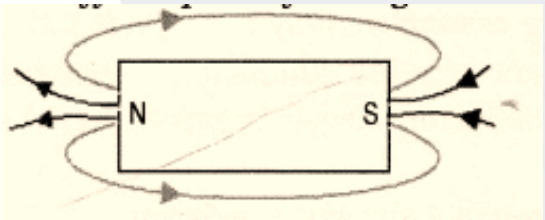
Answer Key

Multiple Choice Answers:

1. (c) if magnetic field lines are parallel and equidistant, they represent zero field strength
2. (c) straight lines parallel to each other (Due to earth's magnetic field)
3. (a) A
4. (c) the pattern of the magnetic field associated with the solenoid is different from the pattern of the magnetic field around a bar magnet
5. (d) there are momentary galvanometer deflections that die out shortly; the deflection are in opposite directions.
6. (d) In India, the AC changes direction after every 50 second.
7. (b) directly below the wire
8. (c) same at all points
9. (b) use of fuse
10. (c) Field lines can cross each other

Very Short Answers:

1. **Answer**:



2. **Answer**: From North pole to South pole.
3. **Answer**: Crowding of magnetic field lines indicates that magnetic field in that region is strong.
4. **Answer**: Near the poles of the magnet.
5. **Answer**: The space around a magnet or current carrying conductor within which its influence can be felt by a magnetic substance like iron is called magnetic field.
6. **Answer**: Direction of magnetic field is determined by a compass needle. The direction of magnetic field is towards the north pole of the compass needle at a point.
7. **Answer**: tesla (T).
8. **Answer**: From South pole to the North pole.
9. **Answer**: t is a curve around a magnet or a current carrying straight conductor such that the tangent at any point on the curve gives the direction of magnetic field at that point.
10. **Answer**:
    - It is used to determine the direction of north and south of earth.
    - It is used to draw the magnetic field lines around a bar magnet.

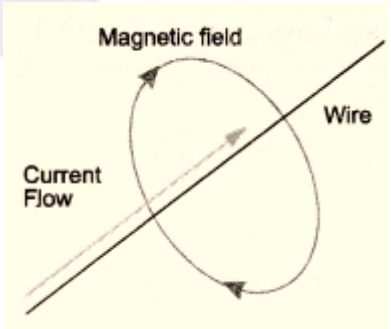
Short Answers:

1. **Answer**: Both P and Q are North poles. Magnetic field lines emerge from North pole.
2. **Answer**:

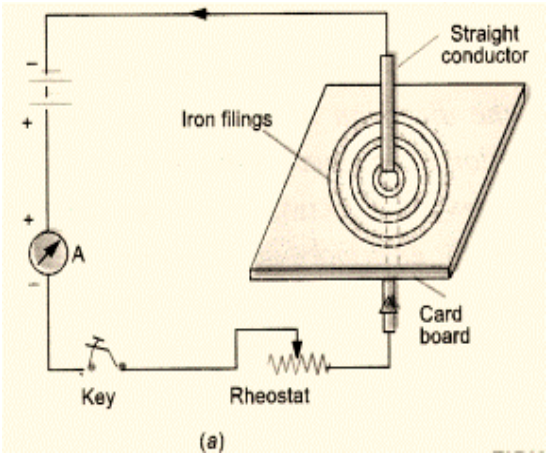
   The strength of magnetic field at a point due to current carrying conductor depends on
   - strength of electric current flowing in the conductor.
   - the distance of the point from the conductor.

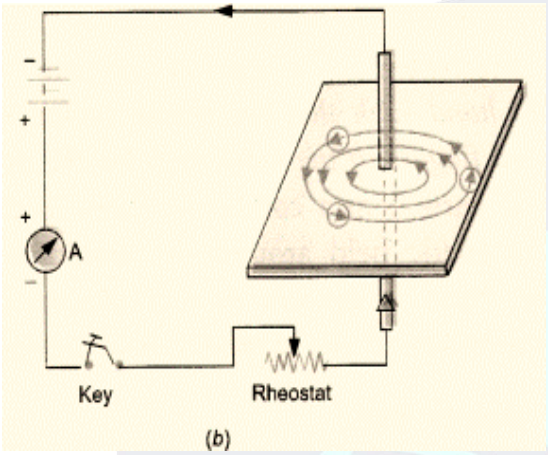
   Right hand thumb rule: If a current carrying conductor is imagined to be held in the right hand such that the thumb points in the direction of the current, then the curled fingers of the hand indicate the direction of magnetic field (Figure 14).
3. **Answer**:

   Describe an activity to plot the magnetic field around a straight conductor carrying current.



   - Take the thick piece of wire consisting of ten turns of insulated copper wire and a cardboard.
   - Pass this thick wire through a hole in the cardboard placed horizontally as shown in Fig 13.a

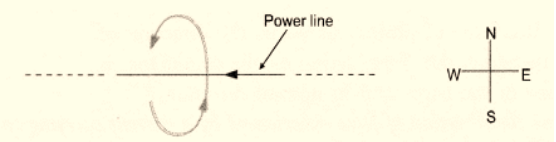




- Now pass electric current (about 4 A) through the wire by pressing the key and sprinkle some iron filings on the cardboard around the wire.
- Tap the cardboard gently.

Observation: We find that the iron filings are arranged in concentric circles around the wire as shown in figure 13(a). If magnetic compass is placed near the current carrying wire and at different positions, we get concentric circles around the wire as shown in figure 13(b). These concentric circles around the wire carrying current represent the magnetic field around the wire.

4. **Answer**: According to right-hand thumb rule:
   - the direction of magnetic field at a point above the power line is from south to north,
   - the direction of magnetic field at a point below the power line is from north to south.



5. **Answer**:
   - We observe that the deflection of the needle of the magnetic compass increases. This is because the magnetic field strength due to a current carrying wire increases, when current in the wire is increased.
   - We observe that the deflection of the needle of the magnetic compass decreases. This is because the magnetic field strength due to a current carrying wire decreases with the increase of the distance from the wire.

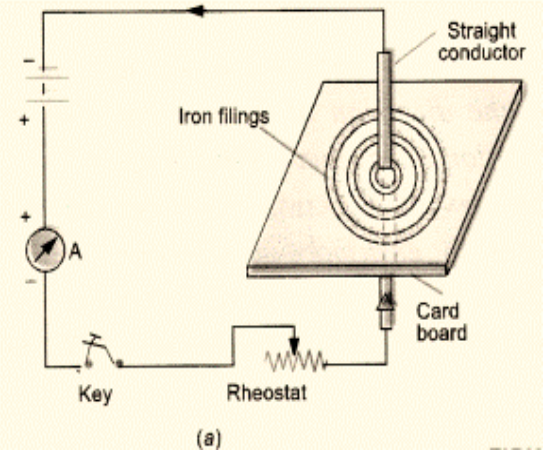
6. **Answer**: Direction of deflection of magnetic needle due to the current passing through a conductor can be found using Ampere's swimming rule as shown in figure A.

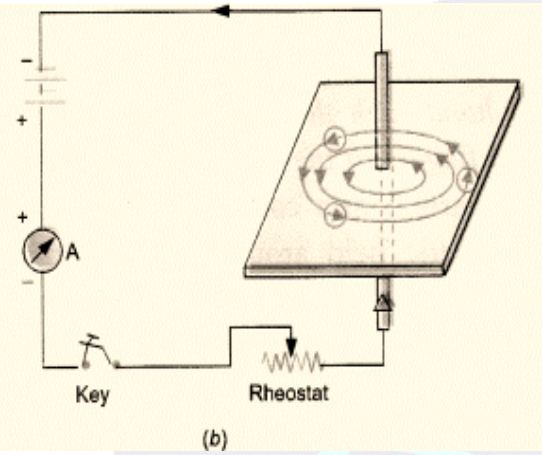
7. **Answer**:

   Observation:
   - is incorrect. Degree of deflection of magnetic compass depends on the strength of the magnetic field produced by the current carrying conductor. Magnetic field increases with the increase in the current through the conductor and hence degree of deflection of the magnetic compass increases.
   - Magnetic field decreases with the increase in the distance from the conductor and hence degree of deflection of the magnetic compass decreases when the compass is moved away from the conductor.

8. **Answer**: When a straight conductor carries electric current (dc), a magnetic field is set up around the conductor. This magnetic field causes the deflection in the needle of the magnetic compass.

   Describe an activity to plot the magnetic field around a straight conductor carrying current.
   - Take the thick piece of wire consisting of ten turns of insulated copper wire and a cardboard.
   - Pass this thick wire through a hole in the cardboard placed horizontally as shown in Fig 13.a.





- Now pass electric current (about 4 A) through the wire by pressing the key and sprinkle some iron filings on the cardboard around the wire.
- Tap the cardboard gently.

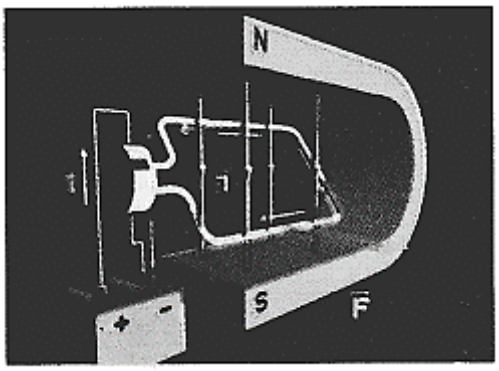
Observation: We find that the iron filings are arranged in concentric circles around the wire as shown in figure 13(a). If magnetic compass is placed near the current carrying wire and at different positions, we get concentric circles around the wire as shown in figure 13(b). These concentric circles around the wire carrying current represent the magnetic field around the wire.

Long Answers:

1. **Answer**:

Electric motor converts electrical energy into mechanical energy.

Principle: Electric Motor is based on the fact that a current carrying conductor placed perpendicular to the magnetic field experiences a force.



Electric Motor

- Armature coil: It consists of a single loop of an insulated copper wife in the form of a rectangle. Rectangle ABCD shown in figure 25 is an armature coil.

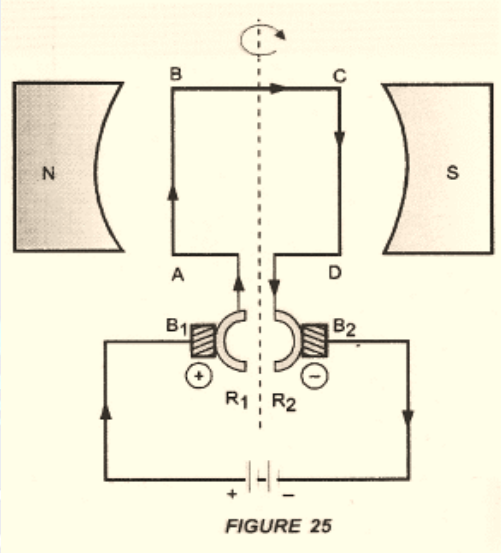


FIGURE 25

- Strong field magnet: Armature coil is placed between two pole pieces (N and S poles) of a strong magnet. This magnet provides a strong magnetic field.
- Split-ring type Commutator. It consists of two halves (R1 and R2) of a metallic ring. The two ends of the armature coil are connected to these two halves of the ring. Commutator reverses the direction of current in the armature coil.
- Two carbon brushes B1 and B2 press against the commutator. These brushes act as the contacts between the commutator and the terminals of the battery.
- A battery is connected across the carbon brushes. This battery supplies the current to the armature coil.

2. **Answer**:

An electric device used to convert mechanical energy (kinetic energy) into electrical energy (electricity) is called an electric generator.

Principle: Electric generator works on the principle of electromagnetic induction. When the coil of electric generator rotates in a magnetic field, induced current flows in the circuit connected with the coil.

Types of electric generator

- AC generator
- DC generator

AC generator: AC generator converts mechanical energy into electrical energy in the form of alternating current or AC.

DC generator: DC generator converts mechanical energy into electrical energy in the form of direct current or DC.

AC Generator Construction: The main components of AC generator are

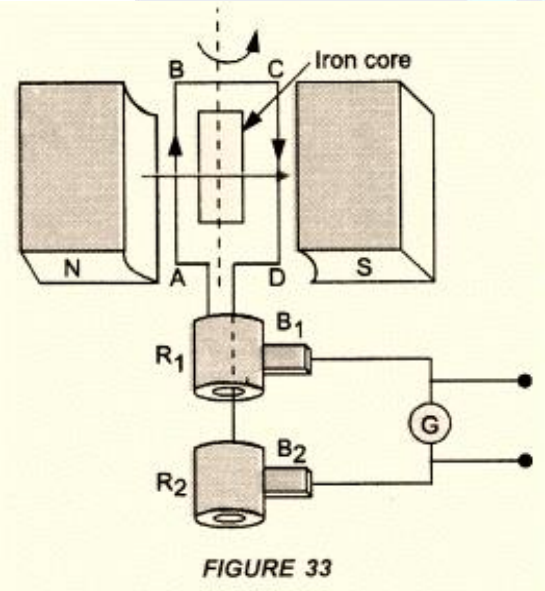


FIGURE 33

- **Armature:** Armature coil (ABCD) consists of large number of turns of insulated copper wire wound over a soft iron core.
- **Strong field magnet:** A strong permanent magnet or an electromagnet whose poles (N and S) are cylindrical in shape is a field magnet. The armature coil rotates between the pole pieces of the field magnet. The uniform magnetic field provided by the field magnet is perpendicular to the axis of rotation of the coil.
- **Slip Rings:** The two ends of the armature coil are connected to two brass slip rings R_1 and R_2. These rings rotate along with the armature coil. Rings R_1 and R_2 are at different heights.
- **Brushes:** Two carbon brushes (B_1 and B_2), are pressed against the slip rings. The brushes are fixed while slip rings rotate along with the" armature. These brushes are connected to the external circuit across which the output is obtained.

Working: When the armature coil ABCD rotates in the magnetic field provided by the strong field magnet, it cuts the magnetic field lines. Thus, the changing magnetic field produces induced current in the coil. The direction of the induced current in the coil is determined by the Fleming's right-hand rule.

The current flows out through the brush B1 in one direction in the first half of the revolution and through the brush B2 in the next half revolution in the reverse direction. This process is repeated. Therefore, induced current produced is of alternating nature. Such a current is called alternating current.

DC generator or Dynamo Construction:

- **Armature coil.** It consists of large number of turns of insulated copper wire wound on iron core in the form of a rectangle coil. Rectangle coil ABCD shown in figure 34 is an armature coil.

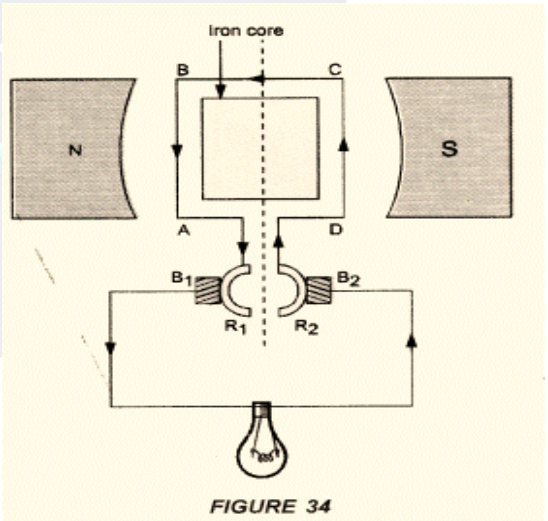


FIGURE 34

- **Strong field magnet**. Armature coil is placed between two pole pieces (N and S poles) of a strong magnet. This magnet provides a strong magnetic field.
- **Split-ring Type Commutator.** It consists of two halves (R_1 and R_2) of a metallic ring. The two ends of the armature coil are connected to these two halves of the ring.

- Two carbon brushes B1 and B2 press against the commutator.
- The output is shown by the glowing bulb connected across the carbon brushes.

Working of d.c. generator: When the coil of d.c. generator rotates in the magnetic field, induced potential difference is produced in the coil. This induced potential difference gives rise to the flow of current through the bulb and hence the bulb glows.

In d.c. generator, the flow of current in the circuit is in the same direction as long as the coil rotates in the magnetic field. This is because one brush is always in contact with the arm of the armature moving up and the other brush is in contact with the arm of the armature moving downward in the magnetic field.

Note: AC generator can be converted into DC generator by replacing slip rings used in AC generator by a split ring type commutator.

Assertion Reason Answer:

1. (c) A is true, but R is false.

Explanation:

In a conductor, the average velocity of electrons is zero. Hence, no current flows through the conductor. Hence, no force acts on this conductor.

2. (a) Both A and R are true, and R is correct explanation of the assertion.

Explanation:

In a rectangular coil carrying a steady current, the direction of current in opposite sides of coil is opposite to each other, therefore, forces acting on each pair of the opposite sides of the coil are equal and opposite, i.e., net force on the coil is equal to zero.

Case Study Answer:

1. i. (d) Both (a) and (b).

ii. (b) The direction of the current in the coil.

Explanation:

The direction of the current has no effect on the size of the turning effect on the coil.

iii. (b) Electrical energy to mechanical energy.

Explanation:

Electric fan works on the principle of electric motor. It converts electrical energy to mechanical energy.

iv. (b) Brushes.

v. (c) Half rotation.

2. i. (d) South.

Explanation:

Fleming's left-hand rule is used to determine the direction of force on electron i.e., in south direction.

ii. (d) Zero.

Explanation:

The angle between velocity and magnetic field is zero. Therefore, magnetic force on the particle is zero.

iii. (a) A stationary electric charge.

iv. (a) Forces both pointing into the plane of paper.

Explanation:

As the direction of current is taken opposite to the direction of motion of electrons, therefore, current from the motion of electron and proton is n the same direction, i.e., from bottom to top. Now, according to Fleming's left-hand rule, the electron and the proton experience forces both pointing into the plane of paper.

(c) Into the page.

Sources of Energy 5

Energy comes in different forms and one form can be converted into another. A source of energy is one which provide adequate amount of energy in a convenient form over a long period of time.

Need of energy

- For making food
- For lightning
- For transport
- For running machines
- For industrial activities and agricultural work

A **source of energy** provides adequate amount of energy over a long period of time.

Renewable source of energy	They are inexhaustible. They are being produced continuously in nature. E.g. Wood
Non-Renewable source of energy	• They are exhaustible. They are not produced continuously in nature. E.g. Coal

A good source of energy would be one which would:

- **Do a large amount of work per unit volume or mass**
- **Be easy to transport from one place to aanother**
- **Be easily accessible**
- **Be economical**

The materials which can be burnt to produce heat energy are known as **fuels**. Wood, coal, petrol, kerosene etc. are fuels.

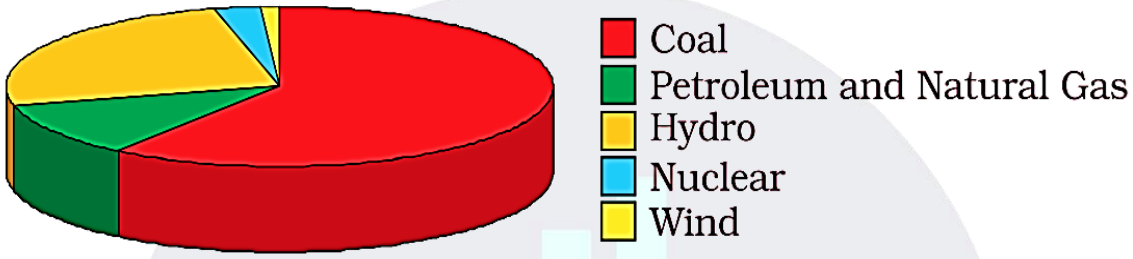
Sources of energy can also be categorised as conventional sources of energy and non-conventional sources of energy.

Conventional Sources of Energy

Conventional sources of energy are those energies that have been predominantly in use for the better part of civilization. They are non-renewable in nature, meaning that once a sample of conventional energy source is used up, it cannot be used again. The most extensive kind of conventional energy source is fossil fuels.

Fossil Fuel

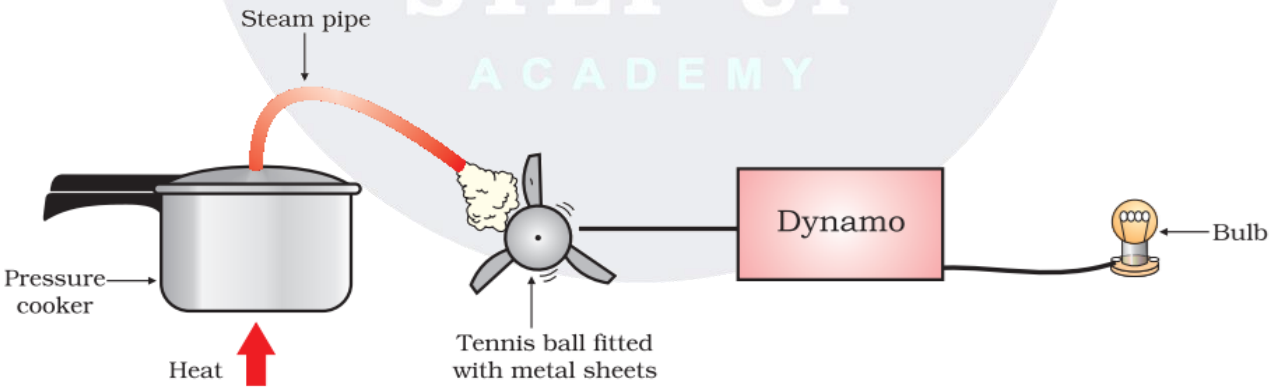
As the name suggests, fossil fuels are formed from the buried bodies of organisms by the natural phenomenon of anaerobic decomposition over thousands of years. Commonly used energy sources like petroleum, coal, natural gas and their derivatives such as kerosene, propane etc., are all examples of fossil fuels. Fossil fuels contain high percentages of carbon because they are derived from carbon-based organisms. The extensive consumption of fossil fuels is problematic for two reasons: The amount of pollution caused by fossil fuels is very hazardous to the health of the environment, and because fossil fuels are not consumed at a sustainable rate so they cannot be replaced as fast as they are getting used up.



Pie-chart showing the major sources of energy for our requirements in India

Thermal Power Plant

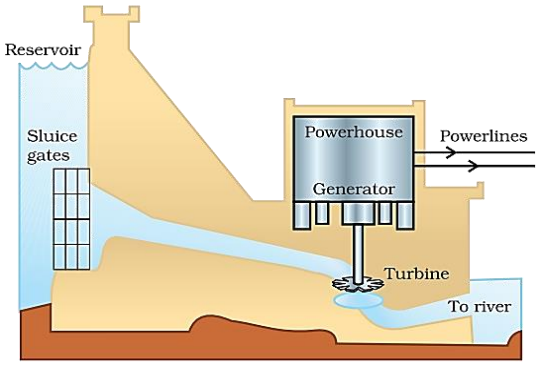
Thermal power plant generate electrical energy from the combustion of coal and petroleum. Consider the world without electricity. Electricity is a fourth need of mankind. In todays life we cannot imagine the world without electricity. Daily requirement of electricity in India is approximately few billions unit. So this huge requirement of electricity led to increase the number of power stations.Power station converts chemical energy of fuel into electrical energy. Thermal power station works on fossil fuel. We can easily transport electrical energy than fuel.



A model to demonstrate the process of thermoelectric production

Hydro Power Plants

The natural or artificial flow of water, even at a small rate, can be used to generate electricity. Though there are many types of hydropower, the most popular type and developed is hydroelectric dams and reservoirs. Hydroelectric dams are built atop rivers that have a decent flow of water. The natural flow of the river is then used to drive turbines that are connected to generators. When the turbines are rotated, electricity is produced by the generator, which is stored and then later transported for consumption.



A schematic view of a hydro power plant

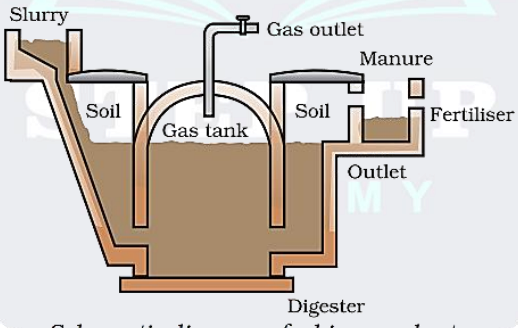
Bio-Mass

Biomass is the source of energy derived from living things (organic matter). For a long time, we relied on wood for the source of heat energy. In India, we make fuel out of biowaste such as cow dung due to the availability of a thriving population of livestock.

When wood is burnt in a limited supply of oxygen and water until volatile materials are removed, the residue left behind is charcoal. Charcoal has good heat generating efficiency. It also burns without flames.

Bio-gas plant

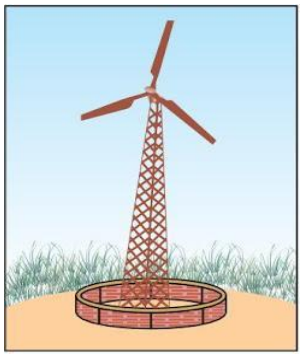
In India cow dung, sewage waste, plant matter are decomposed in absence of oxygen to produce biogas. Since it has cow dung it is often termed as gobar gas. A biogas plant is a dome-like structure built with bricks where cow dung and other biowaste are mixed with water to form a slurry and put into a digester. The digester is a sealed chamber with anaerobic bacteria which breaks down the slurry. This decomposition process releases gases like methane, CO_2, hydrogen sulfide and hydrogen. These gases are drawn via pipes which are transmitted to a turbine for the production of electricity.



Schematic diagram of a bio-gas plant

Wind Energy

Moving air is called wind. The energy possessed by wind is due to its high speed (or motion). The wind possesses kinetic energy.Solar energy (or sun's energy) is responsible for the blowing of wind. Wind blows due to the uneven heating of earth by the sun in different regions.



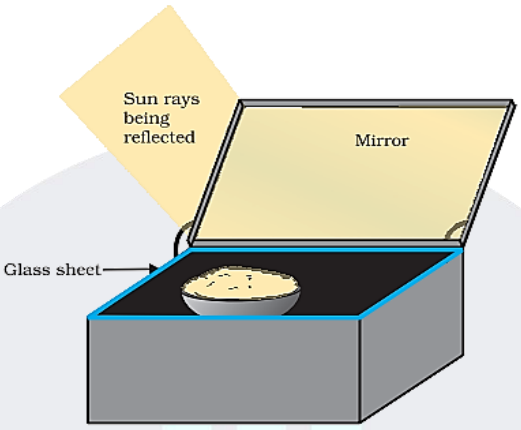
The energy of wind is harnessed by using a windmill. A windmill consists of big sized, table fan like blades which are fixed over the top of a tall pole in such a way that they are free to rotate. When the fast moving wind strikes on the blades of windmill it makes them rotate continuously. The rotatory motion of the windmill is then used to do mechanical work through a shaft connected to the rotating blades.

Non-Conventional Sources of Energy

Sources of energy which are not familiar to most people are known as non-conventional sources of energy.

The types of non-conventional sources of energy are

Solar Energy



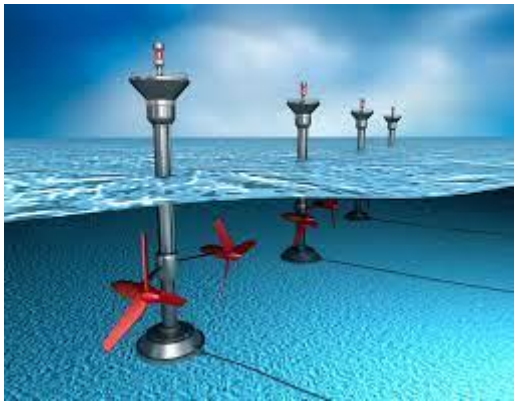
A solar cooker

Light energy and heat energy from the sun are known as solar energy. Sun has been radiating energy from the past 5 billion years and will continue to do so at the same rate for another 5 billion years or more. We must find ways to harness the energy with maximum efficiency, although only a small fraction of the solar energy reaches the earth's surface.

- The Sun is the most powerful source of radiation energy. It has been radiating energy for the past 5 billion years and will continue to do so for the next 5 billion years.
- India receives approximately **5000 trillion kWh** of solar energy per year.
- The **solar constant** is the solar energy reaching unit area at the outer edge of the Earth's atmosphere exposed perpendicularly to the rays of the Sun at an average distance between the Earth and the sun. Its value is approximately equal to **1.4 kJ per second per m^2** or **1.4 kW/m^2**.
- A device which either uses solar energy directly as heat or converts it into electricity is called a **solar energy device.** For example, solar cooker, solar cell, solar water heater etc.

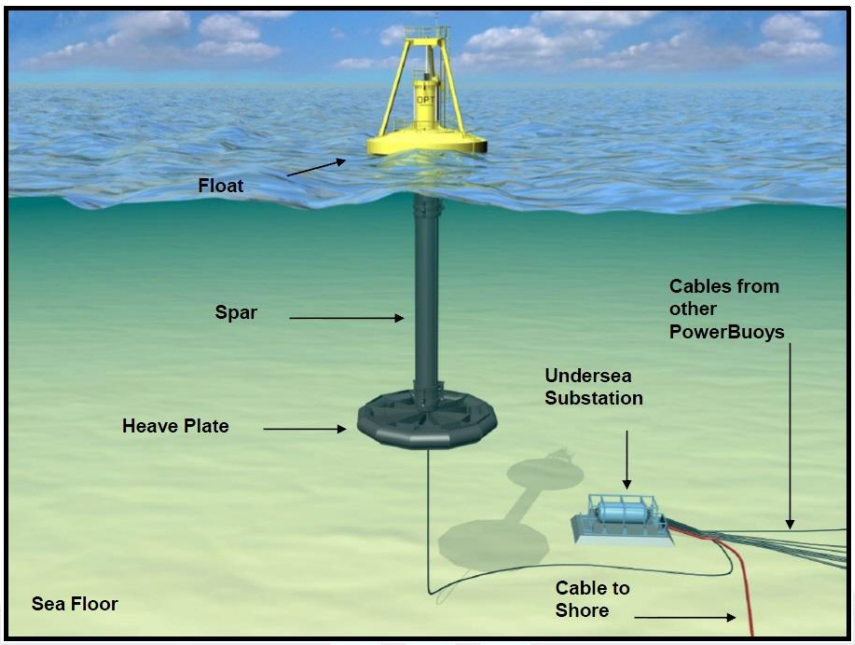
Energy from the Sea

Tidal Energy



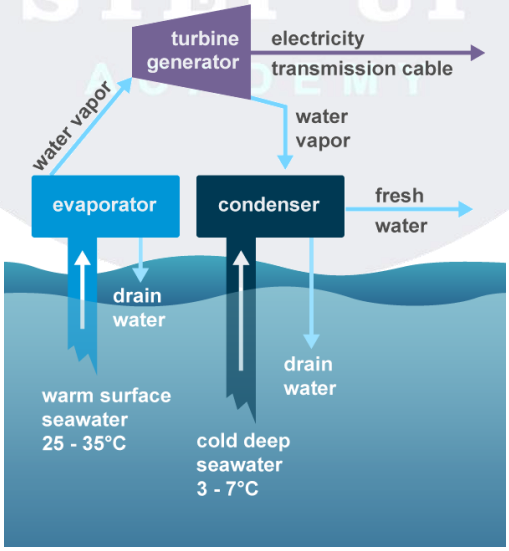
Due to the gravitational pull of mainly the moon on the spinning earth, the level of water in the sea rises and falls. This phenomenon is called high and low tides and the difference in sea-levels gives us tidal energy. Tidal energy is harnessed by constructing a dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity. As you can guess, the locations where such dams can be built are limited.

Wave Energy



The kinetic energy possessed by huge waves near the seashore can be trapped in a similar manner to generate electricity. The waves are generated by strong winds blowing across the sea. Wave energy would be a viable proposition only where waves are very strong. A wide variety of devices have been developed to trap wave energy for rotation of turbine and production of electricity

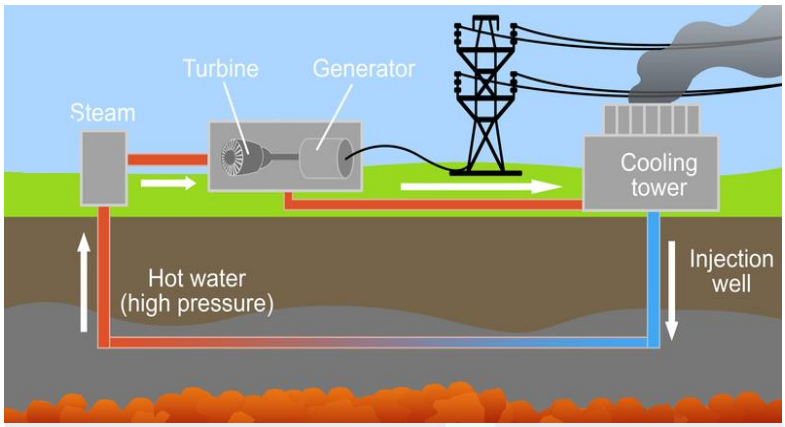
Ocean Thermal Energy



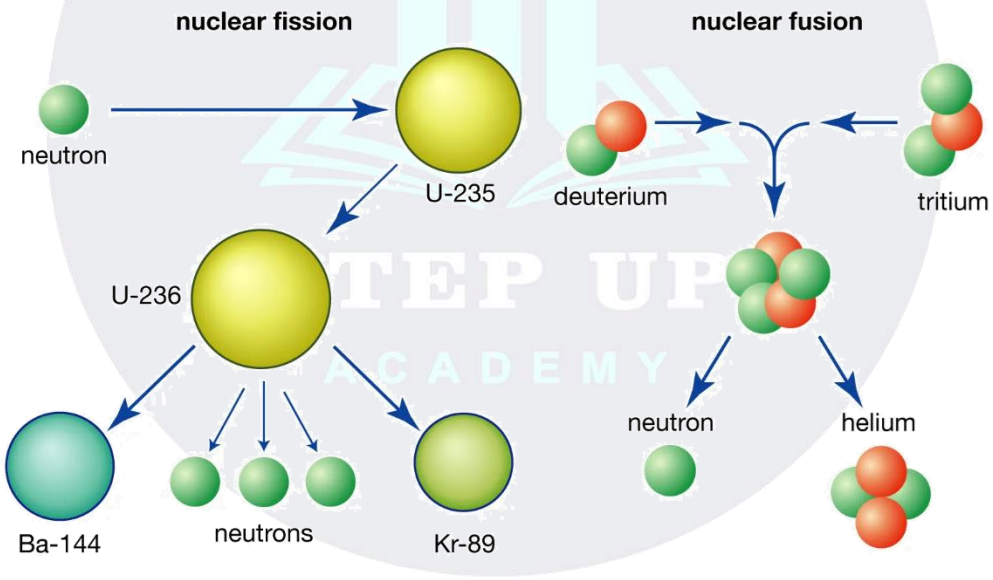
The water at the surface of the sea or ocean is heated by the Sun while the water in deeper sections is relatively cold. This difference in temperature is exploited to obtain energy in ocean-thermal-energy conversion plants. These plants can operate if the temperature difference between the water at the surface and water at depths up to 2 km is 20 K (20°C) or more. The warm surface-water is used to boil a volatile liquid like ammonia. The vapours of the liquid are then used to run the turbine of generator. The cold water from the depth of the ocean is pumped up and condense vapour again to liquid.

Geothermal Energy

- There is a huge amount of heat trapped inside the earth. Molten rocks from Earth's core sometimes come up due to geological changes and get trapped in hotspots. Harnessing this heat energy is called geothermal energy.
- Any underground water present gets heated due to the hotspots and gets converted to steam which escapes from the surface of the earth as hot springs.
- This steam is used to rotate turbines and generate electricity.



Nuclear Energy



- The energy obtained from the nucleus of an atom is called nuclear energy.
- **Nuclear fission** is the phenomenon of splitting of an unstable nucleus of a heavy atom into two medium weight nuclei with the liberation of an enormous amount of energy
- A nuclear reaction in which the particle which initiates the reaction is also produced during the reaction and it carries the reaction further is called a **nuclear chain reaction**.
- An uncontrolled nuclear chain reaction is the basis of the **atom bomb** and a controlled nuclear chain reaction is the basis of a **nuclear power plant**.
- **Nuclear fusion** is the phenomenon of combining two or more lighter nuclei to form a more stable heavy nucleus with the liberation of a large amount of energy.
- Uncontrolled nuclear fusion is the basis of the **hydrogen bomb.**

- The sum of the masses of products of a nuclear reaction is somewhat less than the sum of the masses of the reactants. The difference in mass appears as **mass defect (Δ m)**. It is this mass defect which appears in the form of energy according to **Einstein's mass-energy relation, $E = (\Delta m)c^2$**.

Advantages Or Nuclear Energy:

- Alternative source of energy due to depletion of fossil fuels.
- A significant amount of energy is released from a small amount of fuel.

Disadvantages of using nuclear energy

- Nuclear waste is hazardous as heavy atoms decay into harmful subatomic particles.
- High setup and maintenance cost
- Limited availability of uranium
- Can be used for destructive purposes

Environmental Consequences

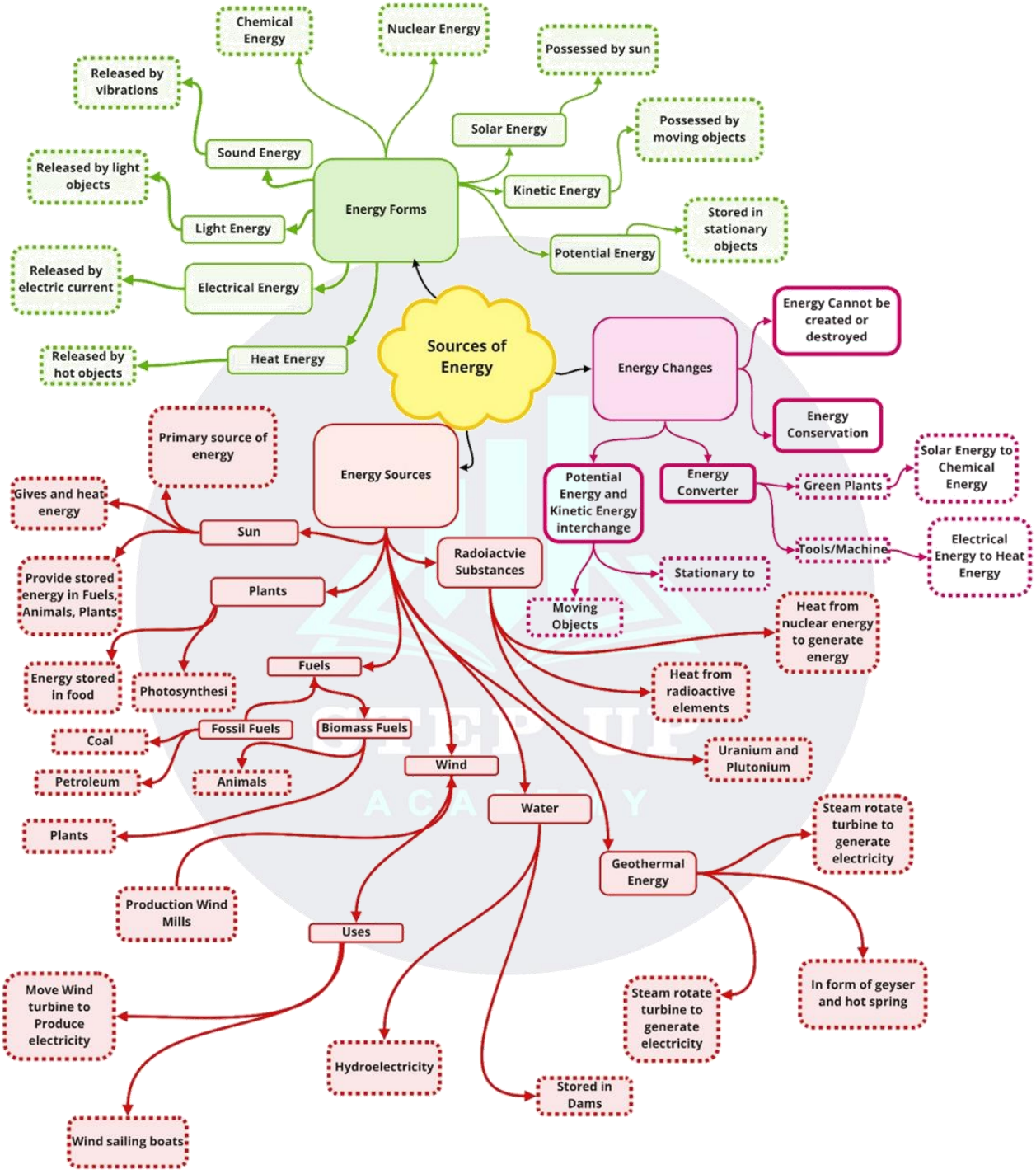
Factors to be kept in mind while choosing a source of energy are:

- The economics of extracting energy from the source.
- The efficiency of the technology available.
- The damage to environment which will be caused by using that source.

Some environmental consequences of the increasing energy demands are:

- Burning of fossil fuels causes air pollution.
- Construction of dams destroys large ecosystems and creates problem of rehabilitation of displaced population.
- Continuous whirling and whistling of windmills cause noise-pollution and plays havoc with the lives of migratory birds.
- Heavy energy structures to exploit wave energy affect marine mammal and seabird population.
- Using wood as fuel results in deforestation which affects environment.
- Assembly of solar cell causes some environmental damage.
- The cutting down of trees from the forests causing soil erosion and destroys wild life.

Class : 10th Physics
Chapter-14 : Sources of Energy



Important Questions

Multiple Choice Questions:

1. Biogas is formed in the
   (a) presence of air only
   (b) presence of water only
   (c) absence of air only
   (d) presence of water and absence of air
2. Biogas is a better fuel than animal dung cake because
   (a) biogas has lower calorific value.
   (b) animal dung cake has high calorific value
   (c) biogas bums smoke and leaves no residue
   (d) biogas is used as a fuel for cooking only whereas dung cake can be used for cooking, illuminant the lanterns.
3. Most of the sources of energy we use represent stored solar energy. Which of the following is not ultimately derived from the Sun's energy?
   (a) geothermal energy
   (b) wind energy
   (c) nuclear energy
   (d) biomass
4. The working fluid in ocean thermal power plant is:
   (a) volatile liquid like ammonia
   (b) petrol
   (c) charcoal
   (d) liquified petroleum gas
5. Ocean thermal energy is produced due to
   (a) pressure difference at different levels in the ocean.
   (b) temperature difference at different levels in the ocean.
   (c) energy stored by waves in the ocean.
   (d) tides rising out of the ocean.
6. A device in which electricity is produced by the process of controlled nuclear fission reaction is called
   (a) nuclear chain reaction
   (b) hydel power plant
   (c) nuclear reactor
   (d) thermal power plant
7. India exploded her first underground nuclear device at
   (a) Ranchi
   (b) Kota
   (c) Jaipur
   (d) Pokhran
8. Fusion reaction is also known as
   (a) chemical reaction
   (b) elastic scattering
   (c) thermonuclear reaction
   (d) photo nuclear reaction
9. A good fuel should possess
   (a) high ignition temperature
   (b) moderate ignition temperature
   (c) high calorific value
   (d) both high calorific value and moderate ignition temperature
10. Geothermal energy is:
    (a) Heat energy in the interior of earth
    (b) energy of molten mars exists in the farm of magma inside the earth.
    (c) molten lava on the surface of earth
    (d) energy obtained from solar thermal electric plants

Very Short Question:

1. What is meant by non-renewable sources of energy?
2. Name two non-renewable or conventional sources of energy.
3. What is a fossil fuel?
4. Give two examples of fossil fuels.
5. How is the increase in demand for energy affecting our environment adversely?
6. What does "LPG" stands for?
7. Write the name of the main constituent of "LPG".
8. What does "CNG stand for?
9. Write the name of the main constituent of "CNG".
10. Name the device/ technique to produce electricity by burning fossil fuels.

Short Questions:

1. Mention any three qualities of an ideal source of energy.
2. Would your choice regarding choice regarding a fuel for cooking food be different if you lived
   (a) in a forest,
   (b) in a remote mountain or small island,
   (c) in New Delhi and
   (d) five centuries ago? If yes, name the type of fuel used in different cases.
3. Why are fossil fuels known as a non-renewable source of energy?

   Or

   State the reason for calling fossil fuels as non-renewable source of energy.
4. Why are many thermal power plants set up near coal or oil fields?
5. What steps can be taken to minimize environmental pollution caused by the burning of fossil fuels?
6. What are fossil fuels? "Burning of fossil fuels leads to acid rain", Justify this statement.
7. List three energy sources that are considered to be inexhaustible. State three reasons in support your answer.
8. Explain how burning of fossil fuels cause acid rain.

Long Questions:

1. Describe the construction of a box type solar cooker or show it with the help of a diagram. How is the rise in temperature obtained in this set up? Mention two advantages and two limitations of solar cookers.
2. What are
   (i) Solar concentrators and
   (ii) Solar cell panels? How are they improvement on simple devices? Why is it that solar panels are costly?
3. Name any three forms of energy of the oceans which can be converted into usable energy forms. Describe how it is done in each case. What is the likelihood of their use on a large scale?

Assertion Reason Questions:

1. Following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:
   (a) Both A and R are true, and R is the correct explanation of A.
   (b) Both A and R are true, but R is not the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false but R is true.

   Assertion(A): Nuclear fusion is used to generate electricity.

   Reason (R): Nuclear power is used because it cannot be controlled.
2. Following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:
   (a) Both A and R are true, and R is the correct explanation of A.
   (b) Both A and R are true, but R is not the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false but R is true.

   Assertion(A): Charcoal is a better fuel than wood for domestic purposes.

   Reason (R): Charcoal burns without flames and does not produce smoke during burning.

Answer Key

Multiple Choice Answers:

1. (d) presence of water and absence of air
2. (c) biogas bums smoke and leaves no residue
3. (c) nuclear energy
4. (a) Volatile liquid like ammonia
5. (b) temperature difference at different levels in the ocean.
6. (c) nuclear reactor
7. (d) Pokhran
8. (c) thermonuclear reaction
9. (d) both high calorific value and moderate ignition temperature
10. (c) molten lava on the surface of earth

Very Short Answers:

1. **Answer**: The sources of energy which have been formed in nature long ago under certain conditions of temperature and pressure. For example, fossil fuels like coal and petroleum.
2. **Answer**:

   Coal,

   Petroleum.
3. **Answer**: The combustible substance formed from the dead remains of the animals and plants which were buried deep under the surface of the earth over millions of years is called fossil fuel.
4. **Answer**: Coal and petroleum.
5. **Answer**: More use of fossil fuels for fulfilling the increasing demand for energy is polluting the air, which is a great health hazard.
6. **Answer**: LPG stands for "Liquid Petroleum Gas".
7. **Answer**: The main constituent of "LPG" is butane.
8. **Answer**: CNG stands for "compressed Natural Gas".
9. **Answer**: The main constituent of CNG is methane.
10. **Answer**: Thermal power plant produces electricity by burning fossil fuels.

Short Answer:

1. **Answer**: A good source of energy should have the following characteristics. It should

   supply enough amount of useful energy.

   be easily stored.

   be easily transported.
2. **Answer**:

   Yes.

   (a) wood would be used for cooking food in a forest.

   (b) Wind energy from a wind mill or energy of flowing water would be used for cooking food in a remote mountain or small island.

   (c) LPG would be used for cooking food in New Delhi.

   (d) Wood and cakes of cow dung were used for cooking food five centuries ago.
3. **Answer**: Fossil fuels like coal, petroleum and natural gases take millions of years for their forma-don. If these fuels are exhausted today, then they will not be formed very soon. Hence, they are known as non-renewable sources of energy.
4. **Answer**: In a thermal power plants, fuel like coal or oil is used in large quantity to produce electricity. These plants are usually set up near coal or oil fields so that the fuel is easily available and the problem of air pollution while transporting the fuel may be minimized.
5. **Answer**: We can minimize environmental pollution caused by the burning of fossil fuel by

   growing more and more trees,

   Using smokeless chulahs and

   smokeless chimneys in thermal power plants.
6. **Answer**: For fossil fuels: The combustible substance formed from the dead remains of the animals and plants which were buried deep under the surface of the earth over millions of years is called fossil fuel.

   Gases produced due to the burning of fossil fuels react with water vapours in air to produce acids like carbonic acid, sulphuric acid and nitric acid. These acids come down to earth with rain known as acid rain.

7. **Answer**:

Coal,

Petroleum

Natural gas.

These are inexhaustible energy' source because

their deposit under earth is limited,

their continuous use will ultimate consume them and

they are formed in very long period of time.

8. **Answer**: Gases produced due to burning of fossil fuels give rise to acids after reacting with water vapours in air. For example.

CO_2 + Water ⟶ Carbonic acid

SO_2 + Water ⟶ Sulphuric acid

NO_2 + Water ⟶ Nitric acid

Long Answer:

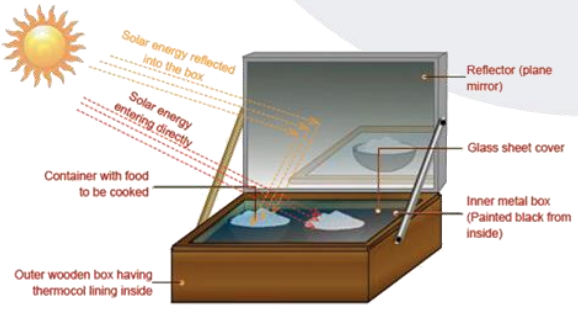
1. **Answer**:

Solar Cooker (Box Type)

Construction:

It consists of a wooden box (rectangular in shape) in which a metallic box painted black is fitted. The space between wooden box and metallic box is filled with an insulating material like thermocol. The insulating material minimizes the heat lose by conduction and radiation.

The metallic box is covered by a thick glass sheet. A plane mirror reflector is used to reflect the sun rays and attached to the box Figure.



The un-cooked food placed in the black container is put inside the box.

Working:

The plane mirror reflector is adjusted in such a way that maximum sun light falls on it. The light reflected by the plane mirror falls on the thick glass sheet cover.

The heat radiation (i.e. infra-red rays coming from the sun have short wavelength and high energy) pass through the glass sheet and are absorbed by the black container or any other object placed in the box and black surface of the box. The heat radiation entered in the box are not able to come out of the box through the glass sheet. Thus, the heat radiation are trapped in the box and the inner part of the box becomes hot. The effect is known as green house effect. (For the detail of green house effect, Refer Additional Topic at the end of this chapter). The temperature inside the box increases from 100° C to 140° C. Thus, the food in the container is cooked.

Advantages of Box type Solar cooker:

Economical: The cost of cooking food in the solar cooker is very small as money is only spent to purchase the solar cooker.

Pollution: No pollution is caused as there is no burning of fuel.

Disadvantages of Solar cooker:

Food cannot be cooked at night.

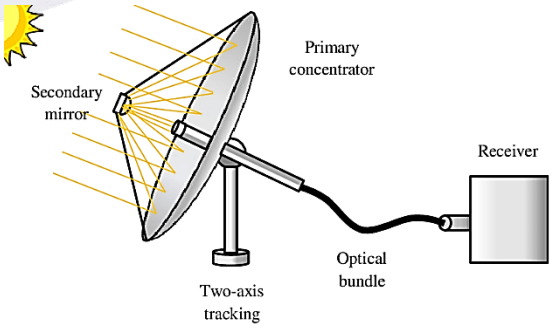
Food cannot be cooked on a cloudy day.

Food cannot be cooked quickly as solar cooker takes 4 to 5 hours to cook it.

2. **Answer**:

(i) Solar concentrators:

Solar concentrators are the devices used to concentrate the solar energy over a small area. When a parallel beam of sunlight falls on a polished concave surface (like concave mirror), then the beam of sunlight concentrates at the focus (F) of the concave surface after reflection Figure.



As a result of this concentrated beam of sunlight, the temperature at point F increases considerably. If we place a piece of paper at F, then it begins to burn after some time. A concave spherical surface which concentrates the beam

of sunlight at a point is called solar concentrator.

(ii) Solar cell panels:

A group of solar cells connected to each other in a certain pattern forms a solar panel (Figure 10).

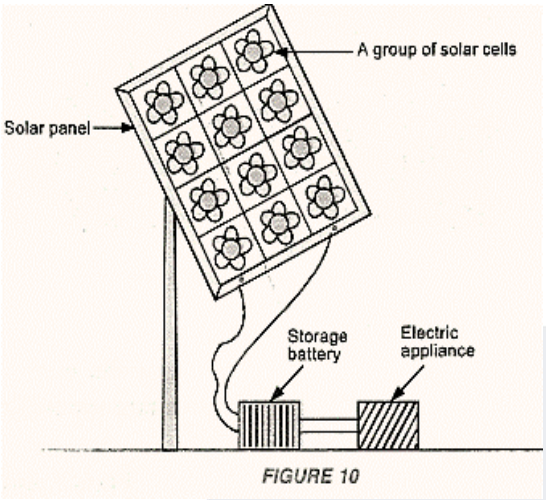


FIGURE 10

A solar panel converts sunlight into electrical energy. The efficiency of solar panel is very large as compared to the efficiency of a solar cell.

During day time, sunlight falling on the solar panel is converted into electrical energy which is stored in a battery connected to it. As soon as sunlight stops falling on it (during night and cloudy day), the battery begins to supply electric current to the appliances like electric bulbs and electric tubes connected to it.

Solar panels have limited uses. They can not be used to meet our domestic needs of electricity.

This is because of the following reasons:

The solar cells used in a solar panel are made of pure silicon. The production of pure silicon is very costly' affair. These solar cells in a solar panel are joined to each other with a best conductor silver to reduce the resistance of the solar panel to get maximum electricity.

But silver metal is also costly. Thus, we find that the cost of fabricating a solar panel is very high.

The storage battery connected to a solar panel can supply direct current (D.C.). So only those electric appliances can operate with the solar panel which require direct current. However, the electric appliances which require alternating current (A.C.) cannot be operated with the solar panel.

Solar panel can supply the electricity continuously only if the sun shines during day time.

3. **Answer**:

The energy from sea or ocean water is available in the following forms :

- Energy of sea waves
- Tidal energy
- Ocean thermal energy

Energy of sea waves:

High winds blow across the sea. These winds produce high waves on the surface of water in the sea or ocean. Thus, the water in the sea moves as water waves'. The kinetic energy of this moving water rotates the turbine of a generator. Hence, electricity is produced.

Limitation of Energy of Sea waves: Energy of sea waves can be used only if strong winds blow all the times across the sea and there are high water waves in the sea. However, as soon as strong winds stop to blow, the electric generator stops producing electricity. Hence, we cannot depend much on the energy of sea waves.

Tidal energy:

The alternate rise and fall of water of the ocean twice in nearly 24 hours is known as tide. The tides are caused due to the gravitational force of attraction exerted by the moon and to some extent by the sun on the water of the ocean. At the time of new and full moon, when the sun and the moon are in a straight line, tides are very high. When the sun and the moon are at right angle from the earth, tides are low. The kinetic

energy of water waves during tides is used to produce electricity.

Tidal power plants are constructed near narrow Bays (Figure 11).

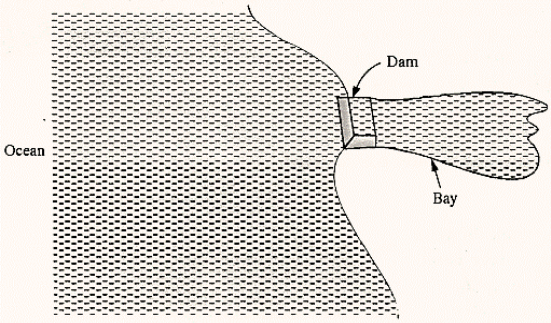
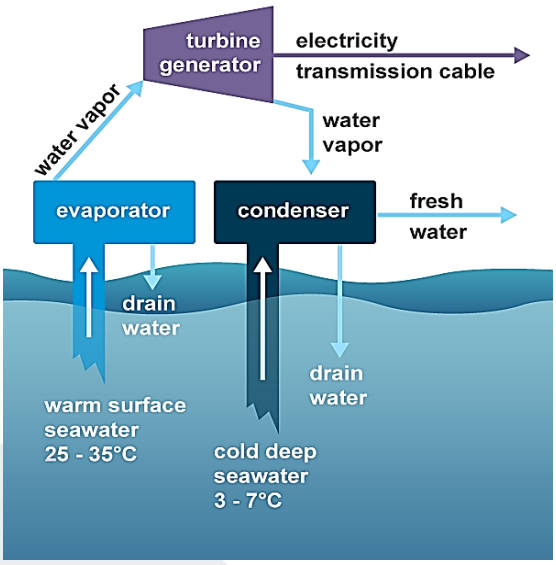


FIGURE 11

During tides, the gates of the dam are opened. The rising water is allowed to fall on the turbine of the generator which produces electricity.

Thus, kinetic energy of the water is converted into electrical energy. During low tides, gates of the dam are closed and hence the water level behind the dam rises. 1 his raised water has potential energy. Again the gates are opened and the water is allowed to fall back into the bay. This falling water is used to rotate the turbine of the generator. Hence the electricity is produced continuously.

Ocean thermal energy:



For operating OTEC power plant, temperature difference of 20°C or more between the surface water of ocean and water deep into the ocean is required. The warm surface water of ocean is used to boil liquid like ammonia or chlorofluorocarbon carbon (CFC). The vapours of this liquid at high pressure are used to rotate the turbine of the generator to produce electricity. The unused vapours (known as dead steam) are again converted into liquid by the cold water pumped up from the deep ocean. This process is repeated time and again to convert ocean thermal energy into electric energy (i.e., electricity). The main advantage of OTEC power plant is that it can be operated for 24 hours in a day throughout the year.

Assertion Reason Answer:

1. (c) A is true but R is false.
2. (a) Both A and R are true, and R is the correct explanation of A.

CHEMISTRY

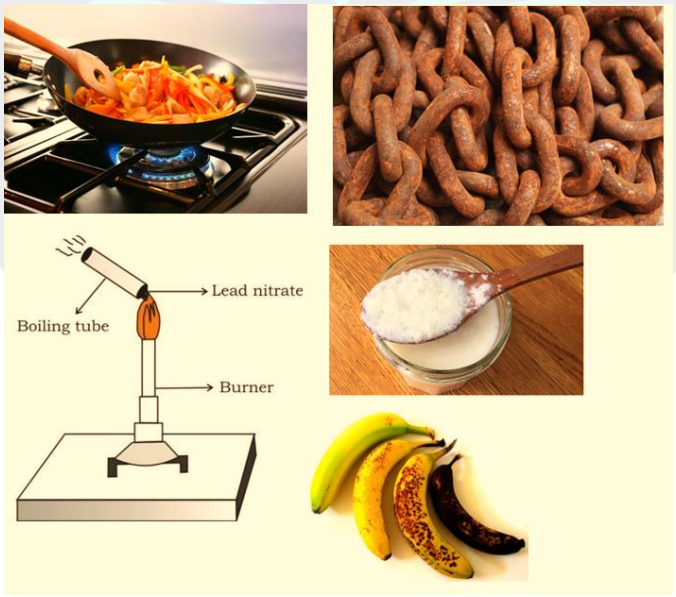
Chemical Reactions and Equations 1

Chemical Reactions and Equations

- Most of the substance around us undergoes various changes. Some of these changes are temporary with no new substance being formed. They are called **physical changes.**

  Example: Water changes to steam on boiling but no new substance is formed (Even though steam and water look different when they are made to react with a piece of Na, they react the same way and give the exact same products). This involves only a change in state (liquid to vapour).

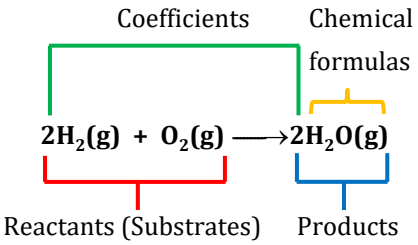
- A substance is said to undergo a **chemical change** when the chemical properties of a substance alter. As a result, there is either formation or breaking of atomic bonds at the molecular level. Some characteristics of a chemical change are:
  - New substances are produced during a chemical reaction.
  - Changes in energy are involved.
  - There is a permanent alteration.
  - Change in properties.



Examples:

- Cooking of food
- Rusting of iron
- Heating of Lead nitrate
- Souring of milk
- Ripening of fruit.
- Digestion of food

Chemical Equation



Writing Chemical Equations

- In a chemical reaction, the reactants are written on the left hand side and the products on the right hand side of the equation.
- An arrow (→) pointing towards the products is inserted between the reactants and the products. It also represents the direction of the reaction.
- A single arrow (→) indicates the direction in which the reaction proceeds.
- A double arrow (⇌) indicates a reversible reaction, i.e. the products recombine to form the reactants.
- A plus sign (+) is inserted between two or more reactants or products formed.
- If reactions are carried out under specific conditions of temperature, pressure, catalyst etc., then these conditions are mentioned on the arrow.
- The chemical equation can be made more informative by mentioning the physical states of the reactants and products.
- If gas is liberated as a product, then it is represented by an arrow pointing upwards (↑). If the product formed is in the form of a precipitate, it is represented by an arrow pointing downwards (↓).

Balancing the Chemical Equations

- In a balanced chemical equation, the total number of atoms of each element of the reactants on the left hand side of the equation is equal to the number of atoms of the products formed on the right hand side of the equation.
- According to the law of conservation of mass "The total mass of the reactants is equal to the total mass of the products or the number of atoms of each element before the reaction and after the reaction is equal."

Steps Involved in Balancing a Chemical Equation

Consider the chemical reaction between magnesium and oxygen to understand the steps involved in balancing a chemical equation.

Step 1

Let us first write the word equation for this reaction.

Magnesium + Oxygen ⟶ Magnesium oxide

Step 2

Write the chemical equation for the reaction between magnesium and oxygen.

$$Mg + O_2 \longrightarrow MgO$$

Step 3

Count the number atoms of an element occurring on both L.H.S. and R.H.S. in this equation.

Mg + O2 ⟶ MgO

Component	Reactant	Product
Magnesium	1	1
Oxygen	2	1

This is an unbalanced equation.

Step 4

- To balance a chemical equation, first draw boxes around each formula. Do not change anything inside the boxes while balancing the equation.

$$Mg + O_2 \longrightarrow MgO$$

- Choose a reactant or a product which has the maximum number of atoms in it. In that compound, select the element which has the maximum number of atoms. In this equation we shall select MgO i.e. magnesium oxide and the element oxygen in it.
- To balance the oxygen atoms, let us multiply magnesium oxide molecule by 2 on the right hand side. The equation can now be expressed as,

$$Mg + O_2 \longrightarrow 2MgO$$

Component	Reactant	Product
Magnesium	1	1 × 2 = **2**
Oxygen	2	1 × 2 = **2**

Step 5

There are two oxygen atoms on either side of the equation but one magnesium atom on the reactant's side and two on the product's side. Therefore, multiply the magnesium atom by 2 on the left hand side.

Component	Reactant	Product
Magnesium	1 × 2 = **2**	2
Oxygen	2	2

Balanced equation is,

$$2\ \boxed{Mg} + \boxed{O_2} \longrightarrow 2\ \boxed{MgO}$$

∴ The number of atoms of each element of reactants = The number of atoms of each element of products

Step 6

Writing Specific Conditions on the Arrow

The reaction is carried out in the presence of 'Heat'. On heating, magnesium combines with oxygen present in air to form magnesium oxide.

$$2\ Mg + O_2 \xrightarrow{Heat} 2\ MgO$$

Step 7

Writing Symbols of Physical States

$$2\ Mg_{(s)} + O_{2\ (g)} \xrightarrow{Heat} 2\ MgO_{(s)}$$

Using these steps, you can balance any chemical equation.

Types of Chemical Reactions

1. Combination Reaction

When two or more substances combine to form a single product, the reaction is known as a combination reaction.

For example:

Example 1. When iron powder is heated with sulphur , iron sulphide is formed

$$Fe_{(s)} + S_{(s)} \longrightarrow FeS(s)$$

Iron Sulphur. Iron sulphide

Example 2. Hydrogen burns in oxygen to form water:

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O$$

Hydrogen oxygen. Water

In this reaction, two elements hydrogen and oxygen, are combining to form single compound, water, so this is an example of a combination reactions

Example 3. Calcium oxide (lime or quick lime) reacts vigorously with water to form calcium hydroxide (slaked lime)

$$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(s) + Heat$$

Calcium oxide. Calcium hydroxide

(Lime or quick lime) (slaked lime)

2. Decomposition Reaction

A chemical reaction in which a single compound splits up into two or more simpler substances is called a decomposition reaction.

A decomposition reaction is just the opposite of a combination reaction.

Decomposition Reaction: There are three types of decomposition reactions.

a) Thermal decomposition

b) Electrolytic decomposition

c) Photolytic decomposition

a) **Thermal Decomposition:** When decomposition reaction carried out by heating , is called thermal decomposition.

Example1: When calcium carbonate is heated, it decomposes to give calcium oxide and carbon dioxide:

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$

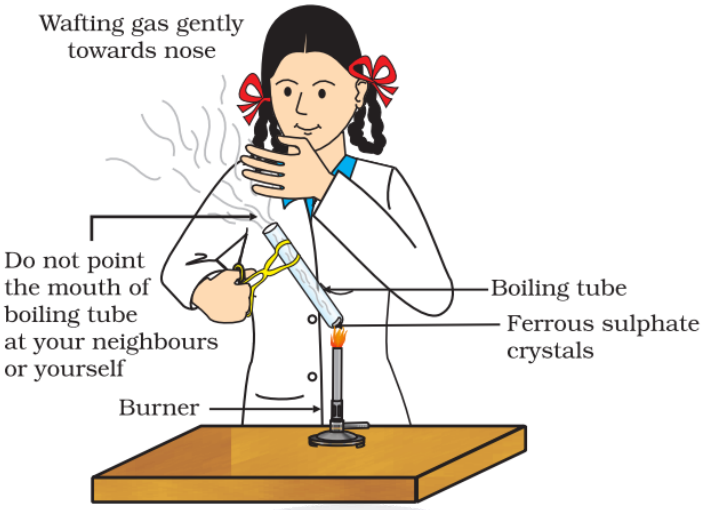
Calcium carbonate Calcium oxide Carbon dioxide

Example 2: When ferrous sulphate is heated strongly , it decomposes to form ferric oxide , sulphur dioxide and sulphur trioxide:

$$2FeSO_4(s) \longrightarrow Fe_2O_{3(s)} + SO_{2(g)} + SO_{3(g)}$$

Ferrous sulphate Ferric oxide. sulphur dioxide. Sulphur trioxide

(Green colour). (Brown colour)



Correct way of heating the boiling tube containing crystals of ferrous sulphate and of smelling the odour

b) **Electrolytic decomposition :** Those decomposition reactions which are carried out by using electricity.

Example 1: When electric current is passed through acidified water, it decomposes to give hydrogen gas and oxygen gas. This decomposition reaction takes place by the action of electricity. It is called electrolysis of water.

$$2H_2O_{(l)} \longrightarrow 2H_{2(g)} + O_{2(g)}$$

Water Hydrogen. Oxygen

Example 2: When electric current is passed through molten sodium chloride ,it decomposes to give sodium metal and chlorine gas:

$$2NaCl_{(l)} \longrightarrow 2Na_{(s)}. + Cl_{2((g)}$$

Sodium chloride (Molten) Sodium metal Chlorine gas

c) **Photochemical/photolytic decomposition :** The chemical reactions which proceed with the absorption of light energy are called photochemical/photolytic decomposition reactions.

Example 1. When silver chloride is exposed to light , it decomposes to form silver metal and chlorine gas:

$$2AgCl_{(s)} \longrightarrow 2Ag_{(s)} + Cl_{2(g)}$$

Silver chloride (White) Silver (Greyish white) Chloride (yellowish-green)

This reaction is used in black and white photography.

Silver bromide also behaves in the same way as silver chloride with light energy .

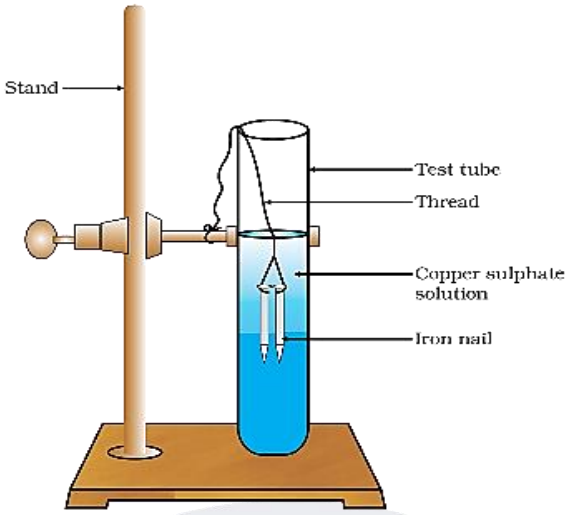
$$2AgBr_{(s)} \longrightarrow 2Ag_{(s)} + Br_2$$

Silver bromide. (Pale yellow) Silver. (Greyish white) Bromine (Red-brown)

The light maybe sunlight or bulb light . This reaction of decomposition of silver bromide is also used in black and white photography.

3. Displacement Reaction

Reactions in which the more reactive element displaces the less reactive element from its compound are called displacement reactions.



Iron nails dipped in copper sulphate solution

Example1: When a piece of iron nail is placed in copper sulphate solution, then iron sulphate solution and copper metal are formed:

$$\underset{\text{Copper sulphate. (Blue solution).}}{CuSO_{4\,(aq).}} + \underset{\text{Iron. (Grey)}}{Fe(s)} \longrightarrow \underset{\text{Iron sulphate (Greenish solution)}}{FeSO_{4(aq)}} + \underset{\text{Copper (red-brown)}}{Cu_{(s)}}$$

In this reaction , iron which is more reactive displaces copper which is less reactive than iron from copper sulphate solution.

Example 2. Zinc displaces copper in copper sulphate to form zinc sulphate.

$$\underset{\text{Zinc (Silvery-white)}}{Zn_{(s)}} + \underset{\text{Copper sulphate (Blue solution)}}{CuSO_{4(aq)}} \longrightarrow \underset{\text{Zinc sulphate (Colourless solution)}}{ZnSO_{4(aq)}} + \underset{\text{Copper (Red-brown)}}{Cu_{(s)}}$$

4. Double Displacement Reaction

Reactions in which ions of the reactants exchange places to form two new compounds, are called double displacement reactions.

For example: When silver nitrate solution is added to sodium chloride solution, then a white precipitate of silver chloride is formed along with sodium nitrate solution:

$$\underset{\text{Silver nitrate}}{AgNO_{3(s)}} + \underset{\text{Sodium chloride}}{NaCl_{(aq)}} \longrightarrow \underset{\text{Silver chloride (White ppt.)}}{AgCl_{(s)}} + \underset{\text{Sodium nitrate}}{NaNO_{3(aq)}}$$

Types of Double Displacement Reactions:

A. Precipitation

Any reaction in which an insoluble solid (called precipitate) is formed that separates from the solution is called a precipitation reaction.

For Example: When barium chloride solution is added to sodium sulphate solution , then a white precipitate of barium sulphate is formed along with sodium chloride solution.

$$\underset{\text{Barium chloride.}}{BaCl_{2(aq)}} + \underset{\text{Sodium sulphate.}}{Na_2SO_{4(aq)}} \longrightarrow \underset{\text{Barium sulphate. (White ppt.)}}{BaSO_{4(s).}} + \underset{\text{Sodium chloride}}{2NaCl}$$

B. Neutralization

The reactants are a base and an acid, and the products are salt and water. Neutralization is a form of double displacement reaction in which the reactants are a base and an acid, and the products are salt and water. The positive charge of the acid's hydrogen ion and the negative charge of the base's hydroxyl ions or oxide ions lose their electrical charge and form covalent water molecules.

Base. + Acid ⟶ Salt. + Water

$NaOH_{(aq)}$ $HCl_{(aq)}$ ⟶ $NaCl_{(aq)}$ + $H_2O_{(l)}$

Sodium hydroxide Hydrocloric acid. Sodium chloride. Water

A neutralization reaction is basically a reaction between H+ and OHions i.e.,

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

5. Oxidation - Reduction Reactions/Redox Reactions

- Reactions which involve the addition of oxygen, or the removal of hydrogen are called **oxidation reactions**.
- Reaction which involve the addition of hydrogen to a substance or the removal of oxygen from a substance is called **reduction reaction** .
- **Substance Oxidised** : Substance loses electrons or gains oxygen or loses hydrogen.
- **Substance Reduced:** Substance gains electrons or loses oxygen or gains hydrogen.
- **Oxidising agent**:I) a substance that oxidises another substance and self-gets reduced.
  II) The substance which gives oxygen for oxidation.
  III) The substance which removes hydrogen.
- **Reducing agent:** I) a substance that reduces another substance and self-gets oxidised.
  II) The substance which gives hydrogen for reduction.
  III) The substance which removes oxygen .
- **In terms of metals and non-metals**
  - The addition of non-metallic element (or removal of metallic element) is called **oxidation**.
  - The addition of metallic element (or removal of non-metallic element)is called **reduction**.

Examples 1:

Removal of hydrogen : Oxidation

$$H_2S + Cl_2 \longrightarrow S + 2HCl$$

Addition of hydrogen : Reduction

(i) Substance oxidised = H_2S

(ii) Substance reduced = Cl_2

(iii) Oxidising agent = Cl_2

(iv) Reducing agent = H_2S

Examples 2:

Removal of hydrogen : Reduction

$$C_4O + H_2 \longrightarrow C_4 + H_2O$$

Addition of hydrogen : Oxidation

(v) Substance oxidised = H_2

(vi) Substance reduced = C_4O

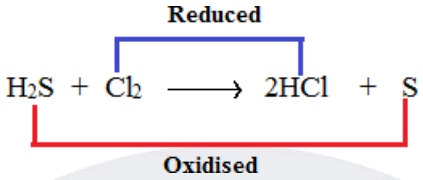
(vii) Oxidising agent = C_4O

(viii) Reducing agent = H_2

Redox Reaction

The chemical reaction in which oxidation and reduction takes place simultaneously is known as a redox reaction.

Effects of Oxidation Reaction In Everyday Life



1-Corrosion of Metals

The slow process of decay and destruction of metals due to the action of air, moisture or acids is called corrosion.

For example:

Iron combines with oxygen present in the air, in the presence of water, to form a red-brown flaky substance called **rust**. This process is commonly called the **rusting of iron.**

The chemical formula of rust is **$Fe_2O_3. \times H_2O$.**

$$\mathbf{4Fe + 3O_2 + 2xH_2O \longrightarrow 2Fe_2O_3.xH_2O}$$

Iron Oxygen water. Hydrated iron(III) oxide (Rust)

Prevention of Corrosion

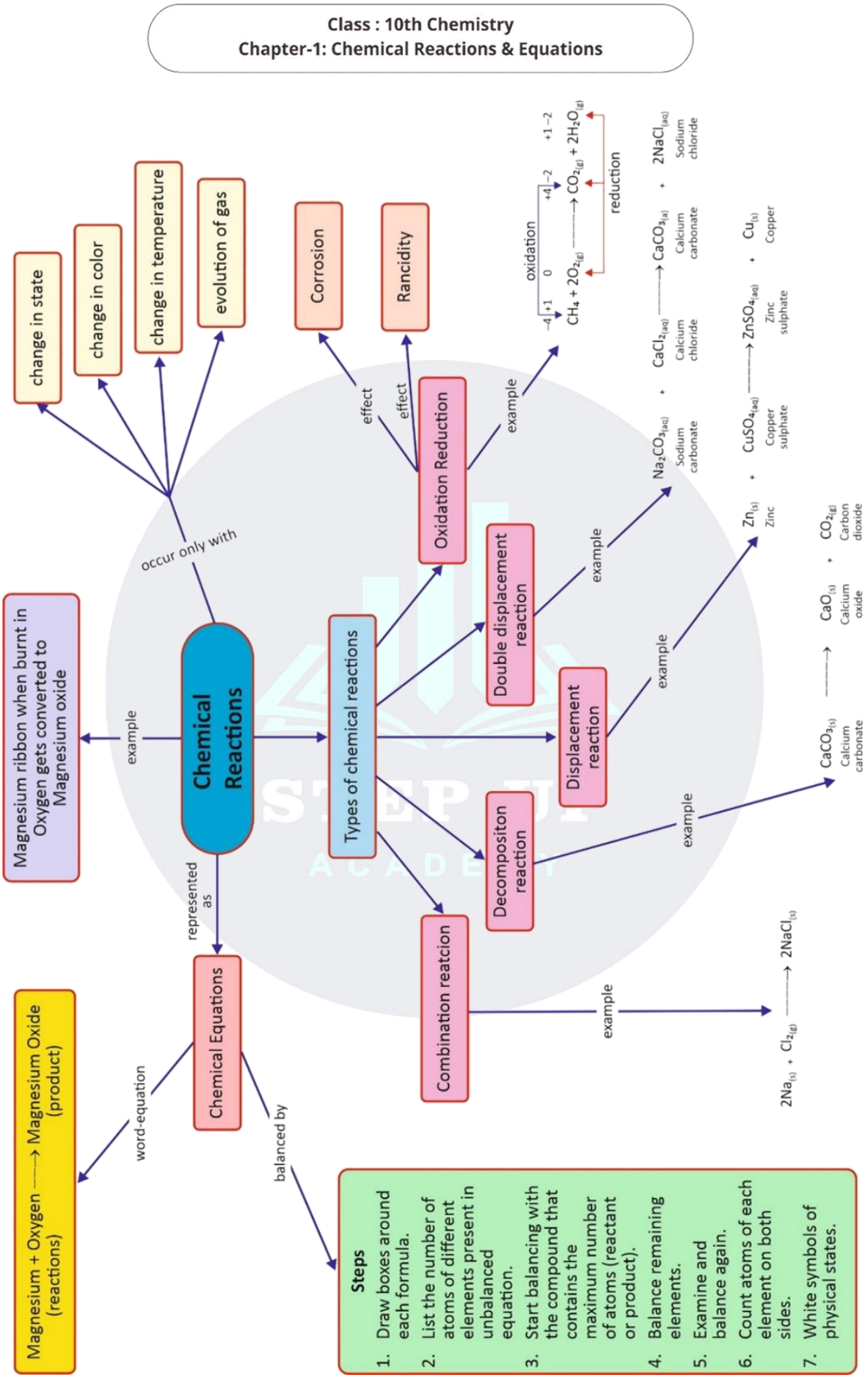
- Corrosion damages buildings, bridges, ships, automobiles and other articles made of iron. Hence, prevention of corrosion is necessary. This will not only save money but can also prevent the occurrence of accidents.
- It can be prevented by processes like galvanising and electroplating with other metals.

2-Rancidity

- Oils and fats react with oxygen and get oxidised or turn rancid. This process is called rancidity.
- Rancidity can be prevented by keeping food in air tight containers or by usingantioxidants.
- Antioxidants are used to prevent oxidation of food containing fats and oils.

  Antioxidant are actually reducing agent when antioxidants are added to foods, then the fats and oils present in them do not get oxidised easily and hence do not turn rancid.

  The two common anti-oxidants used in foods to prevent the development of rancidity are BHA(Butylated Hydroxy-Anisole) and BHT (Butylated Hydroxy-Toluene).
- Rancidity can be prevented by keeping food in a refrigerator.


Class : 10th Chemistry
Chapter-1: Chemical Reactions & Equations
Chemical Reactions
occur only with
change in state
change in color
change in temperature
evolution of gas
example
Magnesium ribbon when burnt in Oxygen gets converted to Magnesium oxide
represented as
Chemical Equations
word-equation
Magnesium + Oxygen ⟶ Magnesium Oxide (reactions)
balanced by
Steps
1. Draw boxes around each formula.
2. List the number of atoms of different elements present in unbalanced equation.
3. Start balancing with the compound that contains the maximum number of atoms (reactant or product).
4. Balance remaining elements.
5. Examine and balance again.
6. Count atoms of each element on both sides.
7. White symbols of physical states.
Types of chemical reactions
Combination reatcion
example
2Na(s) + Cl2(g) ⟶ 2NaCl(s)
Decompositon reaction
example
CaCO3(s) ⟶ CaO(s) + CO2(g)
Calcium carbonate
Calcium oxide
Carbon dioxide
Displacement reaction
example
Zn(s) + CuSO4(aq) ⟶ ZnSO4(aq) + Cu(s)
Zinc
Copper sulphate
Zinc sulphate
Copper
Double displacement reaction
example
Na2CO3(aq) + CaCl2(aq) ⟶ CaCO3(s) + 2NaCl(aq)
Sodium carbonate
Calcium chloride
Calcium carbonate
Sodium chloride
Oxidation Reduction
effect
Corrosion
effect
Rancidity
example
oxidation
reduction
CH4 + 2O2(g) ⟶ CO2(g) + 2H2O(g)
−4 +1 0 +4 −2 +1 −2

Important Questions

Multiple Choice Questions:

1. Which of the following is a displacement reaction?
   (a) $MgCO_3 \longrightarrow MgO + CO_2$
   (b) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$
   (c) $2H_2 + O_2 \longrightarrow 2H_2O$
   (d) $2Pb(NO_3)_2 \xrightarrow{Heat} 2PbO + 4NO_2 + O_2$

2. Magnesium ribbon is rubbed before burning because it has a coating of
   (a) basic magnesium carbonate
   (b) basic magnesium oxide
   (c) basic magnesium sulphide
   (d) basic magnesium chloride

3. Which of the following statements about the given reaction are correct?
   $3Fe\ (s) + 4H_2O\ (g) \rightarrow Fe_3O_4\ (s) + 4\ H_2\ (g)$
   (i) Iron metal is getting oxidized
   (ii) Water is getting reduced
   (iii) Water is acting as reducing agent
   (iv) Water is acting as oxidizing agent
   (a) (i), (zi) and (iii)
   (b) (in) and (iv)
   (c) (i), (ii) and (iv)
   (d) (ii) and (iv)

4. Which of the following are exothermic processes?
   (i) Reaction of water with quick lime
   (ii) Dilution of an acid
   (iii) Evaporation of water
   (iv) Sublimation of camphor (crystals)
   (a) (i) and (ii)
   (b) (ii) and (iii)
   (c) (i) and (iv)
   (d) (ii) and (iv)

5. Oxidation is a process which involves
   (a) addition of oxygen
   (b) addition of hydrogen
   (c) removal of oxygen
   (d) removal of hydrogen

6. The process of reduction involves
   (a) addition of oxygen
   (b) addition of hydrogen
   (c) removal of oxygen
   (d) removal of hydrogen

7. Three beakers labelled as A, B and C each containing 25 ml of water were taken. A small amount of NaOH, anhydrous $CuSO_4$ and NaCl were added to the beakers A, B and C respectively. It was observed that there was an increase in the temperature of the solution contained in beakers A and B, whereas in case of beaker C, the temperature of the solution falls. Which one of the following statement(s) is (are) correct?
   (i) In beakers A and B, exothermic process has occurred.
   (ii) In beakers A and B, endothermic process has occurred.
   (iii) In beaker C exothermic process has occurred.
   (iv) In beaker C endothermic process has occurred.
   (a) (i) only
   (b) (ii) only
   (c) (i) and (iv)
   (d) (iv), (ii) and (iii)

8. Give the ratio in which hydrogen and oxygen are present in water by volume.
   (a) 1:2
   (b) 1:1
   (c) 2:1
   (d) 1:8

9. Which among the following statement(s) is (are) true?
   Exposure of silver chloride to sunlight for a long duration turns grey due to
   (i) the formation of silver by decomposition of silver chloride
   (ii) sublimation of silver chloride
   (iii) decomposition of chlorine gas from silver chloride
   (iv) oxidation of silver chloride

(a) (i) only

(b) (i) and (iii)

(c) (ii) and (iii)

(d) (iv) only

10. $MnO_2 + 4HCl \rightarrow 2 + 2H_2O + Cl_2$

Identify the substance oxidized in the above equation.

(a) $MnCl_2$

(b) HCl

(c) H_2O

(d) MnO_2

Very Short Question:

1. How does the food become rancid?
2. A student burnt a metal A found in the form of ribbon. The ribbon burnt with a dazzling flame and a white powder B was formed which was basic in nature. Identify A and B. Write the balanced chemical equation.
3. What is a balanced chemical equation?
4. Write a balanced equation for a chemical reaction that can be characterized as precipitation.
5. What is rust?
6. A zinc rod is left for nearly 20 minutes in a copper sulphate solution. What change would you observe in the zinc rod?
7. Name two salts that are used in black and white photography.
8. Which chemical process is used for obtaining a metal from its oxide?
9. If you collect silver coins and copper coins you may have seen that after some days a black coating forms on silver coins and a green coating on copper coins. Which chemical phenomenon is responsible for these coatings? Write the chemical name of the black and green coatings.
10. When carbon dioxide is passed through lime water, it turns milky, why?

Short Questions:

1. You are given the following materials

(i) Marble chips

(ii) dilute hydrochloric acid

(iii) Zinc granules

Identify the type of reaction when marble chips and zinc granules are added separately to acid taken in two test tubes.

2. What do you understand by precipitation reaction? Explain with suitable examples.
3. What happens when aqueous solutions of sodium sulphate and barium chloride are mixed? What type of reaction is it?
4. Explain the following terms with suitable examples.

(a) Oxidation

(b) Reduction

5. Complete the missing components/variables given as x and y in the following reactions.

(a) $Pb(NO_3)_2$ (aq) + 2Kl (aq) $\rightarrow$ PbI_2 (x) + $2KNO_3$ (y)

(b) Cu (s) + $2AgNO_3$ (aq) $\rightarrow$ $Cu(NO_3)_2$ (aq) + x (s)

(c) Zn (s) + H_2SO_4 (aq) $\rightarrow$ $ZnSO_4$ (x) + H_2 (y)

6. An iron knife kept dipped in a blue copper sulphate solution turns the blue solution light green. Why?
7. A, B and C are three elements which undergo chemical reactions in the following way.

$A_2O_3 + 2B \rightarrow B_2O_3 + 2A$

$3CSO_4 + 2B \rightarrow B_2(SO_4)_3 + 3C$

$3CO + 2A \rightarrow A_2O_3 + 3C$

Answer the following:

(a) Which element is most reactive?

(b) Which element is least reactive?

8. Write the balanced chemical equations for the following reactions and identify the type of reaction in each case.

(a) Nitrogen gas is treated with hydrogen gas in the presence of a catalyst at 773 K to form ammonia gas.

(b) Sodium hydroxide solution is treated with acetic acid to form sodium acetate and water.

(c) Ethanol is warmed with ethanoic acid to form ethyl acetate in the presence of concentrated H_2SO_4.

(d) Ethene is burnt in the presence of oxygen to form carbon dioxide, water and releases heat and light.

Long Questions:

1. Balance the following equations:
   (a) $Bacl_2 + H_2SO_4 \longrightarrow BaSO_4 + HCl$
   (b) $CH_4 + O_2 \longrightarrow CO_2 + H_2O$
   (c) $FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$
   (d) $Pb(NO_3)_2 \xrightarrow{\Delta} PbO + NO_2 + O_2$
   (e) $KClO_3 \xrightarrow{\Delta} KCl + O_2$
2. On heating blue coloured powder of copper (II) nitrate in a boiling tube, copper oxide (black), oxygen gas and a brown gas X is formed.
   (a) Write a balanced chemical equation of the reaction.
   (b) Identify the brown gas X evolved.
   (c) Identify the type of reaction.
   (d) What could be the pH range of aqueous solution of the gas X?
3. (A) Name the type of chemical reaction represented by the following equation:
   (a) $CaCO_{3(s)} \xrightarrow{Heat} CaO_{(s)} + CO_{2(g)}$
   (b) $CaO_{(s)} + H_2O_{(l)} \xrightarrow{Heat} Ca(OH)_{2(aq)}$
   (c) $Zn(s) + H_2SO_4(ag) \rightarrow ZnSO_4(aq) + H_2(g)$
   (B) "A solution of potassium chloride when mixed with silver nitrate solution, and an insoluble white substance is formed".
      (i) Translate the above statement into a chemical equation.
      (ii) State two types for the classification of this reaction.

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

   Assertion: Silver articles become black after sometime when exposed to sunlight.

   Reason: It is because silver reacts with carbonates present in the air.
2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

   Assertion: A lead nitrate on thermal decomposition gives lead oxide, brown coloured nitrogen dioxide and oxygen gas.

   Reason: Lead nitrate reacts with potassium iodide to form yellow ppt. of lead iodide and the reaction is double displacement as well as precipitation reaction.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   Oxidation has damaging effect on metals as well as on food. The damaging effect of oxidation on metal is studied as corrosion and that on food is studied as rancidity. The phenomenon due to which metals are slowly eaten away by the reaction of air, water and chemicals present in atmosphere, is called corrosion. For example, iron articles are shiny when new, but get coated with a reddish-brown powder when left for some time. This process is known as rusting of iron. Rancidity is the process of slow oxidation of oil and fat (which are volatile in nature) present in the food materials resulting in the change of smell and taste in them.

   i. Rancidity can be prevented by:
      a. Adding antioxidants.
      b. Packaging oily food in nitrogen gas.
      c. Both (a) and (b).
      d. None of these.
   ii. Combination of phosphorus and oxygen is an example of:
      a. Oxidation.
      b. Reduction.
      c. Rancidity.
      d. None of these.

iii. A science teacher wrote the following statements about rancidity:

I. When fats and oils are reduced, they become rancid.

II. ln chips packet, rancidity is prevented by oxygen.

III. Rancidity is prevented by adding antioxidants.

Select the correct option.

a. (I) only

b. (II) and (III) only

c. (III) only

d. (I), (II) and (III)

iv. Two statements are given below regarding rusting of iron.

I. The rusting of iron is a redox reaction and reaction occurs as, $4Fe + 3O_2 \rightarrow 4Fe^{3+} + 6O^{2-}$

II. The metallic iron is oxidised to Fe^{2+} and O_2 is reduced to O^{2-}.

Select the correct statement(s).

a. I only.

b. II only.

c. Both I and II.

d. None of these.

v. Which of the following measures can be adopted to prevent or slow down rancidity?

I. Food materials should be packed in airtight container.

II. Food should be refrigerated.

III. Food materials and cooked food should be kept away from direct sunlight.

a. Only II and III.

b. Only I and III.

c. Only II and III.

d. I, II and III.

2. Read the following and answer any four questions from (i) to (v).

Chemical equation is a method of representing a chemical reaction with the help of symbols and formulae of the substances involved in it. ln a chemical equation, the substances which combine or react are called reactants and new substances produced are called products. A chemical equation is a shorthand method of representing a chemical reaction. A balanced chemical equation has equal number of atoms of different elements in the reactants and products side. An unbalanced chemical equation has unequal number of atoms of one or more elements in reactants and products. Formulae of elements and compounds are not changed to balance an equation.

i. Consider the following reaction:

$pMg_3N_2 + qH_2O \rightarrow rMg(OH)_2 + sNH_3$

When the equation is balanced, the coefficients p, q, r, s respectively are:

a. 1, 3, 3, 2

b. 1, 6, 3, 2

c. 1, 2, 3, 2

d. 2, 3, 6, 2

ii. Which of the following information is not conveyed by a balanced chemical equation?

a. Physical states of reactants and products.

b. Symbols and formulae of all the substances involved in a particular reaction.

c. Number of atoms/ molecules of the reactants and products formed.

d. Whether a particular reaction is actually feasible or not.

iii. The balancing of chemical equations is in accordance with:

a. law of combining volumes.

b. law of constant proportions.

c. law of conservation of mass.

d. both (b) and (c).

iv. Which of the following chemical equations is an unbalanced one?

a. $2NaHCO_3 \rightarrow Na2CO_3 + H_2O + CO_2$

b. $2C_4H_{10} + 12O_2 \rightarrow 8CO_2 + 10H_2O$

c. $2AI + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2$

d. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

v. Which of the following statements is/ are correct?

a. A chemical equation tells us about the substances involved in a reaction.

b. A chemical equation informs us about the symbols and formulae of the substances involved in a reaction.

c. A chemical equation tells us about the atoms or molecules of the reactants and products involved in a reaction.

d. All the above.

Answer Key

Multiple Choice Answers:

1. (b)
2. (a) basic magnesium carbonate
3. (c) (i), (ii) and (iv)
4. (a) (i) and (ii)
5. (a) addition of oxygen
6. (b) addition of hydrogen
7. (c) (i) and (iv)
8. (a) 1 : 2
9. (a) (i) only
10. (d) MnO_2

Very Short Answers:

1. **Answer**: Food becomes rancid when fat and oils present in the food are oxidized.
2. **Answer**: X = Mg, Y = MgO, $Mg + O_2 \rightarrow 2MgO$
3. **Answer**: An equation that has equal number of atoms of each element on both the sides of the equation is called a balanced chemical equation, i.e., mass of the reactants is equal to mass of the products.
4. **Answer**: $BaCl_2(aq) + Na_2SO_4\ (aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$
5. **Answer**: It is a brown mass known as hydrated ferric oxide. Its formula is $Fe_2O_3.\ xH_2O$.
6. **Answer**: The zinc rod will change into zinc sulphate.
7. **Answer**: Both silver chloride and silver bromide are used in black and white photography.
8. **Answer**: The process is known as the reduction of metal oxide.
9. **Answer**: Corrosion is responsible for the formation of this coating. Black coating is due to formation of Ag_2S and green coating is due to formation of $CuCO_3.Cu(OH)_2$.
10. **Answer**: Lime water (calcium hydroxide) combines with carbon dioxide to form a suspension of calcium carbonate which makes lime water milky.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

Short Answer:

1. **Answer**:

   (i) Marble chips react with dilute hydrochloric acid to form calcium chloride and carbon dioxide. It is a double displacement reaction.

   $$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

   (ii) Zinc granules react with dilute hydrochloric acid to give hydrogen gas. It is a displacement reaction.

   $$Zn\ (s) + 2HCl \rightarrow ZnCl_2\ (aq) + H_2\ (g)$$

2. **Answer**: The reaction in which two compounds in their aqueous state react to form an insoluble compound. When two reactants react and product formed remains insoluble and settles as a solid it is substance (precipitate) is called a precipitation reaction.

   For example,

   (i) When aqueous solution of sodium sulphate is mixed with an aqueous solution or barium chloride, barium sulphate is obtained as a white precipitate.

   $$Na_2SO_4\ (aq) + BaCl_2\ (aq) \longrightarrow BaSO_4\ (s) + 2NaCl\ (ag)$$

   (ii) When aqueous solution of sodium chloride is mixed with an aqueous solution of silver nitrate, silver chloride is obtained as a white precipitate.

3. **Answer**:

   On mixing the solutions of sodium sulphate and barium chloride, a white precipitate of barium sulphate is obtained.

   $$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$$

Sodium sulphate	Barium chloride	Barium sulphat	Sodium chloride

   It is a double displacement reaction.

4. **Answer**:

   (a) Oxidation is a process of addition of oxygen to a substance or removal of hydrogen from a substance, for example,

   $$2Cu + O_2 \xrightarrow{\Delta} 2CuO$$

Chemical Reactions and Equations Class 10 Extra Questions with Answers Science Chapter 1, 3

Copper is oxidized to CuO, as oxygen is added to copper.

(b) It is the process of removal of oxygen from a substance or addition of hydrogen to a substance, for example,

$$CuO + H_2 \xrightarrow{\Delta} Cu + H_2O$$

Copper oxide is reduced to copper as it involves removal of oxygen.

5. **Answer**:

(a) x = (s), y = (aq)

(b) x = 2Ag

(c) x = (aq); y = (g)

(d) x = heat

6. **Answer**:

We know that iron is more reactive than copper, so it displaces copper from copper sulphate solution and forms ferrous sulphate which is of light green colour.

$$CuSO_4(aq) + Fe(s) \longrightarrow FeSO_4(aq) + Cu(s)$$

Blue colour Light green colur

7. **Answer**:

(a) The most reactive element is 'B'. It has displaced both 'A' and 'C' from their compounds.

(b) The least reactive element is 'C' as it has been displaced by both 'A' and 'B'.

8. **Answer**:

(a) $N_2(g) + 3H_2(g) \xrightarrow[773\,K]{\text{Catalyst (pt)}} 2NH_3(g)$,

Combination reaction

(b) $KOH(aq) + CH_3COOH(aq) \longrightarrow$

Acetic acid

$CH_3COOK(aq) + H_2O(l)$

Potassium acetate

Double displacement or neutralisation reaction

(c) $C_2H_5OH(l) + CH_3COOH(l) \xrightarrow{H_2SO_4(conc)}$

Ethanol Ethanoic acid

$CH_3COOC_2H_5(l) + H_2O(l)$

Ethyl ethanoate

Combustion or redox reaction

Long Answer:

1. **Answer**:

(a) $Bacl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

(b) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(c) $2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$

(d) $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

(e) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

2. **Answer**:

(a) $2Cu(NO_3)_2 \xrightarrow{\text{Heat}} 2CuO + O_2 + 4NO_2$

Copper (II) nitrate (Black) — Copper (II) oxide — (Brown gas)

(b) Brown gas X is nitrogen dioxide (NO_2).

(c) It is a thermal decomposition reaction.

(d) The gas (NO_2) is an oxide of a non-metal. Hence, its aqueous solution will be acidic, i.e., pH range would be between 0 and 7.

3. **Answer**:

(A) (a) Decomposition reaction

(b) Combination reaction

(c) Displacement reaction.

(B) (i) $KCl\,(aq) + AgNO_3\,(aq) \longrightarrow AgCl\,(s) + KNO_3\,(aq)$

(ii) It is a double displacement reaction also called precipitation reaction.

Assertion Reason Answer:

1. **Answer**:

c. A is true, but R is false.

Silver reacts with sulphur present in the air and form the layer of silver sulphide therefore silver articles get tarnished.

2. **Answer**:

c. Both A and R are true, but R is not the correct explanation of the assertion.

Explanation:

Decomposition reaction is a reaction in which a compound breaks down into two or more simpler substances.

$$2Pb(NO_3)_2 \longrightarrow 2Pb0 + 4NO_2 + O_2$$

Case Study Answer:

1. **Answer**:

   i. (c) Both (a) and (b).

   Explanation:

   Antioxidants and nitrogen gas prevent oxidation of food.

   ii. Oxidation.

   Explanation:

   $4P + 3O_2 \rightarrow 2P_2O_3$

   $4P + 5O_2 \rightarrow 2P_2O_5$

   iii. (c) (III) only

   Explanation:

   The oils and fats are slowly oxidised to certain bad smelling compounds, which release foul smell. This is known as rancidity. Rancidity is prevented by filling nitrogen gas in chips packets.

   iv. Only II and III.

   v. (d) I, II and III.

2. **Answer**:

   i. (b) 1, 6, 3, 2

   Explanation:

   $Mg_3N_2 + 6H_2O - 3Mg(OH)_2 + 2NH_3$

   ii. (d) Whether a particular reaction is actually feasible or not.

   iii. (c) law of conservation of mass.

   Explanation:

   ln a balanced chemical equation, total mass of reactants must be equal to the total mass of products. This is the statement of law of conservation of mass.

   iv. (b) $2C_4H_{10} + 12O_2 \rightarrow 8CO_2 + 10H_2O$

1. (d) All the above.

Acids Bases and Salts 2

Acids

- Acids are those chemical substances which have a sour taste.
- Acids change the colour of blue litmus to red.
- The acid present in plant materials and animals are called **organic acids.**

  Examples of Organic Acids:
  - Acetic acid found in Vinegar(sirka),
  - Citric acid found in citrus fruit such as lemons and oranges.
  - Lactic acid found in sour milk (or curd)
  - Tartaric acid present in tamarind and unripe grapes,
  - Oxalis acid is present in tomatoes,
  - Formic acid (or methanoic acid) is present in ant sting and nettle sting.
- Organic acids (or naturally occurring) are weak acids,
- It is not harmful to eat or drink substances containing naturally occurring acids in them.
- The acids prepared from the minerals of earth are called **minerals acids.**
- **Minerals acids** are man-made acids.
- The three most common minerals acids are: HCl , H_2SO_4 , HNO_3 .
- Carbonic acid is also mineral acid but it is weak acid.
- Acid which contains the minimum possible amount of water in it is called concentrated acid.
- Dilute acid is obtained by mixing the concentrated acid with water

Bases

- Bases are those chemical substances which have a bitter taste.
- Bases change the colour of red litmus to blue.
- A base is a chemical substance which can neutralise an acid.
- All the metal oxides and metal hydroxide are bases.

  Examples:
  - Sodium oxide (Na_2O)
  - Sodium hydroxide (NaOH)
  - Calcium oxide (CaO)
  - Calcium hydroxide [$Ca(OH)_2$]
  - Ammonium hydroxide (NH_4OH)
- Metal carbonates and metal hydrogencarbonates are also considered to be bases because the neutralise the acids.

  Examples:
  - Sodium carbonate (Na_2CO_3)
  - Sodium hydrogencarbonate ($NaHCO_3$)
  - Calcium carbonate ($CaCO_3$)

- A base which is soluble in water is called an alkali.
- NaOH, KOH, $Ca(OH)_2$, NH_4OH and $Mg(OH)_2$ are most common alkalis.

Three different theories have been put forth in order to define acids and bases.

- The Arrhenius theory of acids and bases states that "an acid generates H+ ions in a solution whereas a base produces an OH– ion in its solution".
- The Bronsted-Lowry theory defines "an acid as a proton donor and a base as a proton acceptor".
- Finally, the Lewis definition of acids and bases describes "acids as electron-pair acceptors and bases as electron-pair donors".

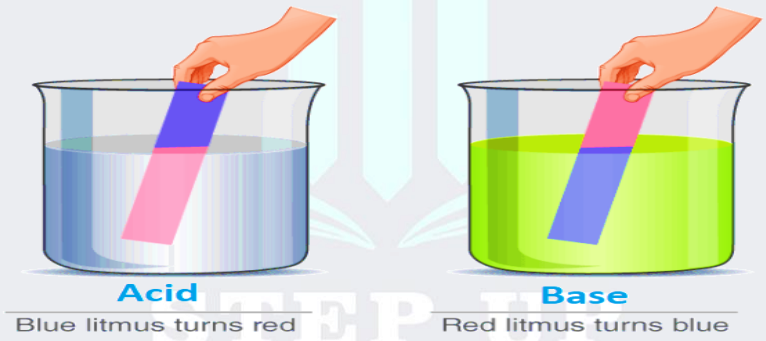
Acids and Bases in the Laboratory

Indicators

An indicator tells us whether a substance is acidic or basic in nature, by the change in colour.

Common Indicators

- An acid turns blue litmus red and a base turns red litmus blue.
- Methyl orange indicator gives a red colour in an acidic solution and gives a yellow colour in a basic solution.
- Phenolphthalein is colourless in an acidic solution and gives a pink colour in a basic solution.



Olfactory Indicators

- Those substances whose odour changes in acidic or basic media are called olfactory indicators. For example: onion, vanilla and clove oil.
- On adding sodium hydroxide solution to a cloth strip treated with onion, the smell of the onion is not detected. An acidic solution does not eliminate the smell of the onion.

Reaction of Acids & Bases with Metals

Acids and bases react with metals to produce salt by displacing hydrogen.

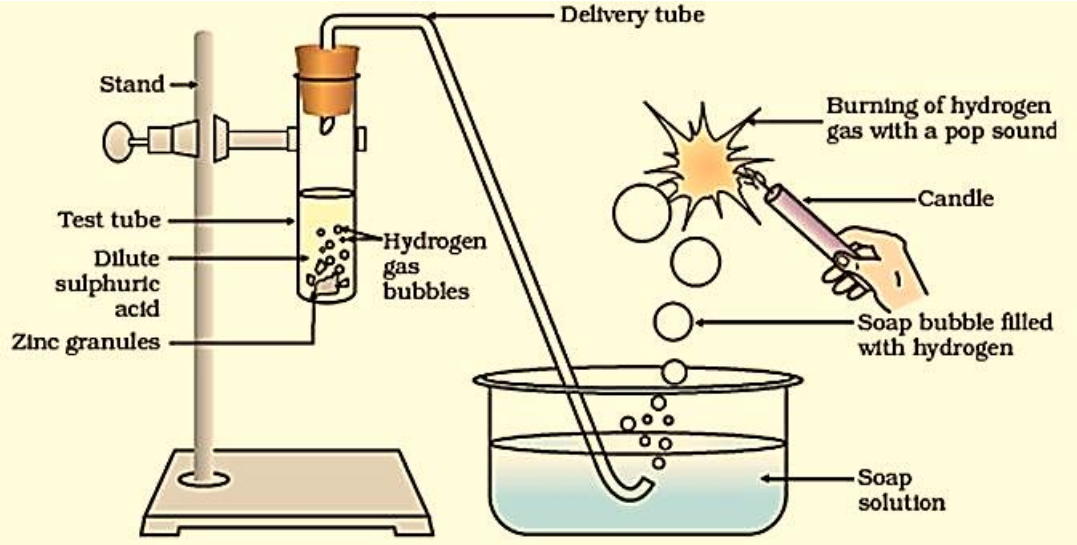
For Example:

1. When dilute sulphuric acid reacts with the metal zinc, zinc sulphate is formed with the evolution of hydrogen gas.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

2. Zinc is the only metal which reacts with sodium hydroxide base to form sodium zincate with the release of hydrogen gas.

$$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$$



Reaction of zinc granules with dilute sulphuric acid and testing hydrogen gas by burning

Reaction of Metal Carbonates & Bicarbonates with Acids

Acids react with metal carbonates or bicarbonates to form salt and water with the evolution of carbon dioxide gas.

For Example:

1. Hydrochloric acid reacts with sodium carbonate to form sodium chloride and water with the release of carbon dioxide gas.

$$Na_2CO_{3(s)} + 2\,HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

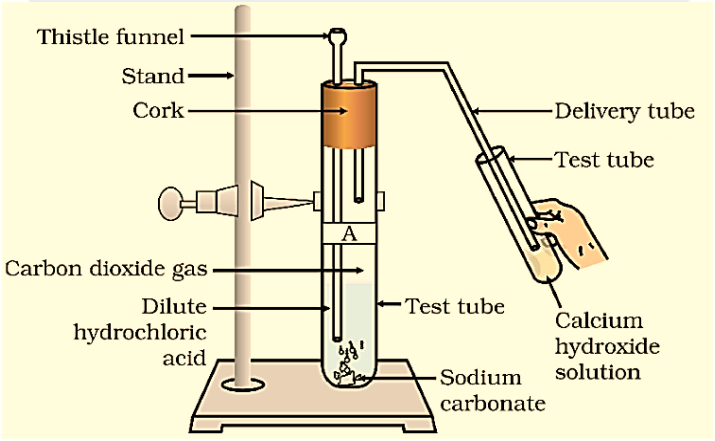
2. Similarly, sodium bicarbonate also reacts with hydrochloric acid to form sodium chloride and water with the release of carbon dioxide gas.

$$NaHCO_{3(s)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

This carbon dioxide gas reacts with lime water (calcium hydroxide solution) turns lime water milky due to the formation of white precipitate of calcium carbonate:

$$Ca(OH)_{2(aq)} + CO_{2(g)} \longrightarrow CaCO_{3(s)} + H_2O_{(l)}$$

Calcium hydroxide carbon dioxide — Calcium carbonate (White ppt.) — (Makes lime water milky)



Passing carbon dioxide gas through calcium hydroxide solution

Acids and Bases React with each other

The reaction between an acid and a base to form salt and water is called a neutralisation reaction.

For example:

Hydrochloric acid reacts with sodium hydroxide to form sodium chloride and water.

$$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

In general, a neutralisation reaction can be written as:

$$\text{Base} + \text{Acid} \rightarrow \text{Salt} + \text{Water}$$

Reaction of Metallic Oxides with Acids

Acids react with metallic oxides to form salt and water.

For Example:

Copper oxide (II), a black metal oxide reacts with dilute hydrochloric acid to form a blue-green coloured copper chloride (II) solution.

$$\underset{\text{Copper (II) oxide (Black)}}{CuO_{(s)}} + \underset{\text{Hydrchloric acid}}{2HCl_{(aq)}} \rightarrow \underset{\text{Copper(II)chloride (Blue-green)}}{CuCl_{2(aq)}} + H_2O_{(l)}$$

Reaction of Non-Metallic Oxides with Base

Bases react with non-metallic oxides to form salt and water.

For Example:

Calcium hydroxide reacts with non-metallic oxides like carbon dioxide to form calcium carbonate salt and water.

$$\underset{\text{Calcium hydroxide (Base)}}{Ca(OH)_{2(aq)}} + \underset{\text{Carbon dioxide (Non-metal oxide)}}{CO_{2(g)}} \rightarrow \underset{\text{Calcium carbonate (Salt)}}{CaCO_{3(s)}} + \underset{\text{Water}}{H_2O_{(l)}}$$

Acids and Bases in Water

Acids

An acid is a substance which dissociates (or ionises) when dissolved in water to release hydrogen ions.

For Example:

An aqueous solution of hydrochloric acid dissociates to form hydrogen ions. Since hydrogen ions do not exist as H^+ in solution, they combine with polar water molecules to form hydronium ions [H_3O^+].

$$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$$
$$H^+ + H_2O \rightarrow H_3O^+$$

The presence of hydrogen ions [H^+] in hydrochloric acid solution makes it behave like an acid.

Bases

A base is a substance which dissolves in water to produce hydroxide ions [OH- ions]. Bases which are soluble in water are called alkalis.

For Example:

Sodium hydroxide dissolves in water to produce hydroxide and sodium ions.

$$NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

The presence of hydroxide ions [OH^-] in sodium hydroxide solution makes it behave like a base.

pH Scale

- pH of a solution: pH of a solution is the negative logarithm to the base 10 of the hydrogen ion concentration expressed in mole per litre.

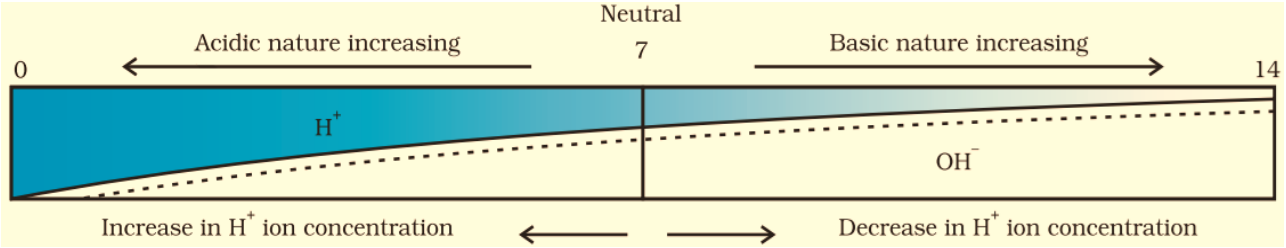
$$pH = -\log_{10}(H^+)$$

p H = 7 - Neutral	$[H^+] = [OH^-]$
pH less than 7 - **Acidic**	$[H^+]$ more than $[OH^-]$
pH more than 7 - **Basic**	$[OH^-]$ more than $[H^+]$

Universal Indicator

In case of a colourless liquid, the accurate pH can be obtained by adding a universal indicator.

It is a mixture of several indicators and shows different colours at different concentration of hydrogen ions in a solution.



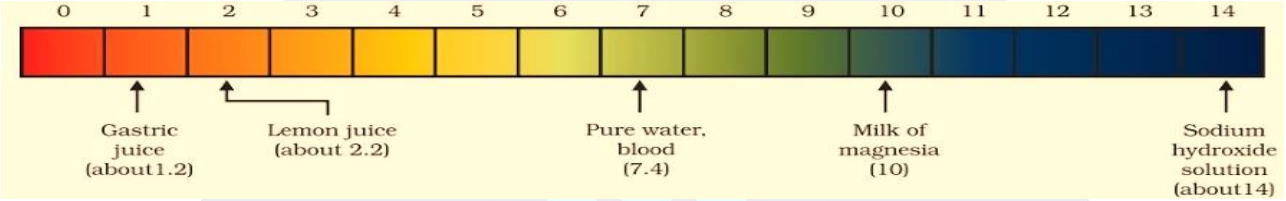
Variation of pH with the change in concentration of H+ (aq) and OH– (aq) ions

For Example:

i. A universal indicator produces green colour in a neutral solution, pH = 7.

ii. The colour changes from blue to violet as pH increases from 7 to 14.

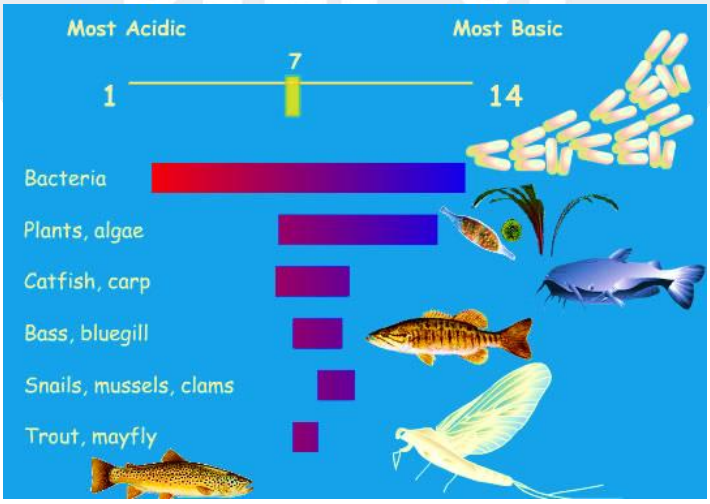
iii. The colour changes from yellow to pink and then to red as pH decreases from 7 to 1.



pH of some common substances shown on a pH paper (colours are only a rough guide)

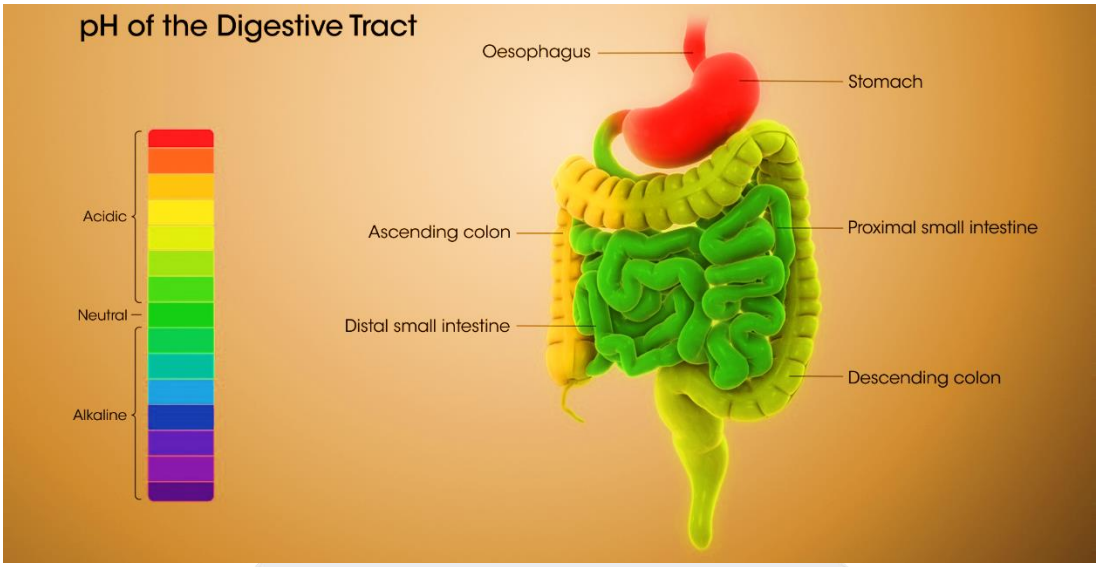
Importance of pH in everyday life

pH change and survival of animals



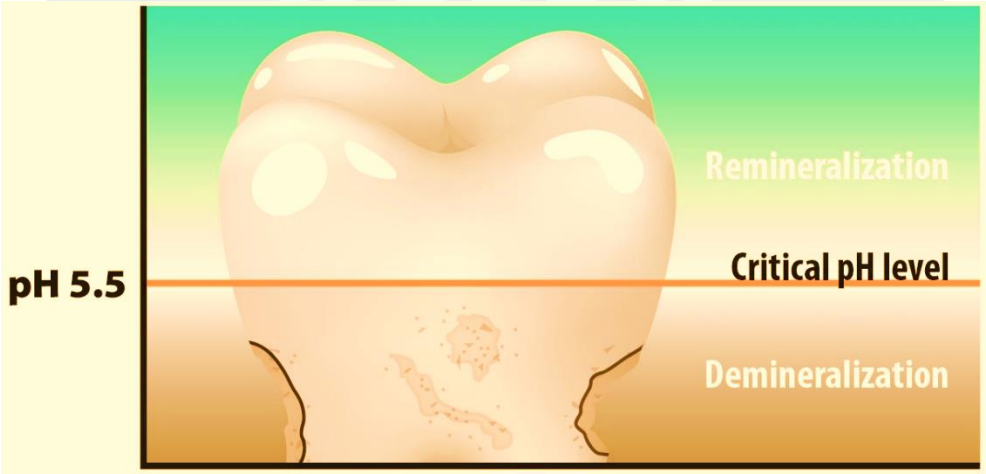
- Our body works well within a narrow pH range of 7.0 to 7.8.
- When the pH of rain water is less than 5.6, it is known as acid rain.
- When this acid rain flows into rivers, it lowers the pH of the river water making the survival of aquatic life difficult.

pH in our digestive system



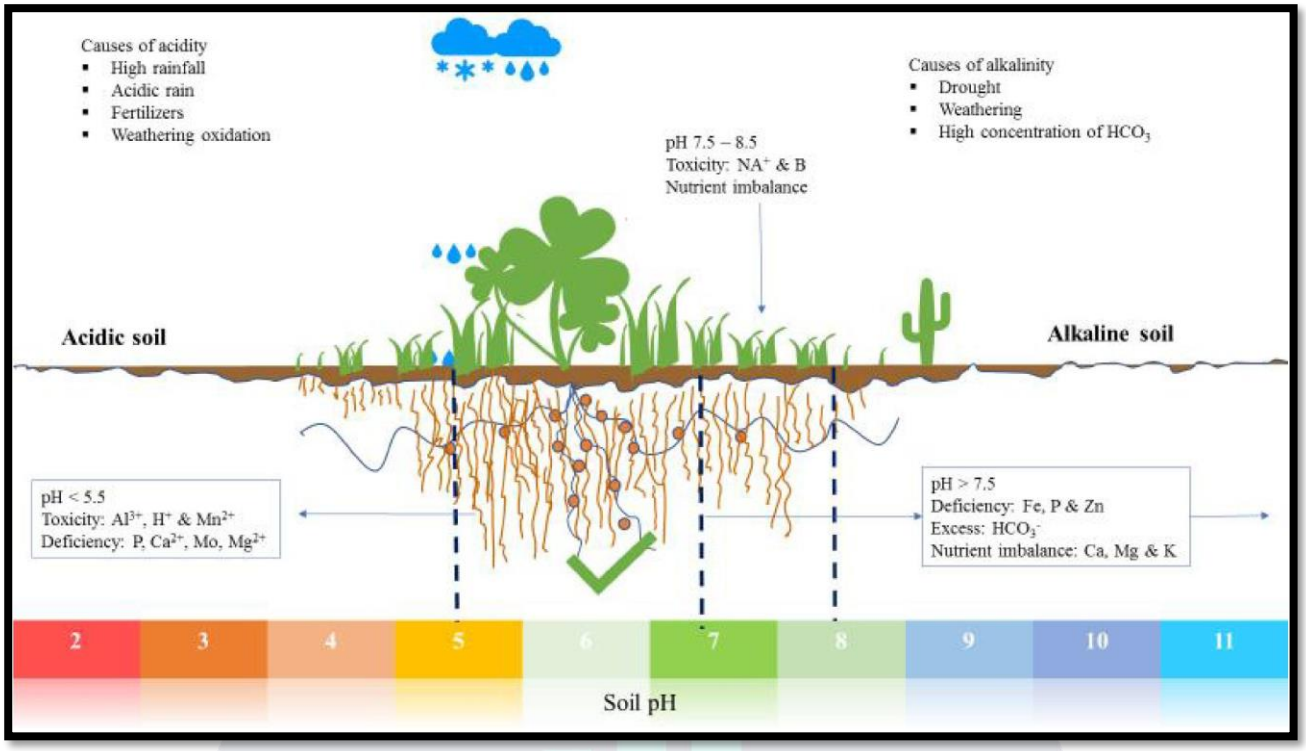
- Our stomach produces hydrochloric acid which helps in the digestion of food without harming the stomach.
- Sometimes excess acid is produced in the stomach which causes indigestion.
- To get rid of this pain, bases called antacids are used.
- Antacids are a group of mild bases which react with the excess acid and neutralise it.
- Commonly used antacids are magnesium hydroxide [$Mg(OH)_2$] & sodium bicarbonate [$NaHCO_3$]

pH change - Cause of tooth decay



- Tooth decay starts when the pH in the mouth falls below 5.5.
- Tooth enamel is made up of calcium phosphate which is the hardest substance in the body.
- It is insoluble in water but gets corroded when the pH in the mouth falls below 5.5.
- The bacteria present in the mouth produce acids due to the degradation of sugar and food particles after eating.
- Hence, to prevent tooth decay, the mouth should be rinsed after eating food and toothpastes which are basic should be used cleaning teeth to neutralise the excess acid.

Soil of pH and plant growth



Most of the plants have a healthy growth when the soil has a specific pH (close to 7) range which should be neither alkaline nor highly acidic. Therefore,

- Compound 'X' is Sodium hydroxide (NaOH).
- Compound 'A' is Zinc sulphate (ZnSO4).
- Compound 'B' is Sodium chloride (NaCl).
- Compound 'C' is Sodium acetate (CH3COONa)

Salts:

The compounds formed by the reaction between an acids and a bases are known as a salts.

Acid + Base → Salt + Water

Salts are ionic compounds which contain positively charged cations and negatively charged anions. During salt formation cation is coming from base and anion is coming from acid.

Example: In Sodium chloride (NaCl) formation cation sodium is coming from sodium hydroxide and anion chlorine is coming from hydrochloric acid.

Classification of salts:

Based on nature the salts have been classified into different types. They are:

- Normal salts
- Acidic salts
- Basic salts
- Double salts

Normal salts:

These salts are formed by the complete replacement of hydrogen in acids by other metal cations from the bases.

NaCl is normal salt formed by the reaction of HCl with NaOH.

$HCl + NaOH \rightarrow NaCl + H_2O$

Acidic salts:

Salts which are formed by the partial replacement of hydrogens atoms of acids are called acidic salts.

Example: NaHSO4 is formed when partial replacement of hydrogen atoms by the sodium atoms of base.

$$H_2SO_4 + NaOH \rightarrow NaHSO_4 + H_2O$$

In general these salts formed when the reacted base is not sufficient for the neutralisation of acid.

Basic salts:

Salts which are formed by the partial replacement of hydroxyl group are called basic salts.

Example: Ca(OH)Cl is formed by the partial replacement of hydroxide group from Ca(OH)2 by chloride ions of acid.

$$Ca(OH)_2 + HCl \rightarrow Ca(OH)Cl + H_2O$$

In general these salts formed when the reacted acid is not sufficient for the neutralisation of base.

Table below giving neutral, acidic and basic salts.

Type of Salt	Type of Acid	Type of Base	Example
Neutral pH = 7	Strong Acids Examples: HCl H_2SO_4	Strong Bases Examples: NaOH KOH	NaCl K_2SO_4
Acidic pH < 7	Strong Acids Examples: HCl HNO_3	Strong Bases Examples: NH_4OH $Mg(OH)_2$	NH_4Cl $Mg(NO_3)_2$
Basic pH > 7	Weak Acids Examples: H_2CO_3 CH_3COOH	Strong Bases Examples: NaOH KOH	Na_2CO_3 CH_3COOK

Double salts:

Salts that are formed by mixing of two simple salts which are obtained crystallisation.

Example:

Potash alum - $K_2SO_4\ Al_2\ (SO_4)_3\ .24H_2O$

Dolomite - $CaCO_3.MgCO_3$

Complex salts:

The salts which contains different types of metal atoms which on hydrolysis produces complex ions along with simple ions are called complex salts.

Example:

$$[Ag(NH_3)_2]Cl \rightleftarrows [Ag(NH_3)_2]^+ + Cl^-$$

Complex salts:

The salts which contains different types of metal atoms which on hydrolysis produces complex ions along with simple ions are called complex salts.

Example:

$$[Ag(NH_3)_2]Cl \rightleftarrows [Ag(NH_3)_2]^+ + Cl^-$$

Complex salts:

The salts which contains different types of metal atoms which on hydrolysis produces complex ions along with simple ions are called complex salts.

Example:

$$[Ag(NH_3)_2]Cl \rightleftarrows [Ag(NH_3)_2]^+$$

Complex salts:

The salts which contains different types of metal atoms which on hydrolysis produces complex ions along with simple ions are called complex salts.

Example:

$$[Ag(NH_3)_2]Cl \rightleftarrows [Ag(NH_3)_2]^+ + \text{Family of salts}$$

pH of Salts

- Salts of strong acid and a strong base are neutral, with a pH value of 7.

  For Example: NaCl, Na_2SO_4
- Salts of strong acid and weak base are acidic, with a pH value less than 7.

  For Example: Ammonium chloride solution has pH value of 6.
- Salts of weak acid and strong base are basic, with a pH value more than 7.

  For Example: Sodium carbonate solution has a pH value of 9.

Salts in Our Daily Life

Common Salt [NaCl]

- Common salt is a neutral salt and can be prepared in the laboratory by the reaction of sodium hydroxide and hydrochloric acid.

$$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H2O_{(aq)}$$

- It is an important raw material for products of daily use such as NaOH, baking soda, washing soda and bleaching powder.

Uses of NaCl:

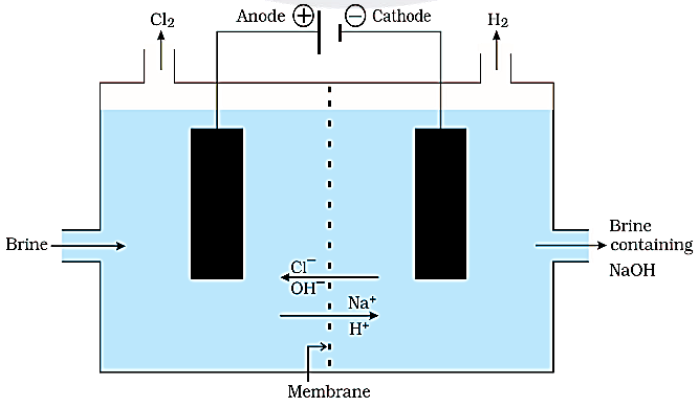
- Common salt (sodium chloride) is used in cooking food.It improves the flavour of food.
- Common salt is used in the manufacture of soap.
- Common salt is used to melt ice which collects on the roads during winter in cold countries

Sodium Hydroxide [NaOH]

- Sodium hydroxide is produced by the electrolysis of an aqueous solution of sodium chloride (called brine).
- The process is called the chlor-alkali process because of the products formed, i.e. 'chlor' for chlorine and 'alkali' for sodium hydroxide.

$$2NaCl_{(aq)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)} + Cl_{2(g)}$$

Sodium chloride (Brine) | Water | Sodium hydroxide | Hydrogen | Chlorine



Important products from the chlor-alkali process

Uses of sodium hydroxide:

- NaOH is used for making soaps and detergents.
- It is used in purifying bauxite ore from which aluminium metal is extracted.
- It is used in de-greasing metals, oil refining and making dyes and bleaches.

Bleaching Powder [$CaOCl_2$]

- It is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$].

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

- It is represented as $CaOCl_2$

Uses

- for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry;
- as an oxidising agent in many chemical industries; and
- to make drinking water free from germs.

Baking Soda [$NaHCO_3$]

- Chemical formula: $NaHCO_3$
- It is produced on a large scale by treating cold and concentrated solution of sodium chloride (brine) with ammonia and carbon dioxide.

$$NaCl. + NH_3 + H_2O + CO_2 \text{———>} NaHCO_3 + NH_4Cl$$

Sodium chloride ammonia — Sodium bicarbonate (Baking soda)

- On heating, it decomposes to give sodium carbonate with the evolution of carbon dioxide.

$$2NaHCO_3 \text{———->} Na_2CO_3 + CO_2 + H_2O$$

Sodium bicarbonate — Anhydrous Sodium carbonate (Soda ash)

Uses

- For making baking powder, which is a mixture of baking soda (sodium hydrogen carbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place:

$$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

- Carbon dioxide produced during the reaction can cause bread or cake to rise making them soft and spongy.
- Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.
- It is also used in soda-acid fire extinguishers.

Washing Soda

- Chemical formula: $Na_2CO_3.10H_2O$
- It is produced on a large scale by treating cold and concentrated solution of sodium chloride (brine) with ammonia and carbon dioxide.

$$NaCl. + NH_3 + H_2O + CO_2 \text{———>} NaHCO_3 + NH_4Cl$$

Sodium chloride ammonia — Sodium bicarbonate (Baking soda)

- On heating, it decomposes to give sodium carbonate with the evolution of carbon dioxide.

$$2NaHCO_3 \text{———->} Na_2CO_3 + CO_2 + H_2O$$

Sodium bicarbonate — Anhydrous Sodium carbonate (Soda ash)

- Anhydrous sodium carbonate (soda ash) is dissolved in water and recrystallised to get washing soda crystals containing 10molecules of water of crystallisation.

$$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3.10H_2O$$

Anhydrous sodium carbonate. (Soda ash). Sodium carbonate decahydrate (Washing Soda)

Uses

- Sodium carbonate (washing soda) is used in glass, soap and paper industries.
- It is used in the manufacture of sodium compounds such as borax.
- Sodium carbonate can be used as a cleaning agent for domestic purposes.
- It is used for removing permanent hardness of water.

Water Of Crystallisation

- Water molecules which form a part of the structure of a crystal are called water of crystallisation.
- The salts which contain water of crystallisation are called hydrated salts.
- Every hydrated salt has a fixed number of molecules of crystallisation in its one formula unit.

  For Example: $CuSO_4.5H_2O$, $Na_2CO_3.10H_2O$, $CaSO_4.5H_2O$, and $FeSO_4.7H_2O$
- Copper sulphate crystals ($CuSO_4.5H_2O$) are blue in colour, and on heating strongly they lose all the water of crystallisation and form anhydrous copper sulphate, which is white.
- On adding water to anhydrous copper sulphate, it gets hydrated and turns blue.

$$CuSO_4.5H_2O \xrightarrow{Heat} CuSO_4 + 5H_2O$$

$$CuSO_4 + 5H_2O \rightarrow CuSO_4.5H_2O$$

Plaster of Paris

Plaster of Paris is prepared by heating gypsum at 373 K. On heating, it loses water molecules and becomes calcium sulphate hemihydrate ($CaSO_4.\frac{1}{2}H_2O$) which is called Plaster of Paris.

$$CaSO_4.2H_2O \xrightarrow{Heat} CaSO_4.\frac{1}{2}H2O + 1\frac{1}{2}H_2O$$

(Gypsum) (Plaster of Paris)

Uses

- Used in hospitals as plaster for supporting fractured bones in the right position.
- Used as a fire-proofing material.

Class : 10th Chemistry
Chapter-2 : Acid Base and Salt

Sour in taste

Turns blue litmus red

Give H+ ions aqueous soultion

Aqueous solution

Physical Properties of Acids

Bitter in taste

Turns red litmus blue

Give OH- ions in aqueous Solution

Does not con duct electricity

Physical Properties of base

Acid Base and Salt

Chemical Properties of Acids

Reacts with metals to liberate hydrogen. Acid+Metal → Salt+Hydrogen Gas

$2HCl + Zn \rightarrow ZnCl_2 + H_2\uparrow$

Reacts with metal carbonates/metal hydrogen carbonate to liberate CO_2

- $2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$
- $HCl + NaHCO_3 \rightarrow NaCl + CO_2 + H_2O$

Reacts with certain metal oxides to form salt and water.
Metal oxide + Acid → Salt + Water

Salts

Chemical Properties of Bases

Alkali reacts with metals to liberate hydrogen. Acid+Metal → Salt+Hydrogen Gas

$2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2\uparrow$

When acid and base are combined under the given condition, Salt is obtained

Bases reacts with acidic oxides to form salts.

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

Washing Soda: $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$

Common salt: $NaOH + HCl \rightarrow NaCl + H_2O$

Types Of Salts

Baking Soda: $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$

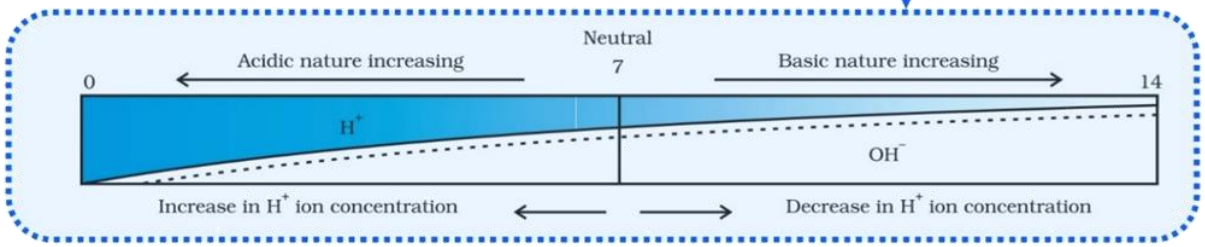
Bleaching Powder: $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

Gypsum: $CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O$

Plaster of Paris: $CaSO_4.2H_2O \rightarrow CaSO_4 \cdot \frac{1}{2}H_2O + 1\frac{1}{2}H_2O$

pH scale: It is the H+ ion Concentration of the solutions, denoted by pH

Classification of Acid, Base and Neutral solutions based on pH scale



Important Questions

Multiple Choice Questions:

1. What happens when a solution of an acid is mixed with a solution of a base in a test tube?
   (i) Temperature of the solution decreases
   (ii) Temperature of the solution increases
   (in) Temperature of the solution remains the same
   (iv) Salt formation takes place
   (a) (i) and (iv)
   (b) (i) and (iii)
   (c) (ii) only
   (d) (ii) and (iv)
2. When hydrogen chloride gas is prepared on a humid day, the gas is usually passed through the guard tube containing calcium chloride. The role of calcium chloride taken in the guard tube is to
   (a) absorb the evolved gas
   (b) moisten the gas
   (c) absorb moisture from the gas
   (d) absorb Cl– ions from the evolved gas
3. Which one of the following salts does not con-tain water of crystallisation?
   (a) Blue vitriol
   (b) Baking soda
   (c) Washing soda
   (d) Gypsum
4. In terms of acidic strength, which one of the following is in the correct increasing order?
   (a) Water < Acetic acid < Hydrochloric acid
   (b) Water < Hydrochloric acid < Acetic acid
   (c) Acetic acid < Water < Hydrochloric acid
   (d) Hydrochloric acid < Water < Acetic acid
5. What is formed when zinc reacts with sodium hydroxide?
   (a) Zinc hydroxide and sodium
   (b) Sodium zincate and hydrogen gas
   (c) Sodium zinc-oxide and hydrogen gas
   (d) Sodium zincate and water
6. Tomato is a natural source of which acid?
   (a) Acetic acid
   (b) Citric acid
   (c) Tartaric acid
   (d) Oxalic acid
7. Brine is an
   (a) aqueous solution of sodium hydroxide
   (b) aqueous solution of sodium carbonate
   (c) aqueous solution of sodium chloride
   (d) aqueous solution of sodium bicarbonate
8. $Na_2CO_3.\ 10H_2O$ is
   (a) washing soda
   (b) baking soda
   (c) bleaching powder
   (d) tartaric acid
9. At what temperature is gypsum heated to form Plaster of Paris?
   (a) 90°C
   (b) 100°C
   (c) 110°C
   (d) 120°C
10. How many water molecules does hydrated calcium sulphate contain?
    (a) 5
    (b) 10
    (c) 7
    (d) 2

Very Short Question:

1. Write a balanced chemical equation for the reaction between sodium carbonate and hydrochloric acid indicating the physical state of the reactants and products.
2. During summer season, a milkman usually adds a small amount of baking soda to fresh milk. Give reason.
3. What is the difference between slaked lime and lime water?
4. Which acid is present in sour milk or curd?
5. Why is potassium iodide added into common salt to use it as table salt?
6. What are the pH values of distilled water and common salt solution
7. A dry pellet of a common base B, when kept in open absorbs moisture and turns sticky. The compound is also a by-product of chloralkali process. Identify B. What type of reaction occurs when B is treated with an acidic oxide? Write a balanced chemical equation for one such solution.

8. Which bases are called alkalies? Give an example of an alkali.
9. A knife, which is used to cut a fruit, was immediately dipped into water containing drops of blue litmus solution. If the colour of the solution is changed to red, what inference can be drawn about the nature of the fruit and why?
10. How do H^+ ions exist in water?

Short Questions:

1. How will you find pH of lemon juice?
2. A sample of bleaching powder was kept in an air tight container. After a month, it lost some of its chlorine content. How will you account for it?
3. An aqueous solution of sodium carbonate is basic and not acidic. Assign reason.
4. An old person complained of acute pain in the stomach. Doctor gave him a small antacid tablet and he got immediate relief. What actually happened?
5. A milkman adds very small amount of baking soda to fresh milk. What happens to its pW?
6. A few drops of phenolphthalein indicator were added to an unknown solution A. It acquired pink colour. Now another unknown solution B was added to it dropwise and the solution ultimately became colourless. Predict the nature of the solutions A and B.
7. A compound which is prepared from gypsum has the property of hardening when mixed with proper quantity of water. Identify the compound. Write chemical equation to prepare the compound. Mention one important use of the compound.
8. The oxide of a metal M was water soluble. When a blue litmus strip was dipped in this solution, it did not undergo any change in colour. Predict the nature of the oxide.

Long Questions:

1. (a) A solution has a pH of 7. Explain how you would you:
   (i) increase its pH
   (ii) decrease its pH
   (b) If a solution changes the colour of the litmus from red to blue, what can you say about its pH?
   (c) What can you say about the pH of a solution that liberates carbon dioxide from sodium carbonate?
2. Explain why:
   (i) Common salt becomes sticky during the rainy season
   (ii) Blue vitriol changes to white upon heating
   (iii) If bottle full of concentrated sulphuric acid is left open in the atmosphere by accident, the acid starts flowing out of the bottle of its own.
3. (a) Name the raw materials used in the manufacture of sodium carbonate by Solvay process.
   (b) How is sodium hydrogen carbonate formed during Solvay process separated from a mixture of NH_4Cl and $NaHCO_3$?
   (c) How is sodium carbonate obtained from sodium hydrogen carbonate?

Assertion Reason Question:

1. For question two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

   Assertion: The process of dissolving an acid or a base in water is highly exothermic reaction.

   Reason: Water must always be added slowly to acid with constant stirring.
2. For question two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

   Assertion: Higher the H+ ion concentration, lower is the pH value.

   Reason: The pH of a neutral solution = 7, that of a basic solution< 7 and that of an acidic solution> 7.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   Bleaching powder is also known as chloride of lime. It is a solid and yellowish white in colour. Bleaching powder can be easily identified by the strong smell of chlorine. When calcium hydroxide (slaked lime) reacts with chlorine, it gives calcium oxychloride (bleaching powder) and water is formed. Aqueous solution of bleaching powder is basic in nature. The material to be bleached is first passed through solution of Na OH to remove greasy matter. Then it is passed through aqueous solution of bleaching powder and very dil. HCl solution. HCl reacts with bleaching powder to liberate nascent oxygen which bleaches material.

   i. Bleaching powder is used as:
      a. Bleaching agent in textile, paper and jute industry.
      b. Disinfectant for water to make water free of germs.
      c. Oxidising agent in many industries.
      d. All of these.

   ii. Bleaching powder is also known as:
      a. Calcium oxychloride.
      b. Calcium hypochlorite.
      c. Chloride of lime.
      d. All of these.

   iii. Bleaching powder gives smell of chlorine because it.
      a. Is unstable.
      b. Gives chlorine on exposure to atmosphere.
      c. Is a mixture of chlorine and slaked lime.
      d. Contains excess of chlorine.

   iv. Select the correct statement (s) regarding bleaching powder.
      a. It is pale yellow powder having smell of chlorine.
      b. It is sparingly soluble in water and gives milky suspension when dissolved in water.
      c. As bleaching powder gives nascent oxygen, it shows bleaching property.
      d. All of these.

   v. Identify the product 'X' in the given reaction.
      $Ca(OH)_2 + Cl_2 \rightarrow X + H_2O$
      a. $CaOCl_2$
      b. $CaCl_2$
      c. $Ca(ClO_3)_2$
      d. $CaCO_3$

2. Read the following and answer any four questions from (i) to (v).

   Baking powder produces carbon dioxide on heating, so it is used in cooking to make the batter spongy. Although, baking soda also produces CO_2 on heating, but it is not used in cooking because on heating, baking soda produces sodium carbonate along with carbon dioxide. Sodium carbonate, thus, produced, makes the taste bitter. Baking powder is the mixture of baking soda and a mild edible acid. Generally, tartaric acid is mixed with baking soda to make baking powder. When baking powder is heated, $NaHCO_3$ decomposes to give CO_2 which makes bread and cake fluffy. Tartaric acid helps to remove bitter taste due to formation of sodium tartrate.

   $2NaHCO_3 + C4H_6O_6 \longrightarrow 2CO_2 + H_2O + Na_2C_4H_4O_6$

   Baking soda | Tartaric acid | Carbon dioxide | Sodium tartaric

   i. On passing excess CO_2 gas in aqueous solution of sodium carbonate, the substance obtained is:
      a. NaOH
      b. $NaHCO_3$
      c. $Na_2CO_3.I0H_2O$
      d. $Na_2CO_3.H_2O$

   ii. When sodium hydrogen carbonate is added to acetic acid, it evolves a gas. Which of the following statements are true about the gas evolved?
      I. It turns lime water milky.
      II. It extinguishes a burning splinter.
      III. It turns lime water milky.
      IV. It has a pungent odour.
      a. (I) and (II).
      b. (I), (II) and (III).
      c. (II), (III) and (IV).
      d. (I) and (IV).

   iii. Select the correct statement regarding sodium hydrogen carbonate.
      a. CO and CO_2 are produced during the heating of $NaHCO_3$.
      b. It is insoluble in water.
      c. It is used in soda-acid fire extinguishers.
      d. All of these.

   iv. Acetic acid was added to a solid X kept in a test tube. A colourless and odourless gas was evolved. The gas was passed through lime water which turned milky. It was concluded that,

a. Solid X is sodium hydroxide and the gas evolved is CO_2.
b. Solid X is sodium bicarbonate and the gas evolved is CO_2.
c. Solid X is sodium acetate and the gas evolved is CO_2.
d. Solid X is sodium chloride and the gas evolved is CO_2.

v. Which of the following statements are correct regarding baking soda?

I. Baking soda is sodium hydrogen carbonate.
II. On heating, baking soda gives sodium carbonate.
III. It is used for manufacture of soap.
IV. It is an ingredient of baking powder.

a. I and IV only.
b. I, II and III only.
c. I, II and IV only.
d. I, II, III and IV

Answer Key

Multiple Choice Answers:

1. (d) (ii) and (iv)
2. (c) absorb moisture from the gas
3. (b) Baking soda
4. (a) Water < Acetic acid < Hydrochloric acid
5. (b) Sodium zincate and hydrogen gas
6. (d) Oxalic acid
7. (c) aqueous solution of sodium chloride
8. (a) washing soda
9. (b) 100°C
10. (d) 2

Very Short Answers:

1. **Answer:** Dilute Hydrochloric(HCl) acid reacts with sodium carbonate(Na_2CO_3) to produce sodium chloride (NaCl), carbon dioxide(CO_2), and water(H_2O). Brisk effervescence is seen due to the formation of carbon dioxide gas.

   The balanced chemical reaction is as follows:

   $2HCl(aq)+Na2CO3(aq) \dashrightarrow 2NaCl(aq) +CO2(g)+H2O(l)$

2. **Answer:** Baking soda acts as a bit like preservative. It makes milk a bit alkaline so as to reduce the pace of bacteria acting on it ,as they add acids (e.g. lactic acid) to the milk and turn it sour. this keeps the milk from becoming sour for a long time.

3. **Answer:** Slaked lime is hydrated calcium hydroxide whereas lime water is a saturated solution of calcium hydroxide. Furthermore, slaked lime has calcium hydroxide in its unsaturated form while lime water has calcium hydroxide in its saturated form in the chemical nature of each these solutions. Similarly, we produce slaked lime from calcium oxide whereas we produce lime water from calcium hydroxide. Below inforgraphic presents more details on the difference between slaked lime and lime water in tabular form.

4. **Answer:** Lactic Acid or milk acid is an organic acid with chemical formula $C_3H_6O_3$. When milk sugar or lactose undergoes fermentation, the product obtained is lactic acid. It is found in cottage cheese, leban, sour milk, yogurt, and Koumiss.

5. **Answer:** Potassium iodide and potassium iodate are commonly added to table salt to prevent iodine deficiency and associated thyroid disease.

6. **Answer:** Normal distilled water has a pH of less than 7.0 and acidic because it dissolves carbon dioxide from the air. pH value of sodium chloride (common salt) in a solution (i.e) common salt solution is about equal to 7.

7. **Answer:** Sodium hydroxide is a byproduct of chloralkali process. When it is kept in open, it absorbs moisture and turns sticky.

   When sodium hydroxide is treated with carbon dioxide, it gives sodium carbonate. It is important to remember that carbon dioxide is an acidic oxide.

   $$2NaOH+CO_2 \dashrightarrow Na_2CO_3+H_2O$$

   Since this reaction is between a basic compound and an acidic compound, hence it is a neutralization reaction.

   B is sodium hydroxide.

8. **Answer:** Alkalis can be defined as bases that are soluble in water. All alkalis are bases, but all bases are not Alkalis. Example: Sodium hydroxide. They are recognized to comprise of high pH value, i.e., above 7.

9. **Answer:** A knife, which is used to cut a fruit, was immediately dipped into water containing drops of blue litmus solution. If the colour of the solution is changed to red, what inference can be drawn about the nature of the fruit and why?

10. **Answer:** H+ ions do not exist independently, it gains the unshared electron pairs on the oxygen in the water molecule to form a hydronium ion.

$$H^+ + H_2O \longrightarrow H_3O^+$$

Hence H^+ ions in water are found as hydronium ions.

Short Answer:

1. **Answer**:
   (a) Take about 5mL of the given sample of lemon juice in a test tube.
   (b) Dip a strip of the universal pH paper in the tube.
   (c) Take out the strip and note its colour. It will acquire a orange red colour.
   (d) On comparison with pH paper chart, the pH of the solution falls in the range between 2 and 3.

2. **Answer**: Bleaching powder if kept even in an airtight container, will slowly decompose of its own and form calcium chlorate and calcium chloride. The reaction is called auto-oxidation. This will result in decrease in its chlorine contents.

$$\underset{\text{Bleaching powder}}{6CaOCl_2} \longrightarrow \underset{\text{Calcium chlorate}}{Ca(ClO_3)_2} + \underset{\text{Calcium chloride}}{5CaCl_2}$$

3. **Answer**: Sodium carbonate reacts with water to form sodium hydroxide and carbonic acid.

$$NaCO_3 + 2H_2O \longrightarrow \underset{\text{(Strong base)}}{2NaOH_2} + \underset{\text{(Weak acid)}}{H_2CO_3}$$

Since the base is strong while acid is weak, the solution is basic and not acidic.

4. **Answer**: The old person was suffering from acute acidity. Antacid tablet contains sodium hydrogen carbonate ($NaHCO_3$). It reacts with the acid (HCl) formed because of acidity and neutralizes its effect. That is how the old person got relief.

5. **Answer**: The pH of fresh milk is nearly 6. Baking soda is sodium hydrogen carbonate ($NaHCO_3$). On adding it to fresh milk, the medium becomes alkaline and its pH therefore, increases.

6. **Answer**: The solution A is basic in nature and phenolphthalein has imparted pink colour to it. The solution B is of an acid which has ultimately made solution A colourless by neutralising its basic effect.

7. **Answer**: The compound is Plaster of Paris ($CaSO_4.½\ H_2O$). It is formed from Gypsum ($CaSO_2.2H_2O$) upon heating to a temperature of 373 K and also changes back to Gypsum on adding water. Plaster of Paris is used for setting fractured bones.

$$\underset{\text{Gypsum}}{CaSO_4.2H_2O} \rightarrow \underset{\text{Plaster of Paris}}{CaSO_4½H_2O} + \tfrac{3}{2}\ H_2O$$

$$CaSO_4.½H_2O + \tfrac{3}{2}\ H_2O \rightarrow CaSO_4.2H_2O$$

8. **Answer**: The metal oxide (MO) is of basic in nature. It dissolves in water to form metal hydroxide as follows:

$$MO + H_2O \rightarrow M(OH)_2$$

A blue litmus does not undergo any change in colour in the basic medium.

Long Answer:

1. **Answer**:
   (a) The solution with pH 7 is neutral. Its pH can be increased by adding a small amount of base like sodium hydroxide. Basic solutions have pH more than 7. Similarly, pH can be decreased by adding small amount of acid like hydrochloric acid. Acidic solutions have pH less than 7.
   (b) The change in colour of litmus from red to blue indicates that the solution is of basic nature with pH more than 7.
   (c) Carbon dioxide can be liberated by reacting sodium carbonate solution with acid like dilute hydrochloric acid. This shows that the solution is of acidic nature with pH less than 7.

2. **Answer**:
   (i) Common salt contains the impurity of magnesium chloride ($MgCl_2$) which is of deliquescent nature. When exposed to atmosphere, it becomes moist. Therefore, common salt becomes sticky during the rainy reason.
   (ii) Blue vitriol ($CUSO_4.5H_2O$) upon heating changes to anhydrous copper sulphate ($CUSO_4$) which is white in colour.
   (iii) Concentrated sulphuric acid is highly hygroscopic. It absorbs moisture from air and gets diluted. Since the volume increases, the acid starts flowing out of the bottle.

3. **Answer**:
   (a) The raw materials used are: NaCl, lime stone or $CaCO_3$ and NH_3.

(b) Sodium hydrogen carbonate ($NaHCO_3$) is sparingly soluble or less soluble in water and gets separated as a preciptate while NH_4Cl remains in solution. The precipitate is removed by filtration.

(c) Sodium hydrogen carbonate is converted to sodium carbonate upon heating.

$$2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + H_2O + CO_2$$

Assertion Reason

1. (c) A is true, but R is false.

Explanation:

The process of dissolving an acid or a base in water is highly exothermic reaction. Acid must always be added slowly to water with constant stirring.

2. (c) A is true, but R is false.

Explanation:

Higher the H^+ ion concentration, lower is the pH value. The pH value less than 7 represents an acidic solution and value more than 7 represents a basic solution.

Case Study Answer:

1. i. (d) All of these.

ii. (d) All of these.

iii. (b) Gives chlorine on exposure to atmosphere.

Explanation:

Bleaching powder gives chlorine on exposure to air by reacting with CO_2.

$$CaClO_2 + CO \rightarrow CaCO + Cl_2$$

iv. (d) All of these.

v. (a) $CaOCl_2$

Explanation:

$$Ca(OH)_2 + Cl_2 \rightarrow CaCOCl_2 + H_2O$$

2. i. $NaHCO_3$

Explanation:

$$Na2CO_3 + H_2O + CO_2 \rightarrow 2HaHCO_3$$

ii. (b) (I), (II) and (III).

Explanation:

$NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + CO_2 \uparrow + H_2O$

Carbon dioxide gas is evolved which turns lime water milky. It extinguishes a burning splinter since it is not a supporter of combustion. It dissolves in sodium hydroxide solution and it is an odourless gas.

iii. (c) It is used in soda-acid fire extinguishers.

Explanation:

$$2NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + H_2O + CO_2$$

$NaHCO_3$ is soluble in water.

iv. (b) Solid X is sodium bicarbonate and the gas evolved is CO_2.

Explanation:

$NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + CO_2 + H_2O$

v. (c) I, II and IV only.

Explanation:

It is not used in manufacture of soap.

Metals and Non-Metals 3

Physical Properties of Metals

- **Physical State:** With the exception of mercury , cesium and gallium, which are liquids at room temperature, metals are solids at room temperature.
- **Lustre:** The property of metals which makes the light reflect from their surfaces is called lustre. This property of a metal of having a shining surface is called ' metallic lustre'(chamak) . Eg., gold and silver.
- **Malleability:** Metals can be beaten into thin sheets with a hammer (without breaking) With the exception of Zinc, which is fragile. Gold and silver metals are some of the best malleable metals.Aluminium and copper metals are also malleable metal.
- **Ductility:** Wires can be made out of metals. With the exception of Zinc, which is fragile.
- The property which allows the metals to be drawn into thin wires is called ductility.
- Gold is the most ductile metal. For example, just 1gram of gold can be drawn into a thin wire about 2 kilometres long.
- Silver is also among the best ductile metals. After these metal copper and aluminium are also very ductile and can be drawn into thin copper wires and aluminium wires(which are used as electric wires).
- **Hardness:** Except for sodium and potassium, which are soft and can be cut with a knife, all metals are hard.
- **Conduction:** Because metals have free electrons, they are good conductors. Silver and copper are the best heat and electricity conductors. Lead is the least efficient heat conductor. Iron, bismuth, and mercury are likewise poor conductors.
- **Density:** Metals have a high density and weigh a lot. Means metals are heavy substance, For example , the density of iron is 7.8g/cm^3 which is high quite.There are , however some exceptions.For example, sodium and potassium metals have low densities .They are very light metals.
- **Melting and Boiling Point:** Metals are known for their high melting and boiling points. The melting point of tungsten is the highest, while the boiling point of silver is the lowest. The melting values of sodium and potassium are both low.

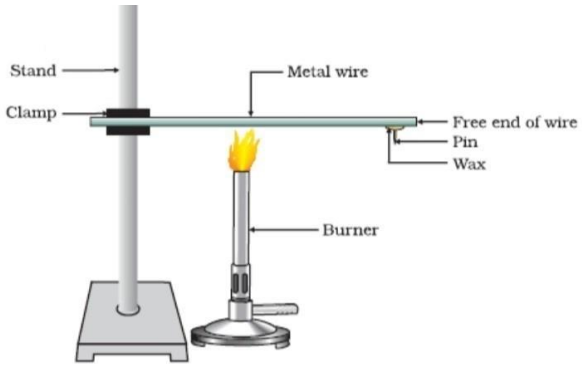
- **Alloy Formation:** Metals combine to create an alloy, which is a homogeneous combination of metals. Brass is a copper and zinc alloy.
- **Sonorous:** Metals, when hit by a solid object, produce sound. This property of a metal is known as sonorous.

Physical Properties of Non-Metals

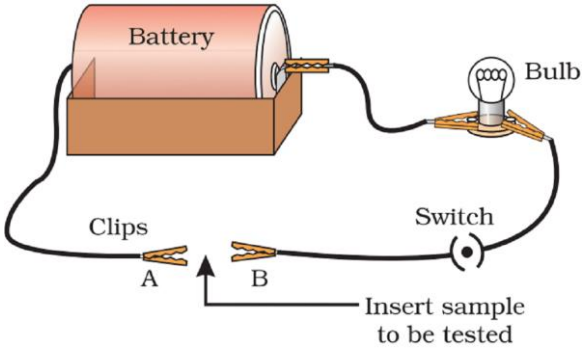
- **Physical State:** At ambient temperature, the majority of non-metals exist in two of the three states of matter: gases (oxygen) and solids (iodine, carbon, sulphur). There is no metallic sheen to them (save iodine) and they do not reflect light. (With the exception of carbon in the form of diamond.)
- **Nature:** Non-metals are extremely fragile, and they can't be coiled into wires or hammered into sheets. Except for diamond, which is the world's hardest substance.
- **Conduction:** Non-metals are poor heat and electrical conductors. (Except graphite conducts heat, both graphite and gas carbon conduct electricity.)
- **Electronegative Character:** Non-metals have a capacity for gaining or sharing electrons with neighbouring atoms. Hence, non-metals are known for their electronegative nature.
- **Reactivity:** When they come into contact with oxygen, they produce acidic or neutral oxides. Hence, non-metals are reactive.
- **Melting and Boiling Points:** Non-metals are known for its low melting and boiling points.

Difference in Physical Properties of Metals and Non-Metals:

Metals	Non-metals
1. Metals are good conductors of heat and electricity.	1. Non-metals are bad conductors of heat and electricity.
2. Metals are malleable that is they can be beaten into sheets.	2. Non-metals are not malleable.
3. Metals are ductile that is they can be drawn into wires.	3. Non-metals are not ductile.
4. Metals are sonorous.	4. Non-metals are non sonorous.
5. Metals have high tensile strength due to high attraction between molecules.	5. Non-metals have low tensile strength due to low attraction between molecules.
6. Metals have high density.	6. Non-metals have low density.



Metals are good conductors of heat.



Metals are good conductors of electricity

Chemical Properties of Metals

1-Reaction of Metals are burnt in Air (with Oxygen)

Almost all metals react with oxygen to form metal oxides.

Metal + Oxygen → Metal oxide (basic oxide)

- Sodium and potassium are the most reactive and react with oxygen present in the air at room temperature to form the oxides. It is kept immersed in kerosene oil as they react vigorously with air and catch fire.

$$4K_{(s)}+O_{2(g)} \rightarrow 2K_2O_{(s)} \text{ (vigorous reaction)}$$

- Magnesium does not react with oxygen at room temperature, but on heating, it burns in the air with intense light and heat to form magnesium oxide.

$$2Mg_{(s)}+O_{2(g)} \rightarrow 2MgO_{(s)} \text{ (Mg burns with white dazzling light)}$$

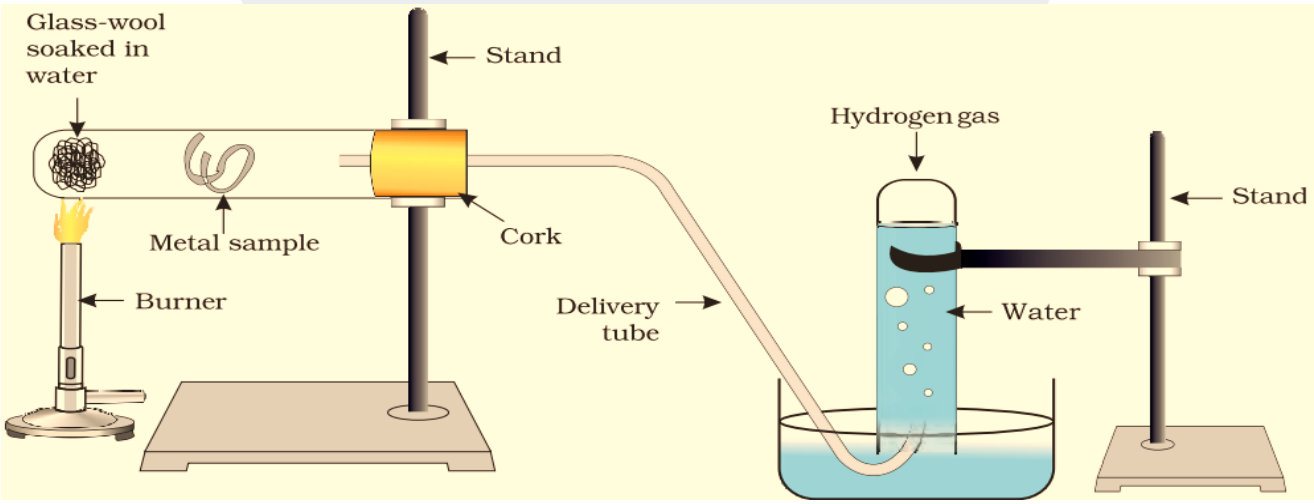
- Silver, platinum and gold don't burn or react with air.

2-Reaction of Metals with Water

Metals react with water and produce a metal oxide and hydrogen gas. Metal oxides that are soluble in water dissolve in it to further form metal hydroxide. But all metals do not react with water.

Metal + Water → Metal hydroxide + Hydrogen

Metal + Steam → Metal oxide + Hydrogen



Action of steam on a metal

- Metals such as sodium and potassium react vigorously with cold water to lead to evolution of hydrogen, which immediately catches fire producing a large quantity of heat.

$$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)} + \text{heat energy}$$

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)} + \text{heat energy}$$

- Metals such as aluminium, zinc and iron do not react with cold or hot water, but they react with steam to form metal oxides and hydrogen.

$$2Al_{(s)} + 3H_2O_{(g)} \rightarrow Al_2O_{3(s)} + 3H_{2(g)}$$

$$3Fe_{(s)} + 4H_2O_{(g)} \rightarrow Fe_3O_{4(s)} + 4H_{2(g)}$$

- Metals such as lead, copper, silver and gold do not react with water at all

3-Reactions of Metals with Acids

Metals react with acids to form salt and hydrogen gas.

Metal + Dilute acid → Salt + Hydrogen

1. Metals react with dilute hydrochloric acid to give metal chloride and hydrogen gas.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

2. Metals react with sulphuric acid to form metal sulphate and hydrogen gas.

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$$

3. Metals react with nitric acid, but hydrogen gas is not evolved since nitric acid is a strong oxidising agent. So, it oxidises the hydrogen to water and itself gets reduced to a nitrogen oxide.

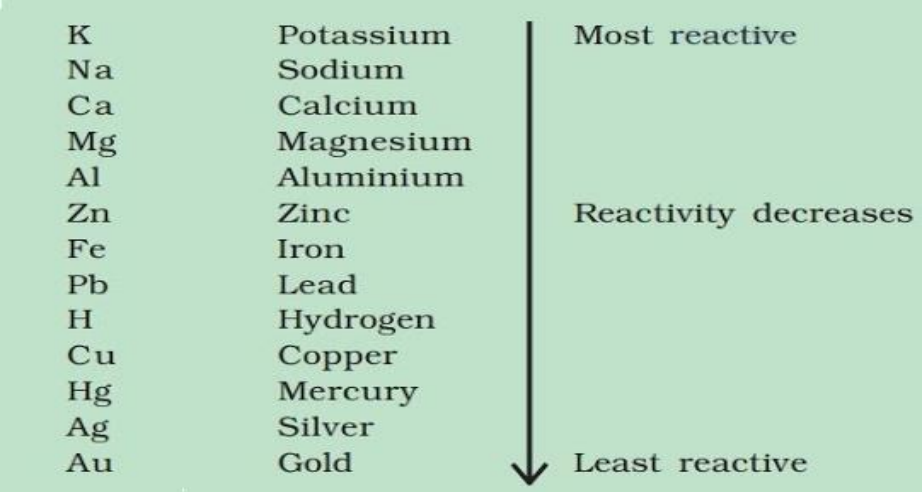
But magnesium and manganese react with dilute nitric acid to evolve hydrogen gas.

$$Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$$

$$Mn + 6HNO_3 \rightarrow Mn(NO_3)_2 + H_2$$

Reactivity Series

The arrangement of metals in the order of decreasing reactivities is called the reactivity series of metals.



Activity series: Relative reactivities of metals

4-Reactions of Metals with Solutions of Other Metal

A more reactive metal displaces a less reactive metal from its salt solution.

Salt solution of metal B +Metal A——-> Salt solution of metal A+ Metal B

For example:

When an iron nail is placed in a copper sulphate solution, the blue colour of $CuSO_4$ fades away slowly and a reddish brown copper metal is formed.

$$CuSO_{4(aq)} + Fe_{(s)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$$

5-Reaction of Metals with Chlorine

Metals react with chlorine to form metal chlorides. **For example:**

- Sodium readily reacts with chlorine to form ionic chloride called sodium chloride.

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

- Calcium reacts vigorously with chlorine to form calcium chloride.

$$Ca_{(s)} + Cl_{2(g)} \rightarrow 2CaCl_{2(s)}$$

6- Reaction of Metals with Hydrogen

Most of the metals do not combine with hydrogen. Only a few reactive metals like sodium, potassium, calcium and magnesium react with hydrogen to form metal hydrides.

- When hydrogen gas is passed over heated sodium, then sodium hydride is formed:

$$2Na_{(s)} + H_{2\,(g)} \text{ ———> } 2NaH_{(s)}$$

Sodium Hydrogen Sodium hydride

Chemical Properties of Non-Metals:

1- Reaction of Non-metals with Oxygen

Non-metals react with oxygen to form acidic oxides or neutral oxides.

The acidic oxides of non-metals dissolve in water to form acids.

- **Carbon** is a non-metal, when carbon burns in air it reacts with the oxygen of air to form an acidic oxide called carbon dioxide:

$$C_{(s)} + O_{2(g)} \text{ ———-> } CO_{2(g)}$$

Carbon Oxygen Carbon dioxide

(Non-metal) (Acidic Oxide)

2- Reaction of Non-Metals with water:

Non-metals do not react with water (or steam) to evolve hydrogen gas.

3- Reaction of Non-Metals with Dilute Acids:

Non -metals do not react with dilute acids

4– Reaction of Non-Metals with Salt Solutions :

A more reactive non-metal displaces a less reactive non-metal from its salt solution.

$$2NaBr_{(aq)} + Cl_{2(g)} \text{———-> } 2NaCl_{(aq)} +. Br_{2(aq)}$$

Sodium bromide. Chlorine. Sodium chloride. Bromine

5- Reaction of Non-metal with Chlorine:

Non-metals react with chlorine to form covalent chlorides which are non-electrolytes (do not conduct electricity).

- **Phosphorus** is non-metal which reacts with chlorine to form a covalent chloride called phosphorus trichloride.

$$P_{4(s).} + 6Cl_{2(g)} \text{ ———-> } 4PCl_{3(l)}$$

Phosphorus Chlorine Phosphorus trichloride

(Covalent chloride)

6- Reaction of Non-Metals with hydrogen

Non-metals react with hydrogen to form covalent hydrides.

- Sulphur is a non-metal which combines with hydrogen to form a covalent hydride called hydrogen sulphide, H_2S.

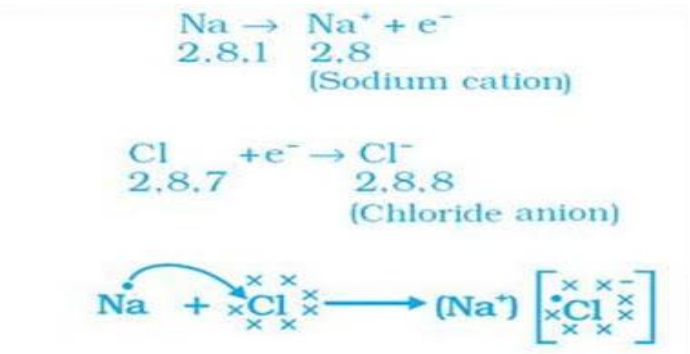
$$H_{2(g)} + S_{(l)} \text{ ——-> } H_2S_{(g)}$$

Hydrogen Sulphur Hydrogen sulphide

(Non-metal) (Covalent hydride)

How do Metals and Non-Metals Reacts:

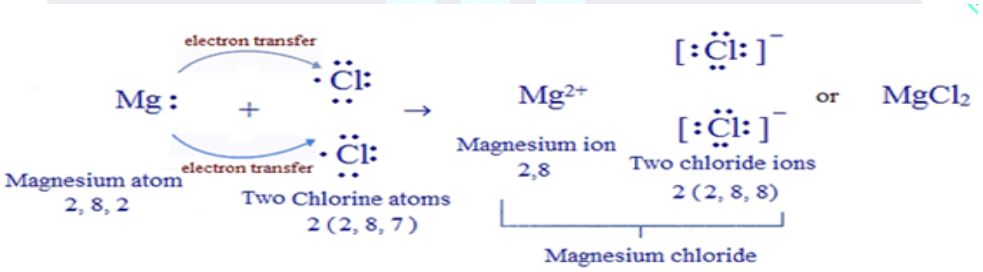
When metals react with non-metals , they form ionic compounds. On the other hand , when non-metals react with other non-metals , they form covalent compounds.



Ionic Bond

The chemical bond formed by the transfer of electrons from one atom to another is known as an ionic bond.

- The ionic bonds are formed between metals and non-metals.
- The strong force of attraction developed between the oppositely charged ions
- Ionic bonds are made up of ions.
- Some ionic compounds such as magnesium chloride, sodium chloride and magnesium oxide etc.



Properties of Ionic Compounds:

- Ionic compounds are hard solids, due to the strong force of attraction between the positive and negative ions.
- They are generally brittle and break into pieces when pressure is applied.
- Ionic compounds have high melting and boiling points, since a large amount of energy is required to break the strong intermolecular attractions.
- They are soluble in water, but insoluble in solvents such as kerosene, petrol, etc.
- They do not conduct electricity in a solid state, because electrostatic forces of attraction between ions in the solid state are very strong but conduct electricity in the fused (or in the aqueous state) because these forces weaken in the fused (or in solution) state so that their ions become mobile.

Metallurgy

- **Minerals**: The naturally occurring compounds of metals, along with other impurities are known as minerals.
- **Ores**: The minerals from which metals are extracted profitably and conveniently are called ores.
- **Gangue**: Earthly impurities including silica, mud, etc. associated with the ore are called gangue.
- **Metallurgy:** The process used for the extraction of metals in their pure form from their ores is referred to as metallurgy.

Extraction of Metals

- The reactivity of elements differs for different metals.
- Three major steps involved in the extraction of metals from their ores are:

Conversion of Concentrated Ore into Metal

- The extraction of a metal from its concentrated ore is essentially a process of reduction of the metal compound present in the ore.
- The method of reduction to be used depends on the reactivity of the metal to be extracted.

Extraction of Less Reactive Metals

Metals at the bottom of the reactivity series are not very reactive and the oxides of these metals can be reduced by heating the ore itself.

Extraction of Mercury

Cinnabar, an ore of mercury is first heated in the air and is converted into mercuric oxide.

$$2HgS_{(s)} + 3O_{2(g)} \xrightarrow{Heat} 2HgO_{(s)} + 2SO_{2(g)}$$

$$2HgO_{(s)} \xrightarrow{Heat} 2Hg_{(s)} + O_{2(g)}$$

Extraction of Moderately Reactive Metals

- The moderately reactive metals in the middle of the reactivity series are extracted by the reduction of their oxides with carbon, aluminium, sodium or calcium.
- It is easier to obtain metals from their oxides (by reduction) than from carbonates or sulphides. So, before reduction can be done, the ore is converted into a metal oxide.
- The concentrated ores can be converted into metal oxides by the process of calcination or roasting.

Calcination is the process in which a carbonate ore is heated strongly in the absence of air to convert it into a metal oxide. The ore is heated to a high temperature in the absence of air, or when air is not present throughout

the reaction. Carbonate ores, as well as ores containing water, are usually calcined to remove carbonate and moisture impurities.

For example:

$$ZnCO_{3(s)} \xrightarrow{Calcination} ZnO_{(s)} + CO_{2(g)}$$

Roasting is the process in which a sulphide ore is strongly heated in the presence of air to convert it into a metal oxide.

$$2ZnS_{(s)} + 3O_{2(g)} \xrightarrow{Roasting} 2ZnO_{(s)} + 2SO_{2(g)}$$

The metal oxides are converted to free metal by using reducing agents such as carbon, aluminium, sodium or calcium.

For example:

- The metal zinc is extracted by the reduction of zinc oxide with carbon. Thus, when zinc oxide is heated with carbon, zinc is produced.
- Aluminium reduces iron oxide to produce the metal iron with the evolution of heat. Due to this heat, the iron is produced in the molten state.

$$Fe_2O_{3(s)} + 2Al(s) \rightarrow 2Fe_{(l)} + Al_2O_{3(s)} + Heat$$

The reaction of iron (III) oxide with aluminium is used to join railway tracks or cracked machine parts. This reaction is known as the thermite reaction.

Extraction of Highly Reactive Metals

Metals high up in the reactivity series are very reactive.

These metals have a strong affinity for oxygen. So, oxides of sodium, magnesium, calcium and aluminium cannot be reduced by carbon.

These metals are obtained by electrolytic reduction.

Sodium, magnesium and calcium are obtained by the electrolysis of their molten chlorides.

For example:

Sodium metal is extracted by the electrolytic reduction of molten sodium chloride. $2NaCl_{(l)}$

$$\xrightarrow{Electrolytic} 2Na_{(s)} + Cl_{2(g)}$$

At Cathode: $Na^+ + e^- \rightarrow Na$

At Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Refining of Metals

- The most widely used method for refining impure metals is electrolytic refining.
- Electrolytic refining means refining by electrolysis. Metals such as copper, zinc, tin, lead, chromium, nickel, silver and gold are refined electrolytically.

Electrorefining

Electrolysis can be used to recover metals that cannot be separated via a chemical reduction technique, as well as to purify metals acquired through other means. The anode in the electrorefining process is a block of impure metal, while the cathode is a thin sheet of pure metal. An aqueous solution of the metal salt is included in the electrolytic cell. When an electric current of a sufficient voltage is passed via the anode, impure metal is dissolved and pure metal is deposited at the cathode.

The following is how metal ions from the anode enter the electrolyte

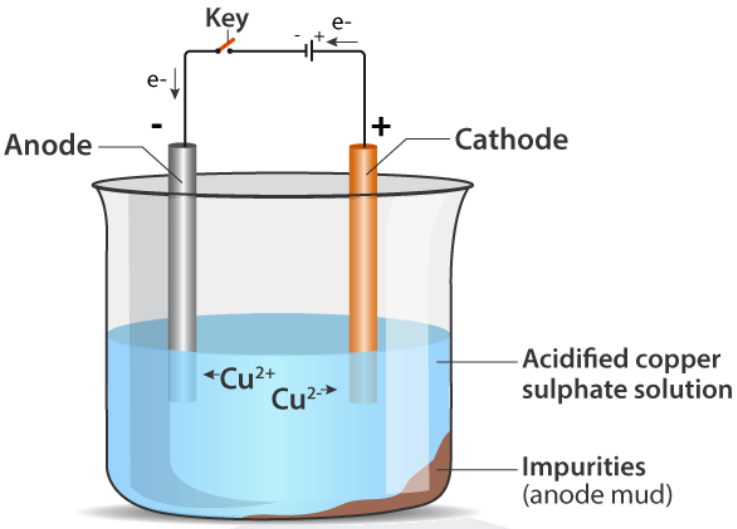
$$Cu \quad - \quad 2e^- \quad \text{——>} \quad Cu^{2+}$$

Copper atoms	Electrons	Copper ions
(From impure anode)	(Given to anode)	(Goes into electrolytic)

These ions get deposited on the cathode in the following manner

$$Cu^{2+} \quad + \quad 2e^- \text{———->} \quad Cu$$

Copper ion	Electrons	Copper atom
(From Electrolyte)	(From cathode)	(Deposits on cathode)



Electrolytic refining of copper. The electrolyte is a solution of acidified copper sulphate. The anode is impure copper, whereas, the cathode is a strip of pure copper. On passing electric current, pure copper is deposited on the cathode.

This technique is used to refine volatile metals with lower boiling points than their impurities, such as copper, silver, tin, and nickel. For example: Mercury and Zinc.

- An electrolyte is a substance (salt, acid, or base) that transmits an electric current in solution or in a molten form while also being decomposed by it. The current is carried by ionised electrolytes, which are electrically charged ions.
- Charged ions migrate towards oppositely charged electrodes in order to lose their electric charge and form atoms, which are then either released or deposited at the electrodes.

Corrosion

Most of the metals keep on reacting with the atmospheric air. This leads to the formation of a layer over the metal. In the long run, the underlying layer of metal keeps on getting lost due to conversion into oxides or sulphides or carbonate, etc. As a result, the metal gets eaten up. The process is called Corrosion.

Rusting of Iron: Rusting of iron is the most common form of corrosion. When iron articles like the gate, grill, fencing, etc. come in contact with moisture present in the air, the upper layer of iron turns into iron oxide. Iron oxide is brown-red in colour and is known as Rust. The phenomenon is called Rusting of Iron.

If rusting is not prevented in time, the whole iron article would turn into iron oxide. This is also known as Corrosion of Iron. Rusting of iron gives a huge loss every year.

Conditions necessary for rusting of iron

i. Presence of air (or oxygen)

ii. Presence of water (or moisture)

Prevention of Corrosion

- **Galvanising**: It is the process of giving coating a thin layer of zinc on iron or steel to protect them from corrosion. Example: shiny nails, pins. etc.
- **Tinning:** It is a process of coating tin over other metals.
- **Electroplating:** In this method, a metal is coated with another metal using electrolysis. Example: silver plated spoons, gold plated jewellery etc.
- **Alloying:** An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal in a definite proportion. The resultant metals, called alloys do not corrode easily.

For example: Brass (copper and zinc), Bronze (copper and tin) and Stainless steel (iron, nickel, chromium and carbon)

Corrosion of Silver

When a shining metal object loses its shine and become dull, we say that it has been **tarnished**.

Silver ornaments (and other silver articles) gradually turn black due to the formation of thin silver sulphide (Ag_2S) layer on their surface by the action of hydrogen sulphide gas present in air.

Silver metal loses its shine and becomes dull (or tarnished) very slowly. Thus , silver metal is fairly resistant to corrosion.

Corrosion of Copper

The copper objects lose their shine after some time due to the formation of a copper oxide layer on them.

When a copper object remains in damp air for a considerable time, then copper reacts slowly with the carbon dioxide and water of air to form a green coating of basic copper carbonate on the surface of the object. The formation of this green coating on the surface of copper object corrode it.

Please note: The green coating of basic copper carbonate is a mixture of copper carbonate and copper hydroxide, $CuCO_3.Cu(OH)_2$.

Alloys:

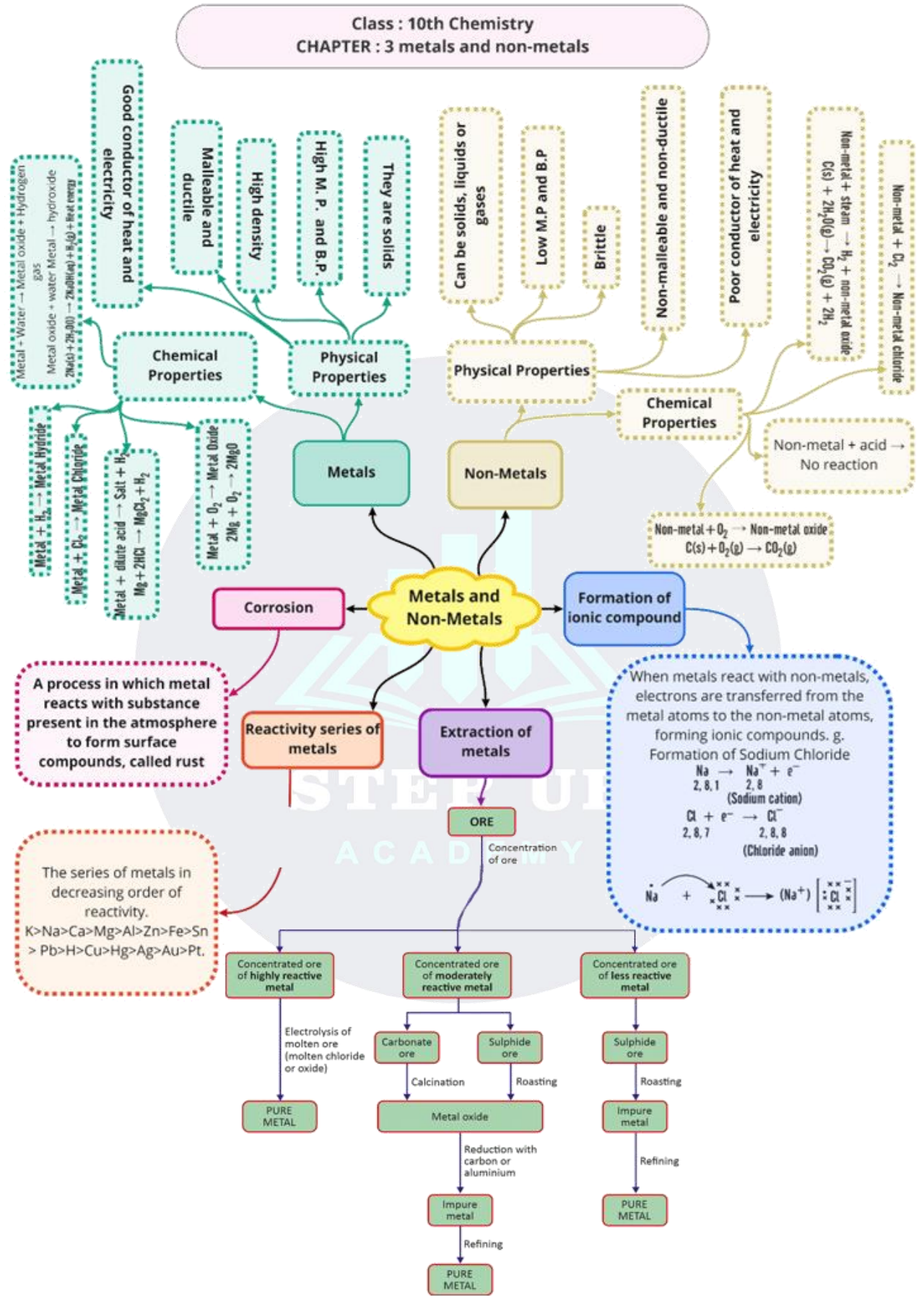
An alloy is a homogeneous mixture of two or more metals (or a metals and small amounts of non-metals).

For Example: **brass** is an alloy of two metals : copper and zinc, whereas **steel** is an alloy of a metal and a small amount of a non-metal : iron and carbon.

- An alloy is prepared by mixing the various metals in molten state in required proportions, and the cooling their mixture to the room temperature.

Properties of Alloys:

- Alloys are stronger than metals from which they are made.
- Alloys are harder than the constituent metals.
- Alloys are more resistant to corrosion.
- Alloys have lower electrical conductivity than pure metals.
- Alloys have lower melting points than the constituent metals.


Class : 10th Chemistry
CHAPTER : 3 metals and non-metals
Metals and Non-Metals
Metals
Non-Metals
Physical Properties
Chemical Properties
Good conductor of heat and electricity
Malleable and ductile
High density
High M. P. and B.P.
They are solids
Can be solids, liquids or gases
Low M.P and B.P
Brittle
Non-malleable and non-ductile
Poor conductor of heat and electricity
Metal + Water → Metal oxide + Hydrogen gas
Metal oxide + water Metal → hydroxide
Metal + H2 → Metal Hydride
Metal + Cl2 → Metal Chloride
Metal + dilute acid → Salt + H2
Mg + 2HCl → MgCl2 + H2
Metal + O2 → Metal Oxide
2Mg + O2 → 2MgO
Non-metal + steam → H2 + non-metal oxide
C(s) + 2H2O(g) → CO2(g) + 2H2
Non-metal + Cl2 → Non-metal chloride
Non-metal + acid → No reaction
Non-metal + O2 → Non-metal oxide
C(s) + O2(g) → CO2(g)
Corrosion
A process in which metal reacts with substance present in the atmosphere to form surface compounds, called rust
Reactivity series of metals
The series of metals in decreasing order of reactivity.
K>Na>Ca>Mg>Al>Zn>Fe>Sn > Pb>H>Cu>Hg>Ag>Au>Pt.
Extraction of metals
ORE
Concentration of ore
Concentrated ore of highly reactive metal
Concentrated ore of moderately reactive metal
Concentrated ore of less reactive metal
Electrolysis of molten ore (molten chloride or oxide)
Carbonate ore
Sulphide ore
Sulphide ore
Calcination
Roasting
Roasting
PURE METAL
Metal oxide
Impure metal
Reduction with carbon or aluminium
Refining
Impure metal
Refining
PURE METAL
PURE METAL
Formation of ionic compound
When metals react with non-metals, electrons are transferred from the metal atoms to the non-metal atoms, forming ionic compounds. g. Formation of Sodium Chloride
Na → Na+ + e−
2, 8, 1 2, 8
(Sodium cation)
Cl + e− → Cl−
2, 8, 7 2, 8, 8
(Chloride anion)

Important Questions

Multiple Choice Questions:

1. Aluminium is used for making cooking utensils. Which of the following properties of aluminium are responsible for the same?
   (i) Good thermal conductivity
   (ii) Good electrical conductivity
   (iii) Ductility
   (iv) High melting point
   (a) (i) and (ii)
   (b) (i) and (iii)
   (c) (ii) and (iii)
   (d) (i) and (iv)
2. The most abundant metal in the earth's crust is
   (a) Iron
   (b) Aluminium
   (c) Calcium
   (d) Sodium
3. The poorest conductor of heat among metals is
   (a) Lead
   (b) Mercury
   (c) Calcium
   (d) Sodium
4. Which property of metals is used for making bells and strings of musical instruments like Sitar and Violin?
   (a) Sonorousness
   (b) Malleability
   (c) Ductility
   (d) Conductivity
5. $Al_2O_3 + 2NaOH \rightarrow + H_2O$
   (a) $Al(OH)_3$
   (b) Na_2O
   (c) $NaAlO_2$
   (d) $AlNaO_2$
6. Which of the following is the correct arrangement of the given metals in ascending order of their reactivity?
   Zinc, Iron, Magnesium, Sodium
   (a) Zinc > Iron > Magnesium > Sodium
   (b) Sodium > Magnesium > Iron > Zinc
   (c) Sodium > Zinc > Magnesium > Iron
   (d) Sodium > Magnesium > Zinc > Iron
7. Which of the following pairs will give displacement reactions?
   (a) $FeSO_4$ solution and Copper metal
   (b) $AgNO_3$ solution and Copper metal
   (c) $CuSO_4$ solution and Silver metal
   (d) NaCl solution and Copper metal
8. Non-metals form covalent chlorides because
   (a) they can give electrons to chlorine
   (b) they can share electrons with chlorine
   (c) they can give electrons to chlorine atoms to form chloride ions
   (d) they cannot share electrons with chlorine atoms
9. Which of the following oxide(s) of iron would be obtained on prolonged reaction of iron with steam?
   (a) FeO
   (b) Fe_2O_3
   (c) Fe_3O_4
   (d) Fe_2O_3 and Fe_2O_4
10. Which of tire following are not ionic compounds?
    (i) KCl
    (ii) HCl
    (iii) CCl_4
    (iv) NaCl
    (a) (i) and (ii)
    (b) (ii) and (iii)
    (c) (iii) and (iv)
    (d) (i) and (iii)

Very Short Question:

1. Name the metal which is most abundant in earth's crust.
2. What is the difference between calcination and roasting ?
3. What is the chemical formula of rust?
4. Name the process used for the enrichment of sulphide ore.
5. Out of zinc and iron, which evolves hydrogen more readily on reacting with dilute HCl?
6. How do alloys brass and bronze differ in composition?
7. Does german silver contain silver in it?
8. Write the chemical formulae of the main ores of iron and aluminium.

9. Name the non-metal which can conduct electricity.
10. Write the names of two neutral oxides.

Short Questions:

1. Which important properties of aluminium are responsible for its great demand in industry?
2. Name an alloy of
   - Aluminium used in construction of air crafts.
   - Lead in joining metals for electric welding.
   - Copper used in household vessels.
3. All ores are minerals but all minerals are not ores. Justify.
4. (a) An iron knife kept in blue copper sulphate solution turns the blue solution into light green. Explain.

   (b) An athlete won a bronze medal in a race competition. After some days, he found that the medal had lost its lustre due to the formation of a greenish layer on it. Name the metals present in the medal. What is the reason for the appearance of a greenish layer on its surface?
5. Why is titanium called a strategic metal? Mention two of its properties which make it so special.
6. A copper plate was dipped into a solution of $AgNO_3$. After Sometime, a black layer was deposited on the copper plate. State the reason for it. Write the chemical equation for the reaction involved.

   On placing a piece of zinc metal in a solution of mercuric chloride, it acquires a silvery surface but when it is placed in a solution of magnesium sulphate, no change is observed. State the reason for the behaviour of zinc metal.
8. Which method of concentration of ore is preferred in the following cases and why?
   - The ore has higher density particles mixed with a large bulk of low density impurities.
   - The ore consists of copper sulphide intermixed with clay particles. Give an example of amalgam.

Long Questions:

1. When the powder of a common metal is heated in an open china dish, its colour turns black. However, when hydrogen gas is passed over the hot black substance formed, it regains its original colour. Based on this information, answer the following questions:
   - What type of chemical reaction takes place in each of the two given steps ?
   - Name the metal initially taken in the powder form. Write balanced chemical equations for both these reactions.
2. (a) Which of the following metals would give hydrogen when added to dilute hydrochloric acid?
   - iron
   - copper
   - magnesium

   (b) Explain why do surfaces of some metals acquire a dull appearance when exposed to air for a long lime.
3. How will your demonstrate that the ionic compounds do not conduct electricity in the solid state and can do so in solution.

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

   Assertion: Aluminium oxide and zinc oxide are acidic in nature.

   Reason: Amphoteric nature means that substances have both acidic and basic character.
2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

   Assertion: C and N do not react with dil. HCI and dil. H_2SO_4.

   Reason: Metals do not react with dil. HCI and dil. H_2SO_4.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

An element is a pure substance made up of same kind of atoms. At present, nearly 118 elements are known but all of them do not occur free in nature, some of them have been synthesized by artificial methods. Based on their properties, they are mainly classified as metals and non-metals. Metals are those elements which lose electrons and form positive ions i.e., they are electropositive in nature. They are generally hard, good conductors of heat and electricity, malleable, ductile and have striking luster. They have a significant role to play in our daily life.

i. Metals which are of vital importance to the national Défense, energy and industry sector are called strategic metals. Which of the following is a strategic metal?
   a. Titanium.
   b. Zirconium.
   c. Manganese.
   d. All of these.

ii. Which metal is the best conductor of electricity?
   a. Silver.
   b. Platinum.
   c. Nickel.
   d. Iron.

iii. Which of the following metals is not a coinage metal?
   a. Copper.
   b. Silver.
   c. Iron.
   d. Gold.

iv. Which of the following are the most malleable metals?
   I. Sodium.
   II. Gold.
   III. Potassium.
   IV. Silver.
   a. (I) and (IV)
   b. (II) and (III)
   c. (III) and (IV)
   d. (II) and (IV)

v. Identify the correct statement(s).
   I. The wires that carry current in our homes have a coating of PVC or a rubber like material.
   II. School bells are made of metals.
   III. Metals do not conduct electricity.
   IV. Metals which produce a sound on striking a hard surface are said to be non-sonorous.
   a. (I) and (III)
   b. (I) and (II)
   c. (III) and (IV)
   d. Only (II)

2. Read the following and answer any four questions from (i) to (v).

Ionic compound is a chemical compound in which ions are held together by ionic bonds. An ionic bond is the type of chemical bond in which two oppositely charged ions are held through electrostatic forces. We know that metal atoms have loosely bound valence electrons in their valence shell and non-metal atoms need electrons in their valence shell to attain noble gas configuration. The metal atom loses the valence electrons while non-metal atom accepts these electrons. By losing electrons, metal atoms change to cations and by accepting electrons, non-metals form anions. Ionic compounds are generally solid and exist in the form of crystal. They have high melting and boiling points.

i. Which of the following can change to a cation?
   a. Fluorine.
   b. Oxygen.
   c. Potassium.
   d. Neon.

ii. Which of the following can change to an anion?
   a. Iodine.
   b. Magnesium.
   c. Calcium.
   d. Xenon.

iii. Ionic compounds are soluble in _____.
   a. Kerosene.
   b. Petrol.
   c. Water.
   d. None of these.

iv. Which of the following statements is correct about ionic compounds?
   I. They conduct electricity in solid state.
   II. They conduct electricity in solutions.
   III. They conduct electricity in molten state.

a. I only.
b. II only.
c. III only.
d. II and III only.

v. Select the incorrect statement.

a. Ionic compounds are generally brittle.
b. Ions are the fundamental units of ionic compounds.
c. Formation of ionic bonds involve sharing of electrons.
d. NaCl is an ionic compound.

Answer Key

Multiple Choice Answers:

1. (d) (i) and (iv)
2. (b) Aluminium
3. (a) Lead
4. (a) Sonorousness
5. (b) $NaAlO_2$
6. (c) Sodium > Magnesium > Zinc > Iron
7. (b) $AgNO_3$ solution and Copper metal
8. (c) they can share electrons with chlorine
9. (d) Fe_3O_4
10. (b) (ii) and (iii)

Very Short Answers:

1. **Answer**: Aluminium (Al) is the most abundant metal in the earth's crust and is present to the extent of 8-1 per cent by mass.
2. **Answer**: Calcination is carried in the absence of air while roasting is done in excess of air.
3. **Answer**: Rust is hydrated ferric oxide and its chemical formula is $Fe_2O_3.xH_2O$.
4. **Answer**: The process is called Froth Floatation process.
5. **Answer**: Zinc evolves hydrogen more readily than iron on reacting with dilute HCl because it is placed above iron in the reactivity series.
6. **Answer**: Constituents of brass are copper and zinc while those of bronze are copper and tin.
7. **Answer**: German silver is an alloy of copper, zinc and nickel. It does not contain any silver in it.
8. **Answer**: The main ore of iron is haematite (Fe_2CO_3) while that of aluminium is bauxite ($Al_2O_3.2H_2O$).
9. **Answer**: Graphite, an allotropy form of carbon conducts electricity.
10. **Answer**: Two neutral oxides are: carbon monoxide (CO) and nitrous oxide (N_2O).

Short Answer:

1. **Answer**: The properties of aluminum metal responsible for its great demand in industry are:
   - The metal is a good conductor of electricity.
   - The metal is not attacked by water.
   - The metal is a powerful reducing agent.

   Answer: The alloy is duralumin: A1 (93%), Cu (4%), Mg (0.5%), Mn (0.5%).
   - The alloy is solder: Pb (50%), Sn (50%)
   - The alloy is brass: Cu (80%), Zn (20%)
2. **Answer**: In the earth's crust, metals are present in the form of minerals and there are more than one mineral for a particular metal. However, metal may not be extracted from all of them. The mineral from which a metal can be profitably and conveniently extracted is known as ore. This clearly means that all ores are minerals but all minerals are not ores. For example, the different minerals of iron are:

   Hematite: Fe_2O_3;

   Limonite: $Fe_2O_3.3H_2O$;

   Siderite: $FeCO_3$;

   Iron pyrites: FeS_2

   Iron is extracted from haematite (Fe_2CO_3). Haematite mineral is the ore of iron while other minerals are not the ores.
3. **Answer**:

(a) Iron lies above copper in the activity series. This means that iron or iron knife will displace copper from copper sulphate solution. As a result of the reaction, ferrous sulphate will be formed and the solution will be light green in colour.

$$\underset{\text{Iron}}{Fe(s)} + \underset{\text{Copper sulphate (blue)}}{CuSO_4(aq)} \rightarrow \underset{\text{Ferrous sulphate (light green)}}{FeSO_4(aq)} + \underset{\text{Copper}}{Cu(s)}$$

(b) The bronze medal is an alloy and the constituting metals are copper and tin. The loss of luster by the medal is due to the formation of a coating of green layer. This layer is at basic copper carbonate.

4. **Answer**: Titanium is called strategic metal because it is used for making certain war equipments. The properties which make the metal so special are:

It is light in weight but at the same time stronger than the other metals.

It is not affected by corrosion even if kept in the open for a very long time.

5. **Answer**: Copper lies above silver in the activity series. This means that copper is more reactive than silver. Therefore, copper had replaced silver from $AgNO_3$ solution. Silver got deposited on the copper plate and changed to black after sometime because silver and also some salts of silver are sensitive to light. They readily become blackish on standing or on exposure to air.

$$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$
(Black)

6. **Answer**: Zinc lies above mercury in the activity series and can easily replace it from mercuric chloride solution. Mercury formed in the reaction gets deposited on the surface of zinc to give it a silvery look.

$$Zn(s) + HgCl_2(aq) \rightarrow ZnCl_2(aq) + Hg(s)$$

But zinc is placed below magnesium in the activity series. Therefore, no chemical reaction occurs between zinc and magnesium sulphate solution.

7. **Answer**:

- The concentration of ore can be done by gravity separation method.
- The concentration of ore is done by Froth Floatation process.
- An amalgam of mercury with silver or gold called dental alloy is used to fill cavities in the teeth.

Long Answer:

1. **Answer**:

The available information suggests the metal is copper. In open air, its is oxidised to form copper (II) oxide which is black in colour. The reaction is known as oxidation reaction. On passing hydrogen gas over the hot substance, the original colour of the metal is regained. It is an example of reduction reaction.

The balanced chemical equations for the reactions are:

$$2Cu(s) + O_2(g) \xrightarrow{heat} 2CuO(s)$$
(Metal) — Copper (II) oxide (Black)

$$CuO(s) + H_2(g) \xrightarrow{heat} Cu(s) + H_2O(g)$$

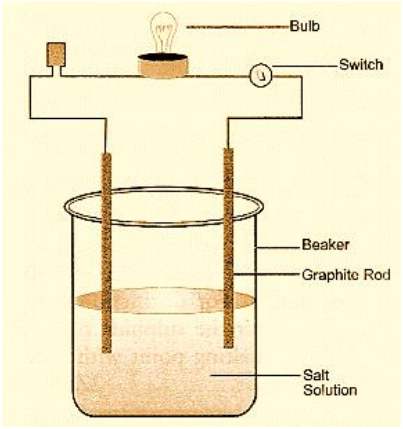
2. **Answer**:

(a) Both iron (Fe) and magnesium (Mg) will evolve hydrogen on reacting with dilute hydrochloric acid. These are active metals and are placed above hydrogen in the activity series. As copper is placed below hydrogen in the series, it will not evolve hydrogen.

(b) Surfaces of some metals acquire a dull appearance when exposed to air for a long time and they lose their lustre. This is due to the formation of layer of oxides, hydroxides, carbonates etc. on the surface For example, surface of aluminium metal becomes dull white due to the formation of coating oi aluminium oxide ($Al2O_3$). Similarly, the surface of copper acquires a greenish colour since a layer oi basic copper carbonate with the formula $Cu(OH)_2CuCO_3$ is deposited on the surface.

3. **Answer**:

- In a glass beaker, take small amount of solid sodium chloride.
- Dip two graphite rods (electrodes) in the solution.
- Connect these rods to a battery through a bulb and a switch.
- Switch on the battery. The bulb will not glow. This show that no current has passed through the solid sodium chloride.
- Now, add some water to the salt so that it may dissolve.
- Repeat the operation. The bulb will immediately glow showing that current has passed through the salt solution.



Explanation: Sodium chloride (NaCl) is a crystalline solid and the current is carried by the mobility (movement) of ions. Since the ions do not move in the solid state, the salt is not conducting. In aqueous solution, both Na^+ and Cl^- ions can move and the salt will be conducting in the solution. That is why the bulb glows.

Assertion Reason Answer:

1. (d) A is false, but R is true.

Explanation:

Aluminium and zinc oxides are amphoteric in nature.

2. (c) A is true, but R is false.

Explanation:

Metals react with dilute HCI and dil. H_2SO_4. Non-metals do not react with dilute acids.

Case Study Answer:

1. i. (d) All of these.

Explanation:

Titanium, zirconium, and manganese are used in Défense equipment's as they are light and durable and therefore, are called strategic metals.

ii. (a) Silver.

iii. (c) Iron.

Explanation:

Copper, silver and gold are called coinage metals because they are used in making coins, jewellery etc.

iv. (d) (II) and (IV)

v. (b) (I) and (II)

Explanation:

Metals conduct electricity. Metals which produce a sound on striking a hard surface are said to be sonorous.

2. i. (c) Potassium.

Explanation:

Potassium, being a metal, can change to cation by losing its valence electron.

ii. (a) Iodine.

Explanation:

Iodine, being a non-metal, can change to anion by gaining electron.

iii. (c) Water.

Explanation:

Ionic compounds are generally soluble in water and insoluble in kerosene and petrol.

iv. (d) II and III only.

Explanation:

Ionic compounds do not conduct electricity in solid state, as ions are very closely packed and are free to move.

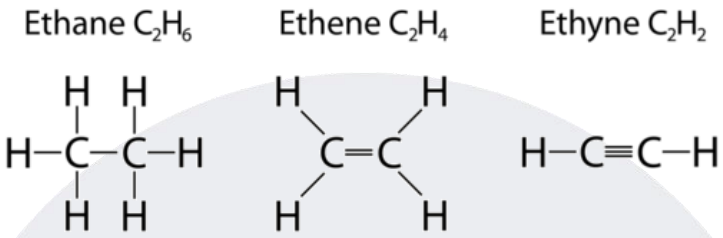
v. (c) Formation of ionic bonds involve sharing of electrons.

Explanation:

Formation of ionic bonds involve complete transfer of electrons from metal atom to non-metal atom.

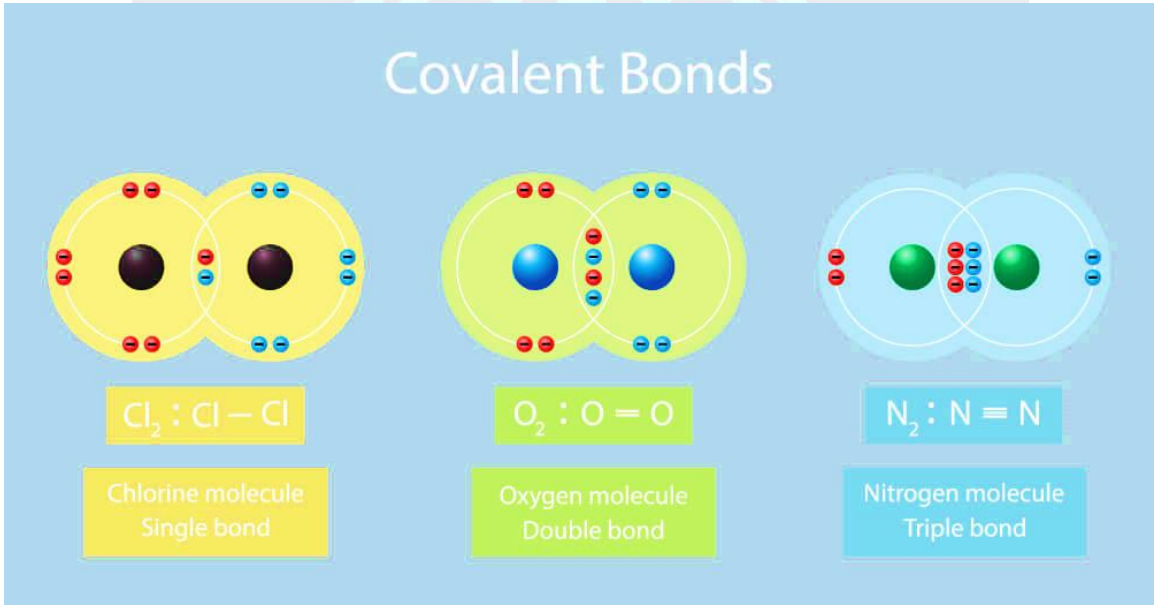
Carbon and Its Compounds 4

Bonding in Carbon



Most carbon compounds are poor conductors of electricity. From the data melting points of the carbon compounds, we find that these compounds have low melting and boiling points as compared to ionic compounds. We can conclude that the forces of attraction between the molecules are not very strong. Since these compounds are largely non-conductors of electricity, we can conclude that the bonding in these compounds does not give rise to any ions.

Covalent Bond

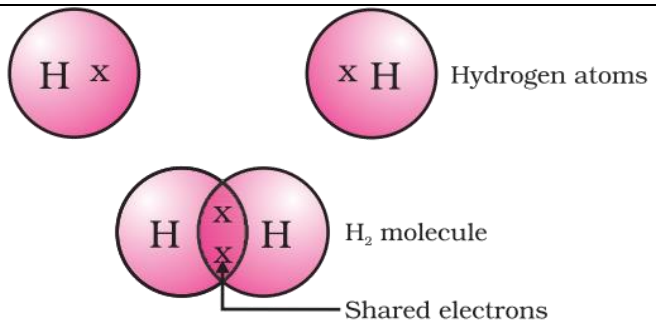
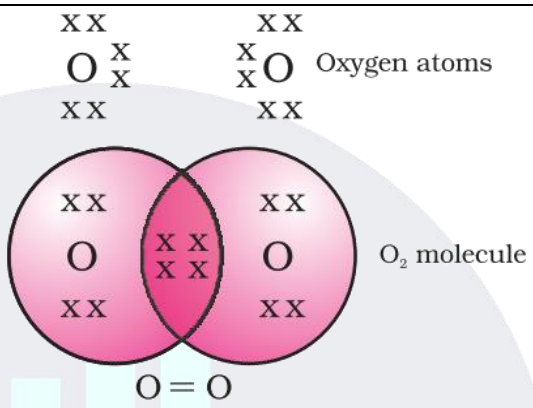
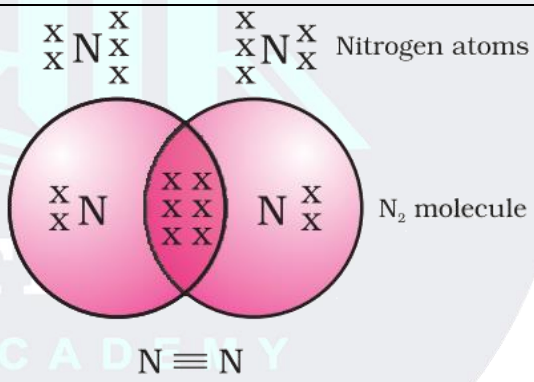


A covalent bond is formed when pairs of electrons are shared between two atoms. It is primarily formed between two same nonmetallic atoms or between nonmetallic atoms with similar electronegativity.

Noble gas configuration of Carbon

Carbon is tetravalent, it does not form ionic bond by either losing four electrons (C4+) or by gaining four electrons (C4-). It is difficult to hold four extra electron and would require large amount of energy to remove four electrons. So, carbon can form bond by sharing of its electrons with the electrons of other carbon atom or with other element and attain noble gas configuration.

- The atoms of other elements like hydrogen, oxygen and nitrogen, chlorine also form bonds by sharing of electrons.

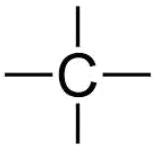
H – H single bond between hydrogen atoms (H2)	
O = O double bond between oxygen atoms (O2)	
N ≡ N triple bond between nitrogen atoms	

Carbon atom has four electrons in its outermost shell.

- It requires four electrons to achieve the stable, 8 electron, inert gas configuration.
- Carbon atoms can achieve the inert gas electron arrangement only by sharing their electrons. Hence, carbon always forms covalent bonds.

The valency of carbon is four since one carbon requires 4 electrons to achieve the nearest inert gas configuration. Thus, we can say that carbon is tetravalent.

- The four valencies of carbon are usually represented by drawing four short lines around the symbol of carbon (C).

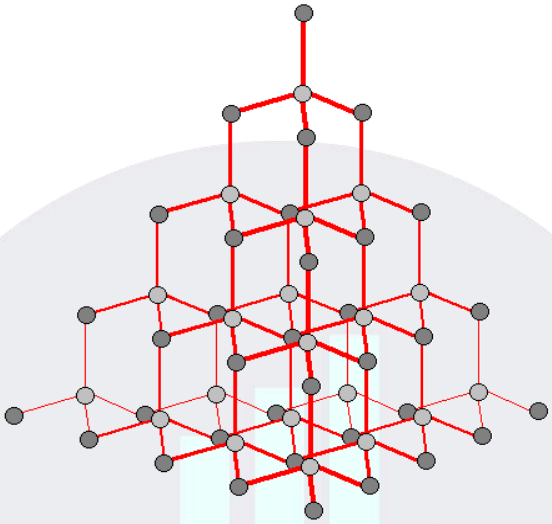


Allotropes of Carbon

The various physical forms in which an element can exist are called the allotropes of that element. Carbon has three allotropes:

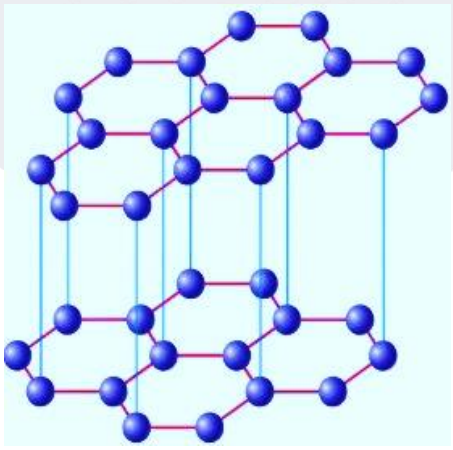
- Diamond
- Graphite
- Buckminster fullerene

Diamond



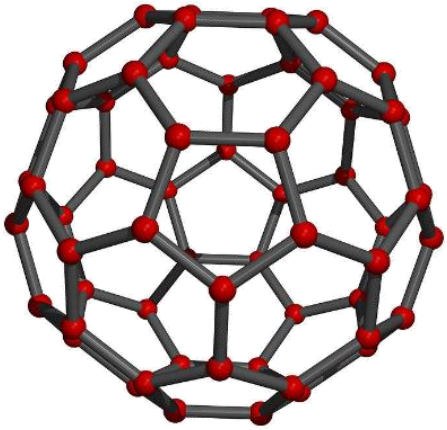
- In diamond, each carbon atom is bonded to four other carbon atoms, forming a three dimensional structure.
- The rigid structure of diamond makes it a very hard substance.
- It is a non-conductor of electricity since there are no free electrons in a diamond crystal.
- It can be synthesised by subjecting pure carbon to a very high pressure and temperature.

Graphite



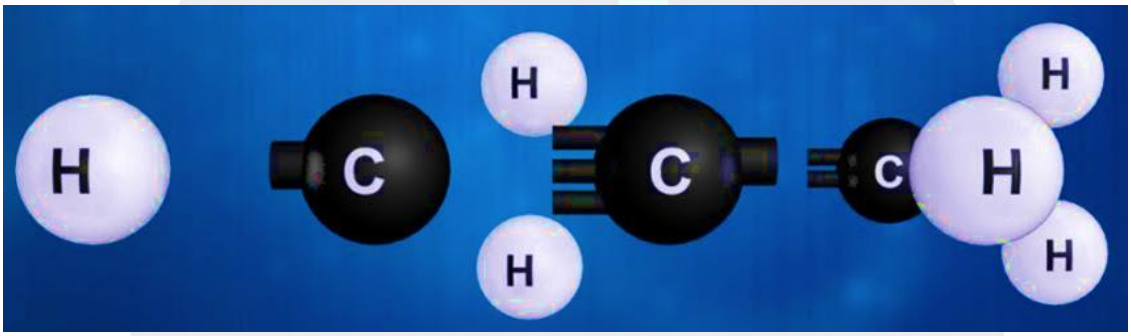
- In graphite, each carbon atom is bonded to three other carbon atoms in the same plane, giving a hexagonal array.
- One of the bonds is a double bond and thus the valency of carbon is satisfied.
- Graphite structure is formed by the hexagonal arrays being placed in layers, one above another.
- Graphite is smooth and slippery.
- It is a very good conductor of electricity due to the presence of free electrons.

Fullerene



- It is an allotrope of carbon containing clusters of 60 carbon atoms joined together to form spherical molecules.
- There are 60 carbon atoms in a molecule of buckminsterfullerene, so its formula is C_{60}.
- The allotrope was named buckminsterfullerene after the American architect Buckminster Fuller.

Versatile Nature of Carbon



The two characteristic properties of the element carbon which leads to the formation of a very large number of organic compounds are:

i. **Catenation**: The property of the element carbon due to which its atoms can join one another to form long carbon chains is called catenation.

Types of Chains

a) Straight chain of carbon atoms

b) Branched chain of carbon atoms

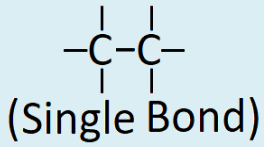
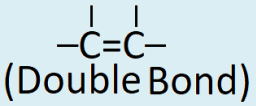
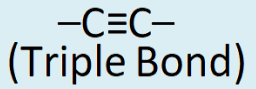
c) Closed or ring chain of carbon atoms

ii. **Tetravalency**: Carbon has a valency of four. So, it is capable of bonding with four other atoms of carbon or atoms of some other monovalent element.

Compounds of carbon are formed with oxygen, nitrogen, hydrogen, sulphur, chlorine and many other elements, giving rise to compounds with specific properties which depend on the elements other than the carbon present in the molecule.

Classification of Hydrocarbons

Comparison of Saturated and Unsaturated Hydrocarbons

Saturated hydrocarbons	Unsaturated hydrocarbons
1. All the four valencies of each carbon atom are satisfied by forming single covalent bonds with carbon and with hydrogen atoms.	1. The valencies of at least two carbon atoms are not fully satisfied by hydrogen atoms.
2. Carbon atoms are joined by a single covalent bond. 	2. Carbon atoms are joined by double covalent bonds.  or by triple covalent bonds. 
3. They are less reactive due to the non- availability or electrons in the single covalent bond, and therefore, they undergo substitution reaction.	3. They are more reactive due to the presence of electrons in the double or triple bond and therefore undergo addition reaction.

Cyclic Hydrocarbons

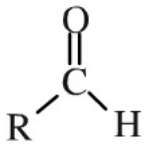
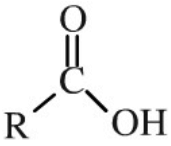
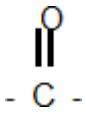
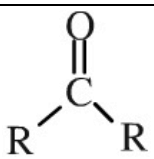
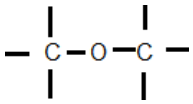
- Hydrocarbons in which the carbon atoms are arranged in the form of a ring are called cyclic hydrocarbons.
- Cyclic hydrocarbons may be saturated or unsaturated.

Saturated cyclic hydrocarbon	Unsaturated cyclic hydrocarbon
• Cyclohexane is an example of a saturated cyclic hydrocarbon. • Formula: C_6H_{12} • Cyclohexane contains 6 carbon atoms arranged in a hexagonal ring, with each carbon atom attached to 2 hydrogen atoms.	• Benzene is an example of an unsaturated cyclic hydrocarbon. • Formula: C_6H_6 • Benzene is made up of 6 carbon atoms and 6 hydrogen atoms.

Functional Groups

- **Functional group**: An atom or a group of atoms present in the molecules, which determines the characteristics property of the organic compounds, is called the functional group.

Functional group	General formulae	Organic compound	Suffix	Examples with common & IUPAC name
Halide-X (F,Cl,Br,I)	R-X	Haloalkanes	-ane	CH_3Cl Common name: Methyl chloride IUPAC name: Chloromethane
Hydroxyl-OH	R-OH	Alcohols	-ol	C_2H_5OH Common name : Ethyl alcohol IUPAC name: Ethanol

Aldehyde- CHO		Aldehydes	-al	CH_3CHO Common name: Acetaldehyde IUPAC name: Ethanal
Carboxyl- COOH		Carboxylic acids	-oic acid	$CH_3CH2COOH$ Common name: Propionic acid IUPAC name: Propanoic acid
Keto 		Ketones	-one	$CH_3COC_2H_5$ Common name: Diethyl ketone IUPAC name: Pentanone
Ethers 	R-O-R'	Ethers	-oxy	$CH_3 – O – C_2H_5$ Common name: Ethyl methyl ether IUPAC name: Methoxy ethane

Homologous Series

It is a group of organic compounds having a similar structure and chemical properties in which the successive compounds differ by a -**CH_2** group.

Characteristics of a Homologous Series

- Each member of the series differs from the preceding one by the addition of a -CH_2 group and by 14 a.m.u.
- All members of a homologous series have the same general formula.
- The physical properties of the members show a gradation in properties as their molecular mass increases.
- All members of a homologous series can be prepared by the same general method of preparation.

Nomenclature of Carbon Compounds:

The system of designating a suitable name to a particular carbon compound based on certain rules is known as nomenclature. of the basic carbon chain modified by a “prefix” “phrase before” or “suffix” “phrase after” indicating the nature of the functional group.

Suffix: The suffix refers to the sort of bond or functional group that exists in the carbon chain.

Prefix: This indicates the presence and position of other functional groups

Most carbon compounds have one of two names:

- **Trivial Names:** The common names for carbon compounds are known as trivial names. They are typically derived from the compound's source, such as the name formic acid, which comes from the Greek term "formicus," which means "red ants." The names that came this way were unclear and repetitive.
- **IUPAC Names:** As the number of carbon compounds increased, it became necessary to name them in a more methodical manner. The International Union for Pure and Applied Chemistry (IUPAC) proposed a system for naming carbon-based compounds with valid scientific names. The names derived from their rules are known all throughout the world and are referred to as IUPAC names.

Chemical Properties of Carbon Compounds

The majority of carbon-containing molecules connected with hydrogen, i.e. hydrocarbons, are fuels that emit heat when burned. Natural gas, petrol, gasoline, kerosene, heavy oils, and, more broadly, wood, biogas, charcoal, and coke are all rich sources of carbon molecules that are utilised as fuels.

Combustion

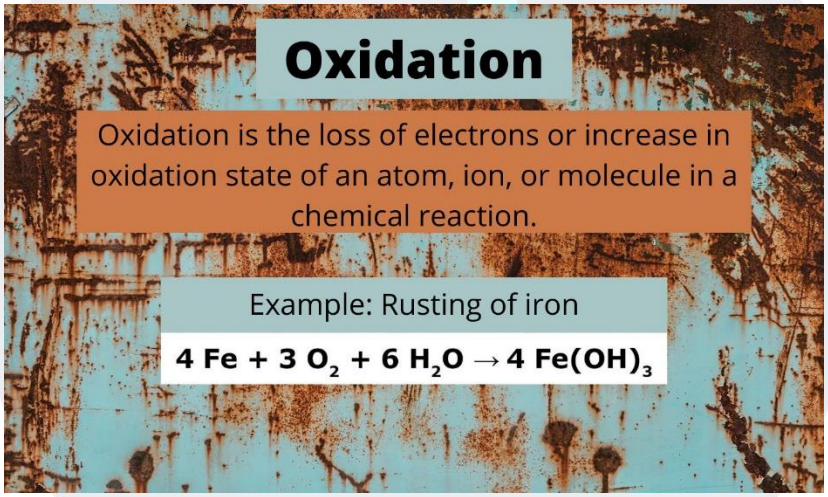
The process of burning a carbon compound in air to give carbon dioxide, water, heat and light is known as combustion.

Flame Characteristics: Saturated hydrocarbons give clean flame while unsaturated hydrocarbons give smoky flame. In the presence of limited oxygen, even saturated hydrocarbons give smoky flame.

For example:

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)} + \text{Heat and Light}$$

Oxidation



Carbon undergoes oxidation when it meets oxygen at a higher temperature, resulting in the formation of oxides such as carbon monoxide (CO) and carbon dioxide (CO_2). When carbon or carbon-containing fuels are burned incompletely, carbon monoxide is produced.

$$CH_3 - CH_2OH \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

We see that some substances are capable of adding oxygen to others. These substances are known as oxidising agents.

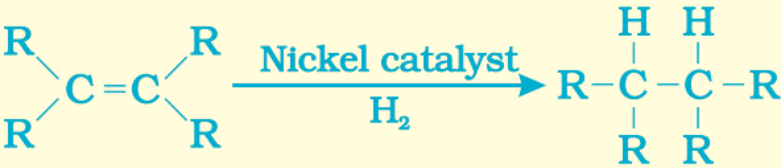
Alkaline potassium permanganate or acidified potassium dichromate are oxidising alcohols to acids, that is, adding oxygen to the starting material. Hence they are known as oxidising agents.

- Carbon compounds can be oxidised.
- Alcohols on oxidation are converted to carboxylic acids.
- Alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$ are used as oxidising agents.

Addition Reaction

Addition reactions are those in which an unsaturated hydrocarbon reacts with another chemical to generate a single product.

Unsaturated hydrocarbon add hydrogen in the presence of catalyst palladium or nickel. Vegetable oils are converted into vegetable ghee using this process.



- This reaction occurs only in unsaturated compounds, where there are double or triple bonds.

The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon is called hydrogenation.

- The process of hydrogenation is used in industries to prepare vegetable ghee (or vanaspati ghee) from vegetable oils.

Substitution Reaction

The reaction in which an atom or group of atoms in a molecule is replaced or substituted by different atoms or group of atoms is called substitution reaction. In alkanes, hydrogen atoms are replaced by other elements.

$$\mathbf{CH_4 + Cl_2 + Sunlight \rightarrow CH_3Cl + HCl}$$

- The reaction in which one or more hydrogen atoms of a hydrocarbon are replaced by atoms of other elements is called a substitution reaction.
- Substitution reactions are a characteristic property of saturated hydrocarbons.

Some Important Carbon Compounds – Ethanol & Ethanoic Acid

Properties of Alcohols

Reaction with Sodium: Sodium reacts steadily with ethanol to form sodium ethoxide along with the evolution of hydrogen gas.

$2C_2H_5OH$	+	2Na	→	$2C_2H_5ONa$	+	$H_2\uparrow$
Ethanol		Sodium		Sodium ethoxide		Hydrogen

- **Dehydration:** Ethanol, on heating with excess of conc. H_2SO_4 at 170°C gets dehydrated to form ethene.

$$\mathbf{C_2H_5OH \ \ conc.\ H_2SO_4 \text{ at } 170^oC \rightarrow CH_2 = CH_2 + H_2O}$$

Reactions of Ethanoic acid

Esterification: Ethanoic acid reacts with alcohols in the presence of a little conc. sulphuric acid to form esters.

$$\mathbf{C_2H_5OH + CH_3COOH \ \ conc.\ H_2SO_4 \rightarrow CH_3COOC_2H_5 + H_2O}$$

The ester, on treating with a base such as NaOH is converted back to alcohol and sodium salt of carboxylic acid. This reaction is known as saponification because it is used in the manufacture of soap.

$$\mathbf{CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa}$$

- **Reaction with a base:** Ethanoic acid reacts with a base such as sodium hydroxide to form a salt and water.

$CH_3COOH + NaOH$	→	CH_3COONa	+	H_2O
Acetic acid		Sodium acetate		Water

- **Reaction with Carbonates & bicarbonates:** Acetic acid reacts with carbonates and bicarbonates to form salt, water and carbon dioxide.

$2CH_3COOH + Na_2CO_3$	→	$2CH_3COONa$	+	$H_2O + CO_2$
Acetic acid		Sodium acetate		

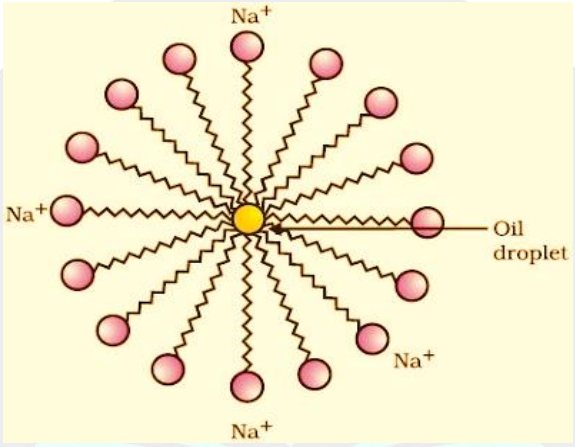
$CH_3COOH + NaHCO_3$	→	CH_3COONa	+	$H_2O + CO_2$
Acetic acid		Sodium acetate		

Soaps & Detergents

The molecules of soap are sodium or potassium salts of long-chain carboxylic acids. The ionic-end of soap interacts with water while the carbon chain interacts with oil. The soap molecules, thus form structures called micelles where one end of the molecules is towards the oil droplet while the ionic-end faces outside. This forms an emulsion in water. The soap micelle thus helps in pulling out the dirt in water and we can wash our clothes clean.

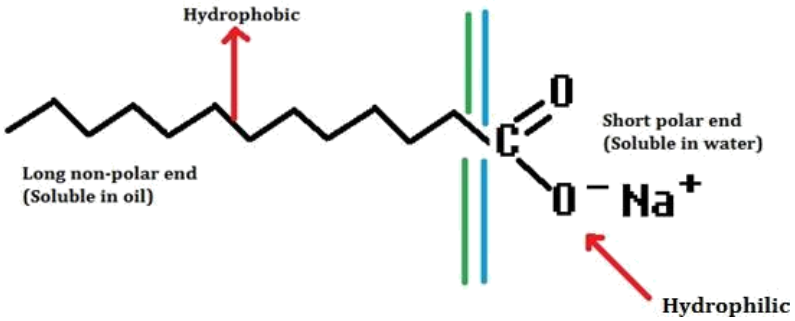
Micelles

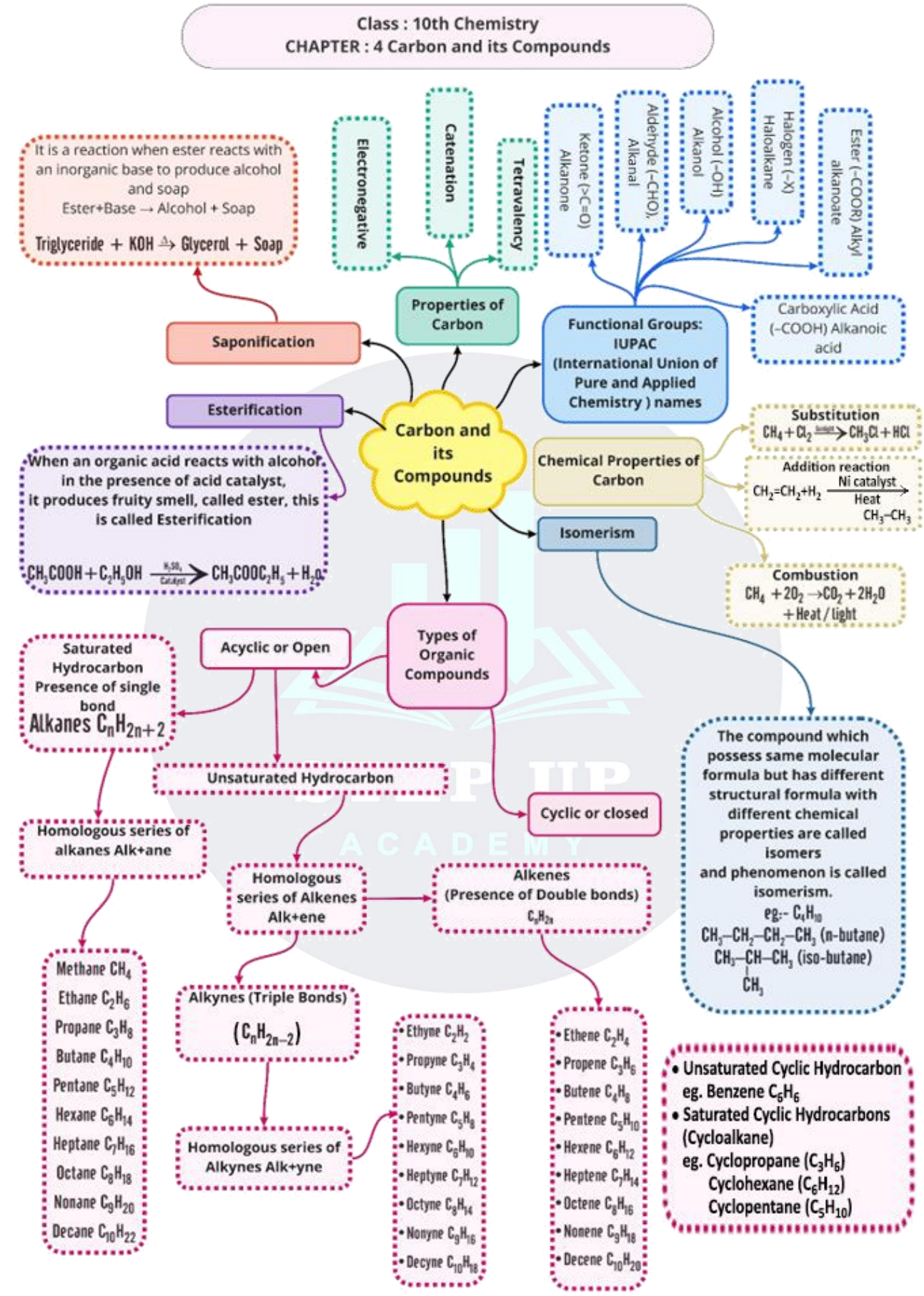
Soaps are molecules in which the two ends have differing properties, one is hydrophilic, that is, it interacts with water, while the other end is hydrophobic, that is, it interacts with hydrocarbons. When soap is at the surface of water, the hydrophobic 'tail' of soap will not be soluble in water and the soap will align along the surface of water with the ionic end in water and the hydrocarbon 'tail' protruding out of water. Inside water, these molecules have a unique orientation that keeps the hydrocarbon portion out of the water. Thus, clusters of molecules in which the hydrophobic tails are in the interior of the cluster and the ionic ends are on the surface of the cluster. This formation is called a micelle.



Soap in the form of a micelle is able to clean, since the oily dirt will be collected in the centre of the micelle. The micelles stay in solution as a colloid and will not come together to precipitate because of ion-ion repulsion. Thus, the dirt suspended in the micelles is also easily rinsed away. The soap micelles are large enough to scatter light. Hence a soap solution appears cloudy.

- Soaps are cleansing agents capable of reacting with water and dislodging the unwanted particles from clothes or skin.
- The molecules of soap are sodium or potassium salts of long chain carboxylic acids.
- A soap molecule has a tadpole shaped structure.
- At one end (long non-polar end) of the soap molecule is a hydrocarbon chain which is insoluble in water but soluble in oil.
- At the other end (short polar end) of the soap molecule, there is a carboxylate ion which is hydrophilic i.e. water soluble but insoluble in oil.

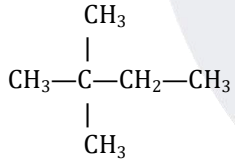



Class : 10th Chemistry
CHAPTER : 4 Carbon and its Compounds
Carbon and its Compounds
Properties of Carbon
Electronegative
Catenation
Tetravalency
Functional Groups: IUPAC (International Union of Pure and Applied Chemistry) names
Ketone (>C=O) Alkanone
Aldehyde (-CHO), Alkanal
Alcohol (-OH) Alkanol
Halogen (-X) Haloalkane
Ester (-COOR) Alkyl alkanoate
Carboxylic Acid (-COOH) Alkanoic acid
Saponification
It is a reaction when ester reacts with an inorganic base to produce alcohol and soap
Ester+Base → Alcohol + Soap
Triglyceride + KOH → Glycerol + Soap
Esterification
When an organic acid reacts with alcohol in the presence of acid catalyst, it produces fruity smell, called ester, this is called Esterification
CH3COOH + C2H5OH → CH3COOC2H5 + H2O
Chemical Properties of Carbon
Substitution
CH4 + Cl2 → CH3Cl + HCl
Addition reaction
CH2=CH2+H2 → CH3–CH3 (Ni catalyst, Heat)
Combustion
CH4 + 2O2 → CO2 + 2H2O + Heat / light
Isomerism
The compound which possess same molecular formula but has different structural formula with different chemical properties are called isomers and phenomenon is called isomerism.
eg:- C4H10
CH3–CH2–CH2–CH3 (n-butane)
CH3–CH(CH3)–CH3 (iso-butane)
Types of Organic Compounds
Acyclic or Open
Cyclic or closed
Saturated Hydrocarbon
Presence of single bond
Alkanes CnH2n+2
Unsaturated Hydrocarbon
Homologous series of alkanes Alk+ane
Methane CH4
Ethane C2H6
Propane C3H8
Butane C4H10
Pentane C5H12
Hexane C6H14
Heptane C7H16
Octane C8H18
Nonane C9H20
Decane C10H22
Homologous series of Alkenes Alk+ene
Alkenes (Presence of Double bonds)
CnH2n
Ethene C2H4
Propene C3H6
Butene C4H8
Pentene C5H10
Hexene C6H12
Heptene C7H14
Octene C8H16
Nonene C9H18
Decene C10H20
Alkynes (Triple Bonds)
(CnH2n−2)
Homologous series of Alkynes Alk+yne
Ethyne C2H2
Propyne C3H4
Butyne C4H6
Pentyne C5H8
Hexyne C6H10
Heptyne C7H12
Octyne C8H14
Nonyne C9H16
Decyne C10H18
• Unsaturated Cyclic Hydrocarbon
eg. Benzene C6H6
• Saturated Cyclic Hydrocarbons (Cycloalkane)
eg. Cyclopropane (C3H6)
Cyclohexane (C6H12)
Cyclopentane (C5H10)

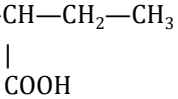
Important Questions

Multiple Choice Questions:

1. Which of the following statements are correct for carbon compounds?
   (i) Most carbon compounds are good conductors of electricity.
   (ii) Most carbon compounds are poor conductors of electricity.
   (iii) Force of attraction between molecules of carbon compounds is not very strong.
   (iv) Force of attraction between molecules of carbon compounds is very strong.
   (a) (ii) and (iv)
   (b) (ii) and (iii)
   (c) (i) and (iv)
   (d) (i) and (iii)
2. C_3H_8 belongs to the homologous series of
   (a) Alkynes
   (b) Alkenes
   (c) Alkanes
   (d) Cyclo alkanes
3. The IUPAC name of



   (a) 2-ethyl-2-methyl propane
   (b) 2, 2-demethyl butane
   (c) 1,1,1-trimethyl propane
   (d) 2, 2-methyl butane
4. Which of the following is the formula of Butanoic acid?
   (a) $CH_3CH_2CH_2CH_2COOH$
   (b) $COOH—CH_2—CH_2—CH_2—CH_3$
   (c)



   (d) $CH_2—CH_2—CH_2—COOH$
5. The number of isomers of pentane is
   (a) 2
   (b) 3
   (c) 4
   (d) 5
6. Which of the following will undergo addition reactions?
   (a) CH_4
   (b) C_3H_8
   (C) C_2H_6
   (d) C_2H_4
7. When ethanoic acid is treated with NaHCO^ the gas evolved is
   (a) H_2
   (b) CO_2
   (c) CH_4
   (d) CO
8. Ethanol on complete oxidation gives
   (a) acetic acid/ ethanoic acid
   (b) CO_2 and water
   (c) ethanal
   (d) acetone/ ethanone
9. Which of the following will give a pleasant smell of ester when heated with ethanol and a small quantity of sulphuric acid?
   (a) CH_3COOH
   (b) CH_3CH_2OH
   (c) CH_3OH
   (d) CH_3CHO
10. Name the functional group present in CH_3COCH_3.
    (a) Alcohol
    (b) Carboxylic acid
    (c) Ketone
    (d) Aldehyde

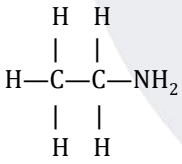
Very Short Question:

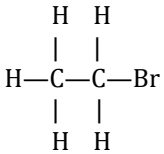
1. What are the essential constituents of all organic compounds?
2. What is the valency of carbon in its compounds?

3. Why are organic compounds present in such a large number?
4. Which is common in all the members of a family?
5. A family of organic compounds has the functional group 'al'. What is its name?
6. Out of ketonic and aldehydic groups, which is the terminal functional group?
7. Why is candle flame generally yellow?
8. The formula of a hydrocarbon is CnH2n. Name the family to which it belongs and also predict its nature.
9. An unknown compound has the smell of vinegar. Identify it.
10. What do we get when ethanoic acid reacts with ethanol in the presence of concentrated sulphuric acid?

Short Questions:

1. Write the structures of
   (i) Ethanoic acid
   (ii) Butanone
   (iii) Hexanal
   (iv) But-2-ene.
2. How will you name the following compounds?
3. Identify the name of the functional groups in the following compounds.

(i)


(ii)


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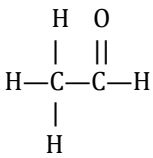
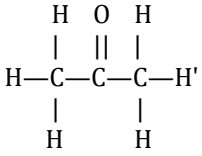
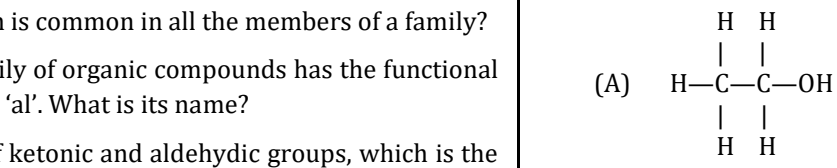
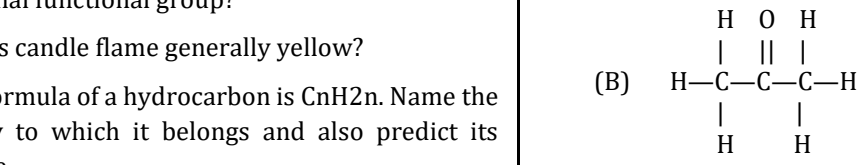
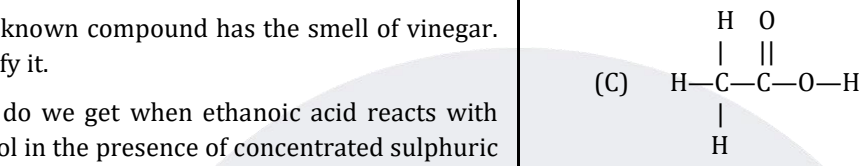


(iv)


4. Write the IUPAC names of the following compounds.

(A)


(B)


(C)


5. Give the electron dot structure and structural formula of first member of alkene and alkyne families.
6. Draw the structural formulae of the possible isomers for the compound with molecular formula C_3H_6O?
7. How will you convert ethene into ethanol? Give the chemical reaction involved.
8. What is an homologous series? Which two of the following organic compounds belong to the same homologous series?

   C_2H_6, C_2H_6O, $C_2H_6O_2$

Long Questions:

1. An organic compound 'A' is an essential constituent of wine and beer. Oxidation of 'A' yields an organic acid 'B' which is present in vinegar. Name the compounds 'A' and 'B' and write their structural formulae. What happens when 'A' and 'B' react in the presence of an acid catalyst? Write the chemical equation for the reaction.
2. Give a chemical test to distinguish between:
   (i) Ethane and ethene
   (ii) Ethanol and ethanoic acid
   (iii) Soaps and detergents.
3. (a) What are homologous series of compounds? List any two characteristics of homologous series.
   (b) What would be observed by adding a 5% solution of alkaline potassium permanganate drop by drop to warm ethanol taken in a test tube?

(c) Write the name of the compound formed during the chemical reaction. How would you distinguish experimentally between an alcohol and a carboxylic acid on the basis of a chemical property?

Assertion Reason Questions:

1. For question two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Diamond and graphite do not have the same crystal structure.

   Reason: Diamond is crystalline while graphite is amorphous.

2. For question two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Olefins have the general formula C_nH_{2n+1}.

   Reason: There is at least one double bond between two carbon atoms in their molecules.

Case study Question:

1. Read the following and answer any four questions from (i) to (v).

   A hydrocarbon (P) has the molecular formula $C_{10}H_{22}$ hydrocarbon (Q) has two carbon atoms less than (P) and belong to the same homologous series. A hydrocarbon (R) has two carbon atoms more than (P) and belong to the same homologous series.

   i. What is the molecular formula of (Q)?

      a. $C_{12}H_{26}$

      b. C_8H_{16}

      c. C_8H_{18}

      d. C_8H_{14}

   ii. To which homologous series do the compound (P), (Q) and (R) belong?

      a. C_nH_{2n}

      b. C_2H_{2n-2}

      c. C_nH_{2n+2}

      d. C_nH_{2n+1}

   iii. What is the molecular formula of (R)?

      a. $C_{12}H_{26}$

      b. $C_{12}H_{24}$

      c. $C_{12}H_{22}$

      d. $C_{12}H_{28}$

   iv. Identify the correct statement about compounds (P), (Q) and (R).

      a. They have same melting and boiling points.

      b. They have same chemical properties.

      c. They have different general formula.

      d. They differ by -CH unit.

   v. Compounds (P), (Q) and (R) are:

      a. Alkanes.

      b. Alkenes.

      c. Alkynes.

      d. None of these.

2. Read the following and answer any four questions from (i) to (v).

   The table given below shows six organic compounds A, B, C, D, E and F having different molecular formula:

Organic compound	Molecular formula
A	C_7H_{16}
B	C_8H_{16}
C	C_4H_6
D	C_6H_{10}
E	C_5H_{10}
F	C_9H_{20}

i. Which of the following compounds belong to same homologous series?
   a. E and F
   b. B and C
   c. A and B
   d. C and D

ii. Which of the following is the member of the same homologous series as E?
   a. D
   b. A
   c. F
   d. B

iii. Identify the correct statements.
   a. A and Fare saturated hydrocarbons while all others are unsaturated hydrocarbons.
   b. C and D belong to a homologous series having general formula C_nH_{2n}.
   c. B and E are alkynes.
   d. All the compounds have same physical and chemical properties.

iv. Compound B is:
   a. An alkane.
   b. An alkene.
   c. An alkyne.
   d. None of these.

v. Compound (F) has a general formula:
   a. C_nH_{2n-2}
   b. C_nH_{2n}
   c. C_nH_{2n+4}
   d. C_nH_{2n+2}

Answer Key

Multiple Choice Answers:

1. (b) (ii) and (iii)
2. (c) Alkanes
3. (b) 2, 2-demethyl butane
4. (d)
5. (b) 3
6. (d) C_2H_4
7. (b) CO_2
8. (b) CO_2 and water
9. (a) CH_3COOH
10. (c) Ketone

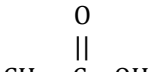
Very Short Answers:

1. **Answer**: Carbon and hydrogen are the essential constituents of all organic compounds. However, carbon tetrachloride (CCl_4) is an exception.
2. **Answer**: Carbon is tetravalent in its compounds.
3. **Answer**: This is due to the self-linking property of carbon known as catenation.
4. **Answer**: They have the common functional group.
5. **Answer**: The family is of aldehydes also called alkanals.
6. **Answer**: Aldehydic group

(—C—H) is the terminal functional group.
7. **Answer**: Candle flame is generally yellow due to the presence of unburnt carbon particles. When light falls on these particles, they scatter yellow colour. This shows that the combustion of hydrocarbons present in wax or candle is not complete.
8. **Answer**: The hydrocarbon belongs to alkene family. It is unsaturated in nature.
9. **Answer**: The compound is ethanoic acid also called acetic acid.
10. **Answer**: Ethyl ethanoate ($CH_3COOC_2H_5$) is formed by esterification reaction. It has fruity smell.

Short Answer:

1. **Answer**:

(i) 

Ethanoic acid

(ii) $CH_3—\overset{\overset{O}{\|}}{C}—CH_2—CH_3$

Butanone

(iii) $CH_3—CH_2—CH_2—CH_2—CH_2—\overset{\overset{O}{\|}}{C}—H$

Hexanal

(iv) $CH_3—CH=CH—CH_3$

But-2-ene

2. **Answer**:

(a) Ethanal

(b) Ethanol

(c) Methanal

(d) Chloroethane.

3. **Answer**:

(i) $—NH_2$ (amino)

(ii) —Br (bromo)

(iii) $—\overset{\overset{O}{\|}}{C}—H$ (al)

(iv) $—\overset{\overset{O}{\|}}{C}—$(one)

4. **Answer**:

(a) Ethanol

(b) Propanone

(c) Ethanoic acid.

5. **Answer**:

(i) $H:\overset{\overset{H}{..}}{\underset{\underset{H}{..}}{C}}::\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}:H$ or $H—C=C—H$

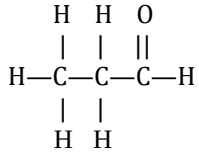
Ethene

(ii) $H:C:::C:H$ or $H—C\equiv C—H$

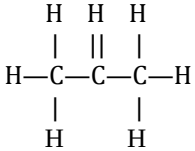
Ethyne

6. **Answer**:

The given organic compounds represents two structural isomers which are actually functional isomers in nature.



Propanal



Propanone

7. **Answer**:

Ethene is converted into ethanol by passing its vapours through water in the presence of sulphuric acid. This reaction is called hydration of ethene.

$$H_2C=CH_2+H_2O \xrightarrow{(H_2SO_4)} CH_3—CH_2—OH$$

8. **Answer**:

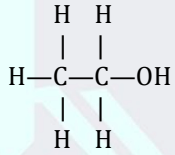
Homologous series represent different families of organic compounds into which these are divided. Two characteristics of homologous series are listed.

The compounds CH_4O and C_2H_6O belong to the same homologous series known as alkanols.

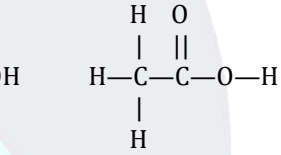
Long Answer:

1. **Answer**:

The available information suggests that the compound 'A' is ethanol and the compound 'B' formed by the oxidation of 'A' is ethanoic acid. Their structural formulae are:



Ethanol (A)



Ethanoic acid (B)

When 'A' and 'B' react in the presence of an acid like cone. H2SO4, the compound is ethyl ethanoate (ester) with a pleasant smell.

$$CH_3—\overset{\overset{O}{\|}}{C}— OH+H\ O—C_2H_5 \xrightarrow{H_2SO_4(conc.)}$$

(B) (A)

$$CH_3—\overset{\overset{O}{\|}}{C}—OC_2H_5+H_2O$$

Ethyl ethanoate

2. **Answer**:

(i) Ethene decolorizes the yellow colour of bromine water while ethane does not.

(ii) Ethanoic acid gives a brisk effervescence with sodium hydrogen carbonate while ethanol does not.

(iii) Soaps form curdy white precipitate or scum with hard water while detergents do not form any precipitate.

3. **Answer**:

(a) Homologous series represent different families of organic compounds into which these are divided.

Two characteristics of homologous series are listed.

- All the members in a particular homologous series of family have the same characteristic functional group. For example, in organic acids, the functional group is carboxyl group (—COOH).
- Any two consecutive members in a particular family have the same common difference of CH_2 in their molecular formulae. For example, the first three members of the family of alkanes are: CH_4 (methane), C_2H_6 (ethane) and propane (C_3H_8).

(b) On adding a 5% solution of alkaline potassium permanganate to ethanol, it will be oxidized to ethanoic acid.

The pink colour of the solution will get discharged upon warming.

$$CH_3CH_2OH + 2(O) \xrightarrow{KMnO_4(OH^-)} CH_3COOH + H_2O$$

Ethanol Ethanoic acid

(c) A carboxylic acid gives a brisk effervescence when an aqueous solution of sodium hydrogen carbonate ($NaHCO_3$) is added to it. This is due to the evolution of CO_2 gas. However, alcohol will not give any reaction.

$$ROOH + NaHCO_3 \longrightarrow RCOONa + H_2O + CO_2$$

Carboxylic acid Sod. Salt

Assertion Reason Answer:

1. (c) A is true, but R is false.

Explanation:

In diamond, C-atoms are sp^3 hybridized while in graphite, they are sp^2 hybridized. Diamond and graphite both are crystalline forms of carbon.

2. (d) A is false, but R is true.

Explanation:

Olefins are unsaturated hydrocarbons. There is at least one double bond between two carbon atoms in their molecules and they have the general formula C_nH_{2n}.

Case Study Answer:

1. i. (c) C_8H_{18}

Explanation:

Molecular formula of (Q) is C_8H_{18} as it has two carbon atoms less than (P).

ii. (c) C_nH_{2n+2}

Explanation:

Compounds (P), (Q) and (R) are alkanes having general formula C_nH_{2n+2}.

iii. (a) $C_{12}H_{26}$

Explanation:

Molecular formula of (R) is $C_{12}H_{26}$ as it has two carbon atoms more than (P).

iv. (b) They have same chemical properties.

Explanation:

Compound (P), (Q) and (R) belong to same homologous series So they have different physical properties but similar chemical properties. They have same general formula C_nH_{2n+2}. They differ by 2 carbon atoms and 4 hydrogen atoms.

v. (a) Alkanes.

2. i. (d) C and D

Explanation:

A and Fare alkanes; B and E are alkenes; C and Dare alkynes.

ii. (d) B

Explanation:

B is an alkene having general formula C_nH_{2n} the homologous series to which E belongs.

iii. (a) A and Fare saturated hydrocarbons while all others are unsaturated hydrocarbons.

Explanation:

C and D belong to a homologous series having general formula C_nH_{2n-2} B and E are alkenes. All the compounds have different physical and chemical properties.

iv. (b) An alkene.

Explanation:

(B) is alkene.

v. (d) C_nH_{2n+2}

Explanation:

(F) is an alkane.

Periodic Classification of Elements 5

Early Attempts of Classification of Elements

- Matter around us is present in the form of elements, compounds and mixtures.
- Elements are substances containing atoms of only one type. E.g., Na, Mg, Au, etc.
- There are 118 elements known to us. All these have different properties.
- To make the study of these elements easy, these elements have been divided into few groups in such a way that elements in the same group have similar properties.

Dobereiner's Triads

Law of Triads: When elements are arranged in the order of their increasing atomic masses, the atomic mass of the middle element was approximately the mean of the atomic masses of the other two elements.

Dobereiner arranged a group of three elements with similar properties in the order of increasing atomic masses and called it a triad. He showed that the atomic mass of the middle element is approximately the arithmetic mean of the other two. But, Dobereiner could identify only the following three triads from the elements known at that time.

For example:

Consider the triad of lithium, sodium and potassium. The atomic mass of sodium is the mean of the atomic masses of lithium and potassium.

Element	Atomic Mass	Average
Lithium	6.9	Atomic mass of Na= $\frac{6.9+39}{2} = 23$
Sodium	23	
Potassium	39	

Newlands' Law of Octaves

- **Law of Octaves:** When elements are arranged in the increasing order of their atomic masses, the properties of every eighth element is similar to the first.

sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	F
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	_____	____

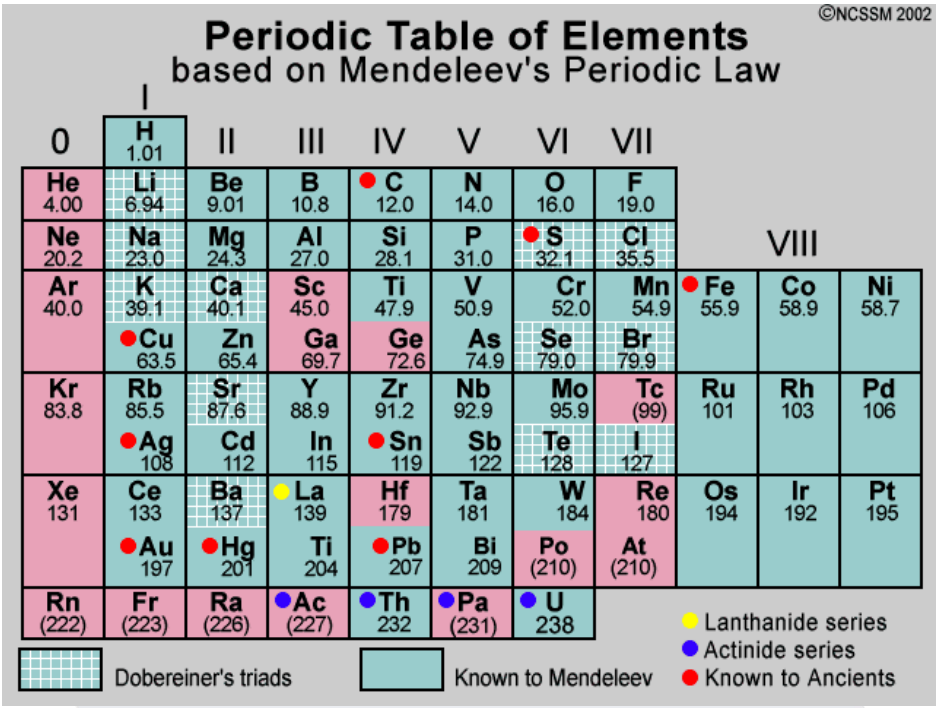
Limitations

- Newland could arrange elements only up to calcium, out of the total 56 elements known.
- After calcium, every eighth element did not possess properties similar to that of the first.
- Only 56 elements were known at the time of Newland, but later several new elements were discovered.
- In order to fit the existing element arrangement, Newland placed two elements in the same position which differed in their properties.

For example: Iron, an element which resembles cobalt and nickel in its properties is placed far away from these elements.

- The periodic table did not include inert gases because they were not discovered then.

Mendeleev's Periodic Table



Mendeleev's Periodic Law: The physical and chemical properties of elements are a periodic function of their atomic masses.

Achievements of Mendeleev's Periodic Table:

- Systematic Study of Elements – The table provided the arrangements of elements showing similar properties into groups. This was very useful in studying and remembering the properties of a large number of elements in a systematic way.
- Prediction of New Elements – Mendeleev had predicted new elements and had left three blanks for these undiscovered elements. He was able to predict their properties more or less accurately. He named them eka-boron, eka-aluminium and eka-silicon.
- Correction of Atomic Masses - Based on the elements' positions in the periodic table, Mendeleev was able to correct their atomic masses. The atomic mass of beryllium was corrected from 13.5 to 9.0.

Features of Mendeleev's Periodic Table

- There are seven horizontal rows in the periodic table, numbered from 1 to 7. These seven rows are called periods.
- There are eight vertical columns numbered from I to VIII. These eight columns are called groups. Groups I to VII are further divided into sub groups A and B.
- The properties of elements in a particular period show regular gradation from left to right.

Merits of Mendeleev's Periodic Table

- Mendeleev kept some blank spaces in the periodic table for the elements which were yet to be discovered.

Predicted element	Actual element discovered later
Eka-boron	Scandium
Eka-aluminium	Gallium
Eka-silicon	Germanium

- He also predicted properties of some elements even before their discovery which were later found to be correct.

Property	Eka-aluminium	Gallium
Atomic mass	68	69.7
Formula of oxide	E_2O_3	Ga_2O_3
Formula of chloride	ECl_3	$GaCl_3$

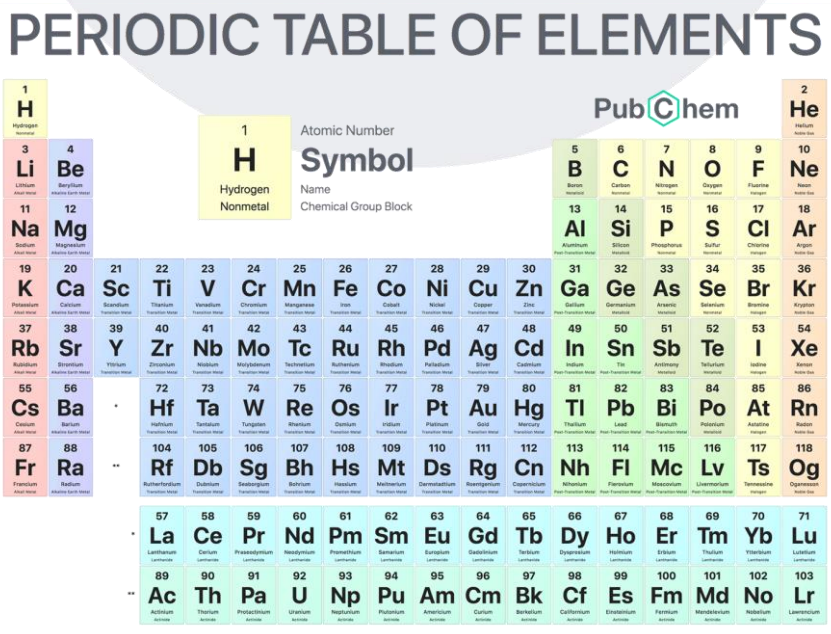
- Mendeleev's periodic table could accommodate noble gases when they were discovered.

Demerits of Mendeleev's Periodic Table

- Hydrogen resembles alkali metals as well as halogens. So, a correct position could not be assigned to hydrogen in the periodic table.
- The position of isotopes could not be explained. Isotopes are atoms of the same element having similar chemical properties but different atomic masses. If the elements are arranged according to atomic masses, the isotopes should be placed in different groups of the periodic table.
- At certain places, an element of higher atomic mass was placed before an element of lower atomic mass.
- For example: Cobalt (Co = 58.93) was placed before nickel (Ni = 58.71).
- Some elements placed in the same sub group had different properties.

For example: Manganese is placed with the halogens which are totally different in their properties.

Modern Periodic Table



- In the year 1913, an English physicist named Henry Mosely found that the atomic number of an element, which was denoted by the symbol 'Z' was a more basic property to group them instead of their atomic masses. Thus Mendeleev's periodic table was modified for the same. The elements were now grouped based on the increasing atomic number.
- This came to be known as the **Modern Periodic Law** and it states, 'properties of the elements are a periodic function of their atomic number'. Hence the new classification of the elements based on this came into existence and was termed as 'Modern Periodic Table.
- With this system of grouping, it was easy to predict the properties of the elements when they were arranged in the order of increasing atomic numbers. It is to be noted that the periodicity of the elements is based on the electronic configuration or the number of protons in the nucleus.

Position of Elements in the Periodic Table

Periods

- The horizontal rows in the Modern Periodic Table are called periods.
- There are 7 periods in this table. The periods have the same elements that have the same valence shell or the energy shell. Example - Na, Mg, Al, Si, P, S, Cl are placed in the same shell as they have the electronic shells as K, L and M.
- In a period, the number of electrons present in the energy shells increases by 1 on moving from left to right within a period. Example - Na - 1, Mg - 2, Al - 3, and so on.
- The number of elements present in a period can be determined by the formula $2n^2$, where n is the number of the shell from the nucleus.
- The first period consists of two elements only namely, hydrogen and helium as they have only 1 valence shell. Example - hydrogen (Z = 1 or shell as K = 1), helium (Z = 2 or shell as K = 2)
- The second period has 8 elements with 2 shells and it starts with lithium (Z = 3 or shells as K = 2, L = 1) and ends with neon (Z = 10 or shells as K = 2, L = 8).
- The third period has 8 elements with 3 shells and it starts with sodium (Z = 11 or shells as K = 2, L = 8, M = 1) and ends with argon (Z = 18 or shells as K = 2, L = 8, M = 8).
- Similarly, the fourth period has 18 elements with 4 shells and starts with potassium (Z = 19) and ends with krypton (Z = 36).
- The fifth period having 18 elements with 5 shells starts with rubidium (Z = 37) and ends with xenon (Z = 54).
- The sixth period with 32 elements has 6 shells and it starts with caesium (Z = 55) ending with radon (Z = 86).
- The seventh and last period is incomplete with 19 elements starts francium (Z = 87) and going on till oganesson (Z = 118).

Groups

- The vertical columns are called groups and consist of eighteen groups numbered from 1 to 18.
    - Group 1 elements are known as alkali metals.
    - Group 2 elements are known as alkaline earth metals.
    - Group 3 to 12 elements are known as transition elements.
    - Group 15 elements are known as pnictogens.
    - Group 16 elements are known as chalcogens .
    - Group 17 elements are known as halogens.
    - Group 18 elements are known as noble gases.
- Elements having the same number of valence electrons are present in the same group.
- Elements present in the same group show the same chemical properties.

Blocks

The periodic table is also divided into 4 blocks that are based on the subshell of the valence electrons. They are:

- **s-Block elements:** All the elements of group 1 and 2 are included in this block and their general electronic configuration is ns^{1-2} Example - Hydrogen (H), Sodium (Na), etc from group 1 and Magnesium (Mg), Calcium (Ca), etc from group 2.
- **p-Block elements:** This includes the elements from group 13 to 18. They have an electronic configuration as ns^2np^{1-6}.
- **d-block elements:** This includes group 3 to 12 elements. They have a general electronic configuration as $(n-1)d^{1-10}ns^{1-2}$.
- **f-block elements:** This block has sets of elements, lanthanides and the actinides. They have the electronic configuration of $(n-2)f^{1-14}(n-1)^{d0-1}ns^2$. The lanthanides starts from Lanthanum (La) - Lutetium (Lu) and the actinides starts from Actinium (Ac) - Lawrencium (Lr).

Trends in the Modern Periodic Table

Valency

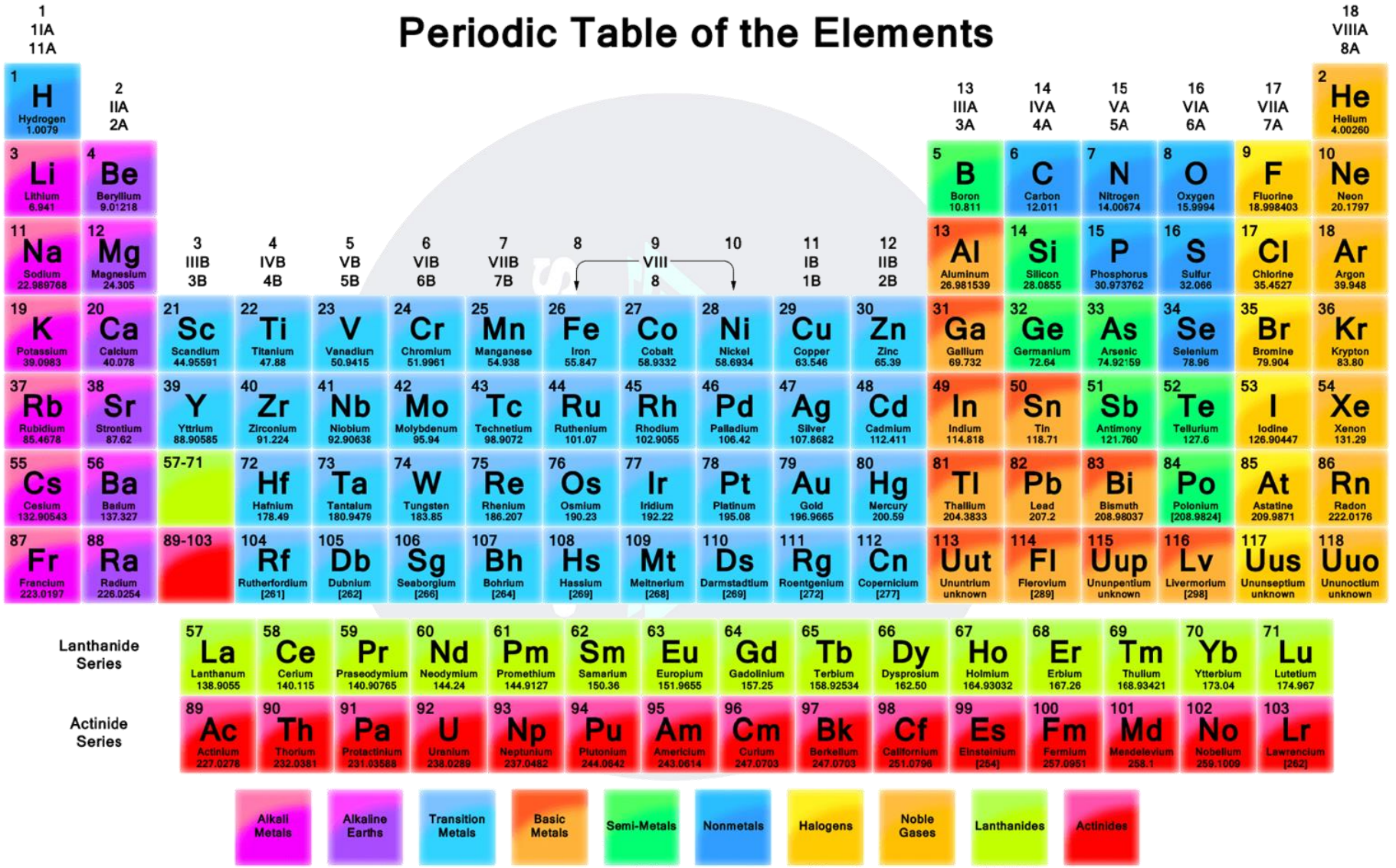
- The valency of an element is determined by the number of valence electrons present in its outermost shell.
- In a group, all the elements have the same number of valence electrons.
- On moving from left to right in each short period, the valency increases from 1 to 4 and then decreases to zero.

Atomic Size

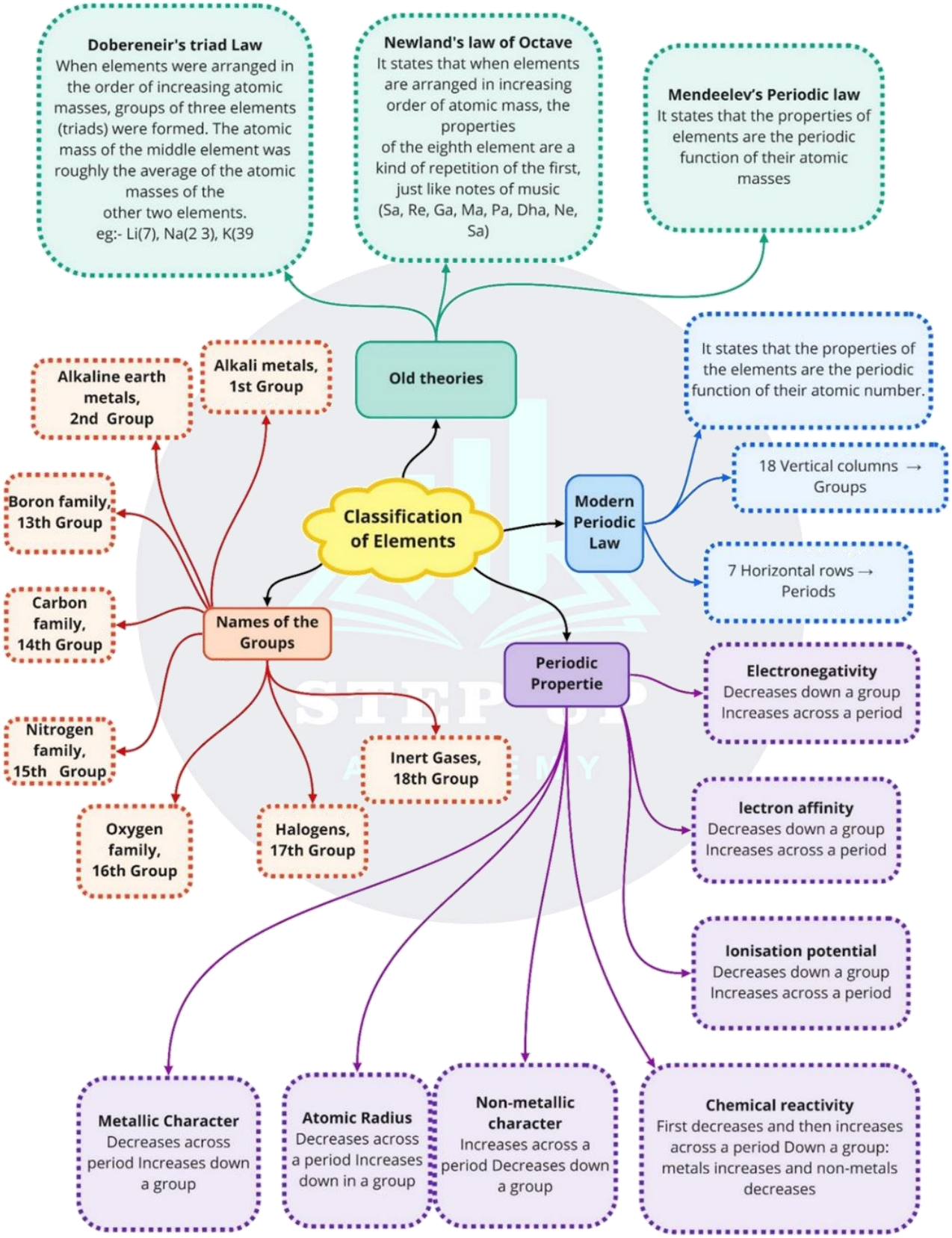
- Atomic size refers to the radius of the atom.
- It is the distance between the centre of the nucleus and the outermost shell of an isolated atom.
- In a period, the atomic radius decreases from left to right. This is because electrons are added to the same shell and so they experience a greater pull from the nucleus.
- Moving in a group from top to bottom, the atomic radius increases as new shells are added, resulting in the outermost electrons being farther away from the nucleus.

Metallic & Non-metallic Properties

- Metals show a tendency to lose electrons and are said to be electropositive.
- Non-metals show a tendency to accept or share electrons and are said to be electronegative.
- Moving from left to right in a period, the metallic character decreases and the non-metallic character increases. The atomic size decreases and so electrons are not released easily.
- In a group, the metallic character increases from top to bottom and the non-metallic character decreases. This is because, as the atomic size increases the valence electrons can be easily removed.
- Elements on the left of the periodic table are all metals and on the right of the periodic table are all non-metals.
- A zigzag line in the periodic table separates the metals from non-metals. The borderline elements show intermediate properties and are called metalloids.


Periodic Table of the Elements
1 1IA 11A
2 IIA 2A
3 IIIB 3B
4 IVB 4B
5 VB 5B
6 VIB 6B
7 VIIB 7B
8
9 VIII 8
10
11 IB 1B
12 IIB 2B
13 IIIA 3A
14 IVA 4A
15 VA 5A
16 VIA 6A
17 VIIA 7A
18 VIIIA 8A
1 H Hydrogen 1.0079
2 He Helium 4.00260
3 Li Lithium 6.941
4 Be Beryllium 9.01218
5 B Boron 10.811
6 C Carbon 12.011
7 N Nitrogen 14.00674
8 O Oxygen 15.9994
9 F Fluorine 18.998403
10 Ne Neon 20.1797
11 Na Sodium 22.989768
12 Mg Magnesium 24.305
13 Al Aluminum 26.981539
14 Si Silicon 28.0855
15 P Phosphorus 30.973762
16 S Sulfur 32.066
17 Cl Chlorine 35.4527
18 Ar Argon 39.948
19 K Potassium 39.0983
20 Ca Calcium 40.078
21 Sc Scandium 44.95591
22 Ti Titanium 47.88
23 V Vanadium 50.9415
24 Cr Chromium 51.9961
25 Mn Manganese 54.938
26 Fe Iron 55.847
27 Co Cobalt 58.9332
28 Ni Nickel 58.6934
29 Cu Copper 63.546
30 Zn Zinc 65.39
31 Ga Gallium 69.732
32 Ge Germanium 72.64
33 As Arsenic 74.92159
34 Se Selenium 78.96
35 Br Bromine 79.904
36 Kr Krypton 83.80
37 Rb Rubidium 85.4678
38 Sr Strontium 87.62
39 Y Yttrium 88.90585
40 Zr Zirconium 91.224
41 Nb Niobium 92.90638
42 Mo Molybdenum 95.94
43 Tc Technetium 98.9072
44 Ru Ruthenium 101.07
45 Rh Rhodium 102.9055
46 Pd Palladium 106.42
47 Ag Silver 107.8682
48 Cd Cadmium 112.411
49 In Indium 114.818
50 Sn Tin 118.71
51 Sb Antimony 121.760
52 Te Tellurium 127.6
53 I Iodine 126.90447
54 Xe Xenon 131.29
55 Cs Cesium 132.90543
56 Ba Barium 137.327
57-71
72 Hf Hafnium 178.49
73 Ta Tantalum 180.9479
74 W Tungsten 183.85
75 Re Rhenium 186.207
76 Os Osmium 190.23
77 Ir Iridium 192.22
78 Pt Platinum 195.08
79 Au Gold 196.9665
80 Hg Mercury 200.59
81 Tl Thallium 204.3833
82 Pb Lead 207.2
83 Bi Bismuth 208.98037
84 Po Polonium [208.9824]
85 At Astatine 209.9871
86 Rn Radon 222.0176
87 Fr Francium 223.0197
88 Ra Radium 226.0254
89-103
104 Rf Rutherfordium [261]
105 Db Dubnium [262]
106 Sg Seaborgium [266]
107 Bh Bohrium [264]
108 Hs Hassium [269]
109 Mt Meitnerium [268]
110 Ds Darmstadtium [269]
111 Rg Roentgenium [272]
112 Cn Copernicium [277]
113 Uut Ununtrium unknown
114 Fl Flerovium [289]
115 Uup Ununpentium unknown
116 Lv Livermorium [298]
117 Uus Ununseptium unknown
118 Uuo Ununoctium unknown
Lanthanide Series
57 La Lanthanum 138.9055
58 Ce Cerium 140.115
59 Pr Praseodymium 140.90765
60 Nd Neodymium 144.24
61 Pm Promethium 144.9127
62 Sm Samarium 150.36
63 Eu Europium 151.9655
64 Gd Gadolinium 157.25
65 Tb Terbium 158.92534
66 Dy Dysprosium 162.50
67 Ho Holmium 164.93032
68 Er Erbium 167.26
69 Tm Thulium 168.93421
70 Yb Ytterbium 173.04
71 Lu Lutetium 174.967
Actinide Series
89 Ac Actinium 227.0278
90 Th Thorium 232.0381
91 Pa Protactinium 231.03588
92 U Uranium 238.0289
93 Np Neptunium 237.0482
94 Pu Plutonium 244.0642
95 Am Americium 243.0614
96 Cm Curium 247.0703
97 Bk Berkelium 247.0703
98 Cf Californium 251.0796
99 Es Einsteinium [254]
100 Fm Fermium 257.0951
101 Md Mendelevium 258.1
102 No Nobelium 259.1009
103 Lr Lawrencium [262]
Alkali Metals
Alkaline Earths
Transition Metals
Basic Metals
Semi-Metals
Nonmetals
Halogens
Noble Gases
Lanthanides
Actinides

Class : 10th Chemistry
CHAPTER : 5 Classification of Elements



Important Questions

Multiple Choice Questions:

1. Newlands relation is called.
   (a) Musical Law
   (b) Law of Octaves
   (c) Periodic Law
   (d) Atomic Mass Law
2. Upto which element, the Law of Octaves was found applicable?
   (a) Oxygen
   (b) Calcium
   (c) Cobalt
   (d) Potassium
3. In Mendeleev's Periodic Table, gaps were left for the elements to be discovered later. Which of the following elements found a place in the Periodic Table later?
   (a) Chlorine
   (b) Silicon
   (c) Oxygen
   (d) Germanium
4. At the time of Mendeleev, the number of elements known was
   (a) 63
   (b) 65
   (c) 62
   (d) 64
5. The properties of eka-aluminium predicted by Mendeleev are the same as the properties of later discovered element:
   (a) Scandium
   (b) Germanium
   (c) Gallium
   (d) Aluminium
6. An atom of an element has the electronic configuration 2,8,2. To which group does it belong?
   (a) 4th group
   (b) 6th group
   (c) 3rd group
   (d) 2nd group
7. The arrangement of elements in the Modem Periodic Table is based on their
   (a) increasing atomic mass in the period
   (b) increasing atomic number in the horizontal rows
   (c) increasing atomic number in the vertical columns
   (d) increasing atomic mass in the group
8. Where would you locate the element with electronic configuration 2, 8 in the Modern Periodic Table?
   (a) Group 8
   (b) Group 2
   (c) Group 18
   (d) Group 10
9. Element 'X' forms a chloride with the formula XCl_2, which is a solid with high melting point. X would most likely be in the same group of the periodic table as:
   (a) Si
   (b) Mg
   (c) Al
   (d) Na
10. Which of these belong to the same period?

Element	A	B	C
Atomic number	2	10	5

   (a) A, B
   (b) B, C
   (c) C, A
   (d) A, B and C

Very Short Question:

1. Indicate the elements which belong to the same group from their atomic numbers as 9, 17, 24, 30, 35, 45.
2. Arrange the following in decreasing atomic size:
   (i) Na, Mg, K
   (ii) N, F, O
   (iii) N, S, P
3. Give the name and electronic configuration of second alkali metal.
4. What is the similarity in the electronic configuration of Mg, Ca and Sr?

5. Name the members of alkaline earth family. Which out of them is radioactive in nature?

   Answer: The members of alkaline earth family (group 2) are: Be, Mg, Ca, Sr, Ba, Ra. The last element radium (Ra) is radioactive in nature.

6. The two isotopes of chlorine have atomic mass 35 u and 37 u. Should they be placed in separate slots in the periodic table?

7. An element "X" has mass number 35 and number of neutrons is 18.

   Identify group number and period of the element "X".

8. Flow does metallic character of the elements vary

   (i) in a group

   (ii) in a period?

9. Name three elements which behave as metalloids.

10. Which property do all the elements possess which are present in the same period as the element boron?

Short Questions:

1. Identify the non-metals from the elements given below.

   (a) 2, 8, 1

   (b) 2, 8, 7

   (c) 2, 8, 3

   (d) 2, 8, 5.

2. Identify the elements X and Y from the following information.

   (a) X has 17 protons and 18 neutrons

   (b) Y has 17 protons and 20 neutrons.

3. Identify the elements from the following characteristics and arrange them in increasing order of metallic character.

   (a) An element which imparts golden yellow colour to the flame.

   (b) An element whose oxide is used as a white wash.

   (c) An element which is constituent of chlorophyll i.e. green coloring matter in plants.

4. (a) Atomic numbers of Mg and Al are 12 and 13 respectively. "Write their electronic configuration.

   (b) Mention the period of the Modern Periodic Table to which the above two elements belong. Give reason for your answer.

5. From the part of a periodic table, answer the following questions:

1 Hydrogen	2	13	14 Carbon	15	16 Oxygen	17 Fluorine
X			P			Q
Y						R
Z						T

   (a) Atomic number of oxygen is 8. What would be the atomic number of, Fluorine?

   (b) Out of 'X' and 'Q' which element has larger atomic size? Give reason for your answer.

   (c) Out of 'Y' and 'Z' which element has smaller atomic size? Give reason for your answer.

6. Calcium is an element with atomic number 20.

   (i) Is it a metal or non-metal?

   (ii) Will its size be more or smaller than that of potassium?

   (iii) Write the formula of its chloride.

7. An element 'X' has mass number 35 and number of neutrons 18. Write atomic number and electronic configuration of 'X'. Also write group number, period number and valency of 'X'.

8. Given below are some of the elements of first group Li, Na, K

   (Their atomic numbers are 3, 11, 19 respectively and they belong to 2nd, 3rd and 4th period respectively). Arrange these in the decreasing order of metallic character exhibited by them.

Long Questions:

1. Three elements A, B and C have atomic numbers 7, 8 and 9 respectively.

   (a) What would be their positions in the modern periodic table? (Mention group and period both)

   (b) Arrange A, B and C in decreasing order of their size.

   (c) Which one of the three elements is most reactive and why?

2. The elements with atomic number 3 to 10 belong to the second period. Taking into account the trends in the general periodic properties, predict.

   (a) The most electronegative element

   (b) The most electropositive element

   (c) The element belonging to noble gas family

   (d) The element which constitutes large number of organic compounds.

3. "Elements in Periodic Table show periodicity of properties". List any four properties.

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Atomic size of as is more than that of P.

   Reason: Atomic size decreases along a period.

2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Chlorine is the most electronegative element of the halogen family.

   Reason: Size of chlorine is more than that of fluorine.

1. Read the following and answer any four questions from (i) to (v).

   "Properties of elements are the periodic function of their atomic numbers." This is known as modern periodic law. It means that the properties of elements depend on their atomic numbers, and the elements are given positions in the periodic table on the basis of their increasing atomic number. Atomic number determines the distribution of electrons in the orbit, and electrons of the outermost orbit determine the properties of an element. There are 18 groups (vertical columns) and 7 periods (horizontal lines) in modem form of the periodic table. The number of the period is equal to the number of shells in the atoms of the elements belonging to that period.

   i. What is the atomic number of elements of period 3 and group 17?

      a. 10

      b. 14

      c. 17

      d. 12

   ii. Atomic number of an element is 2, 8, 6. Its period number and valency are respectively.

      a. 3, 2

      b. 6, 6

      c. 6, 2

      d. 2, 2

   iii. An element has mass number 40 and contains 20 neutrons in its atom. To which period and group of the periodic table does it belong?

      a. Period-3, Group-3

      b. Period-4, Group-3

      c. Period-4, Group-2

      d. Period-4, Group-4

   iv. An elements 'X' has an atomic number of 16. With which of the following elements will it show similar.

      a. Ne (10)

      b. N (7)

      c. O (8)

      d. Be (8)

   v. Identify the statement(s) which is(are) true for the modern periodic table.

      a. It reflects trends in physical and chemical properties of the elements.

      b. It helps to reflect the relative atomicity of bonds between any two elements.

      c. It helps to predict the stable valency state of the elements.

      d. All of these.

2. Read the following and answer any four questions from (i) to (v).

   The recurrence of properties of the elements after a certain regular interval, when they are arranged in the increasing order of their atomic numbers, is called periodicity. There are a number of physical properties such as atomic size, metallic and non-metallic character, etc. which show periodic

variation. ln periodic table, various properties vary differently from moving left to right in a period and going down in a group. ln a period, properties vary because from moving left to right in a period, number of shells remain same, but valence electron increases by one number hence nuclear charge increases. ln a group, ongoing down, number of valence shells increases while number of valence electrons remains same.

i. From top to bottom in a group of the periodic table, the electropositive character of the element.
   a. Increases.
   b. Decreases.
   c. Remains unchanged.
   d. Changes irregularly.

ii. Which element has the largest size in the second period?
   a. N
   b. F
   c. Li
   d. Be

iii. Which of the following elements has three valence electrons?
   a. Cs
   b. Ca
   c. Al
   d. S

iv. ln the periodic table, the metallic character of elements.
   a. Decreases from left to right and decreases down the group.
   b. Decreases from left to right and increases down the group.
   c. Increases from left to right and increases down the group.
   d. Increases from left to right and decreases down the group.

v. Which of the following increases along the period?
   a. Number of valence electrons.
   b. Atomic size.
   c. Electropositive character.
   d. All of these.

Answer Key

Multiple Choice Answers:

1. (b) Law of Octaves
2. (b) Calcium
3. (d) Germanium
4. (a) 63
5. (c) Gallium
6. (d) 2nd group
7. (b) increasing atomic number in the horizontal rows
8. (c) Group 18
9. (b) Mg
10. (b) B, C

Very Short Answers:

1. **Answer**: Elements with atomic numbers 9, 17 and 35 belong to the same group i.e., halogen family.
2. **Answer:**
   (i) K, Na, Mg
   (ii) N, O, F
   (iii) P, S, N.
3. **Answer**: The second alkali metal is sodium (Na). Its electronic configuration is 2, 8, 1.
4. **Answer**: All the elements belong to group 2 and have two electrons in their valence shell.
5. **Answer**: The members of alkaline earth family (group 2) are: Be, Mg, Ca, Sr, Ba, Ra. The last element radium (Ra) is radioactive in nature.
6. **Answer**: No, they should be placed in the same slot (or position) because the periodic table is based on the atomic numbers of the elements. Both the isotopes of the element chlorine have the same atomic number (Z = 17).
7. **Answer**:
   Atomic number of X = Mass No. – No. of neutrons = 35 – 17 = 18.

Electronic configuration = 2, 8, 7;

Group No. = 17, Period No. = 3.

8. **Answer**:

(i) The metallic character of the elements increases downwards in a group.

(ii) The metallic character of the elements decreases from left to the right along a period.

9. **Answer**: The elements are: arsenic (As), antimony (Sb) and germanium (Ge).

10. **Answer**: In all the elements, the last electron is present in the same shell i.e., L-shell or second shell.

Short Answer:

1. **Answer**: The element chlorine (Cl) corresponding to configuration (b) and the element phosphorus (P) corresponding to configuration (d) are both non-metals.

2. **Answer**: Both the elements X and Y are the isotopes of the same element chlorine because they have the same number oi protons (17).

Remember: Two different elements cannot have the same number of protons. Therefore, X and Y are the isotopes of the same element.

3. **Answer**:

(a) Sodium

(b) Calcium

(c) Magnesium.

Sodium (Na) belongs to group 1. Both calcium (Ca) and magnesium (Mg) are present in group 2. The element Ca is placed below Mg in the group. Since the metallic character of the elements decreases along a period and increases down the group, in the light of these observations, the increasing order of metallic character is: Mg < Na < Ca.

4. **Answer**:

(a) The electronic configuration of the elements are:

Mg(Z = 12) 2, 8, 2 ;

Al (Z = 13) 2, 8, 3.

(b) Both these elements belong to third period since their atoms have three shells.

5. **Answer**:

(a) Atomic number of Fluorine is (8 + 1) = 9.

(b) Since the atomic size of the elements decreases along a period the element 'Q' has a smaller size than element 'X'.

(c) Since the atomic size of the elements increases down the group, the element 'Y' has a smaller size than element 'Z'.

6. **Answer**:

The electronic configuration of calcium (Z = 20) is 2, 8, 8, 2.

(i) Since it has only two valence electrons, it is present in group 2. It is a metal.

(ii) Both potassium (K) and calcium (Ca) are present in fourth period. Since atomic size decreases along a period, calcium is smaller in size.

(iii) The valency of calcium is 2. The formula of its chloride is $CaCl_2$.

7. **Answer**:

Atomic number of the element 'X' = 35 – 18 = 17

Electronic configuration of the element 'X' = 2, 8, 7

Group number = 17;

Period number = 3.

Valency of the element 'X' = 8 – 7 = 1.

8. **Answer**: All the three elements belong to the group (1) of alkali metals. Since the metallic character of the elements increases down a group, the decreasing order of metallic character is K > Na > Li.

Long Answer:

1. **Answer**:

The electronic configuration of these elements are:

(a) A (Z = 7) 2, 5;

B (Z = 8) 2, 6;

C (Z = 9) 2, 7

Position of element A = 15th group and 2nd period

Position of element B = 16th group and 2nd period

Position of element C = 17th group and 2nd period.

(b) In general, atomic size decreases along a period. Therefore, decreasing order of size is A > B > C

(c) The element C (Z = 9) is fluorine. It is the most reactive element since it needs only one electron to acquire a noble gas configuration.

2. **Answer**:

(a) The most electronegative element has atomic number (Z) = 9. It is fluorine (F).

(b) The most electropositive element has atomic number (Z) = 3. It is lithium (Li)

(c) The element belonging to noble gas family has atomic number (Z) = 10. It is neon (Ne)

(d) The element which constitutes large number of organic compounds has atomic number (Z) = 6. It is carbon (C).

3. **Answer**:

Periodicity i.e., repetition of similar properties is shown by the elements present in a group and separated by definite gaps of atomic number. For example,

Elements in a group have same number of valence electrons and same valency.

Elements present in a group show similar chemical properties.

The atomic sizes of the elements in a group increase regularly.

The m.p. and b.p. of the elements in a group increase regularly.

Assertion Reason Answer:

1. (b) Both A and R are true, but R is not the correct explanation of the assertion.

Explanation:

Atomic size increases down a group.

2. (d) A is false, but R is true.

Explanation:

Fluorine is most electronegative element of the halogen family.

Case Study Questions:

1. i. (c) 17

Explanation:

The element is chlorine (Z = 17).

ii. (a) 3, 2

Explanation:

The element (sulphur) belongs to third period and its valency is 2.

iii. (c) Period-4, Group-2

Explanation:

Atomic number of the element= 40- 20 = 20
Electronic configuration of the element is 2, 8, 8, 2; i.e., the element is calcium which belongs to 4th period and 2nd group of the periodic table.

iv. (c) O (8)

Explanation:

The element is sulphur. Sulphur and oxygen belong to group 16.

v. (d) All of these.

2. i. (a) Increases.

Explanation:

As the size of the atom increases down the group, electropositive character increases.

ii. (c) Li

Explanation:

Li is the first element of the second period. As the size decreases in the period from left to right, therefore, Li is the largest atom in the period.

iii. (c) Al

Explanation:

Al (Z = 13): 2, 8, 3

iv. (b)

Explanation:

Metallic character of elements decreases from left to right and increases down the group.

v. (a) Number of valence electrons.

Explanation:

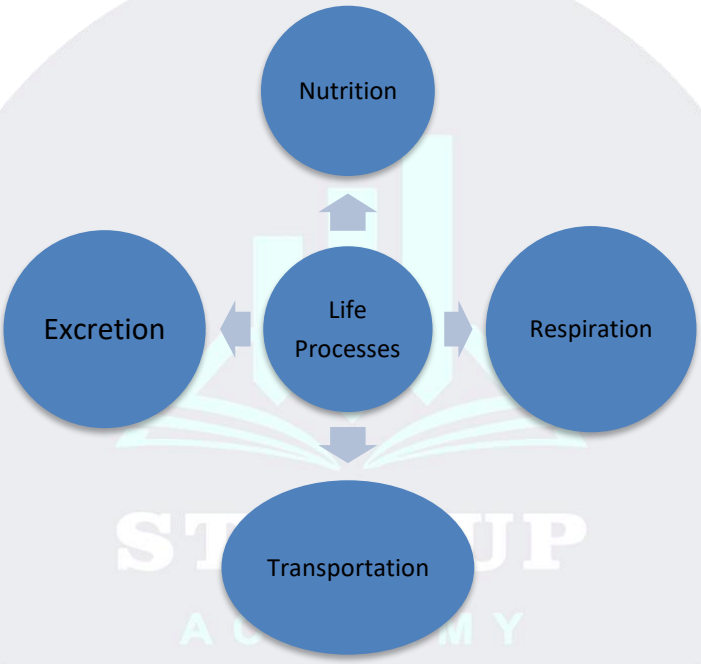
As we move from left to right along a period, the number of valence electrons increases from 1 to 8.

BIOLOGY

Life Processes 1

The basic functions performed by organisms to maintain their life on Earth are called **life processes**.

All living things perform certain life processes like growth, excretion, respiration, circulation etc. All the processes like respiration, digestion, which together keep the living organisms live and perform the job of body maintenance are called life processes.

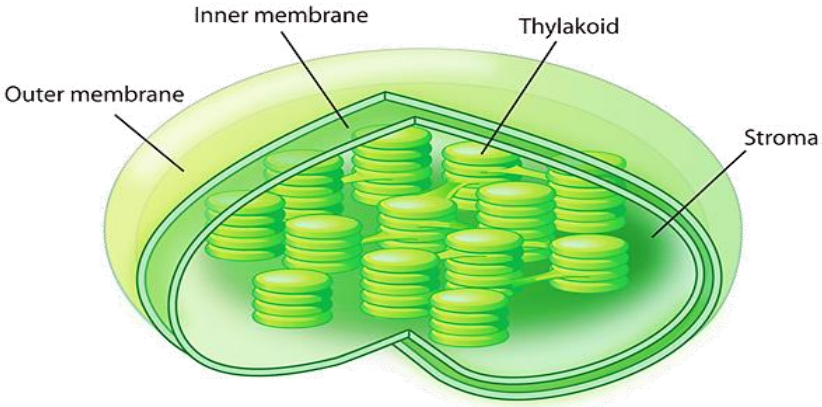


Nutrition

Autotrophic Nutrition

- It is the mode of nutrition in which organisms synthesis their own food from simple inorganic substances such as water and carbon dioxide.
- Green plants are autotrophs. They synthesis food by the process of photosynthesis.
- **Photosynthesis** is a physiological process by which plant cells containing chlorophyll produce food in the form of carbohydrates using carbon dioxide, water and light energy. Oxygen is released as a by- product in this process.
- **Chlorophyll** is the green pigment found in green plants.
- Chlorophyll is present in chloroplasts.
- **Chloroplast** is a membrane-bound oval cell organelle.
- It is enclosed by a double membrane. Its interior contains closely packed flattened sacs called **thylakoids**. Chlorophyll is present in the thylakoids.
- Thylakoids are arranged in piles called **grana** lying in a colourless ground substance called **stroma**.

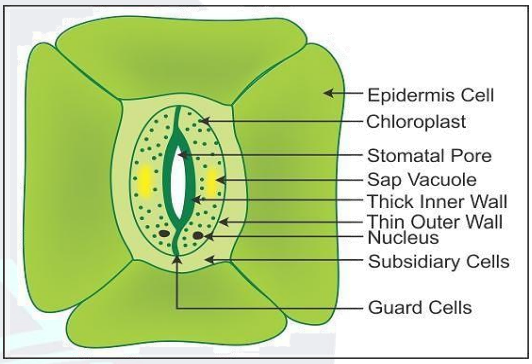
- Cells present in the spongy mesophyll layer and the palisade layer contain chloroplasts; therefore, they are the site of photosynthesis.



Chloroplast

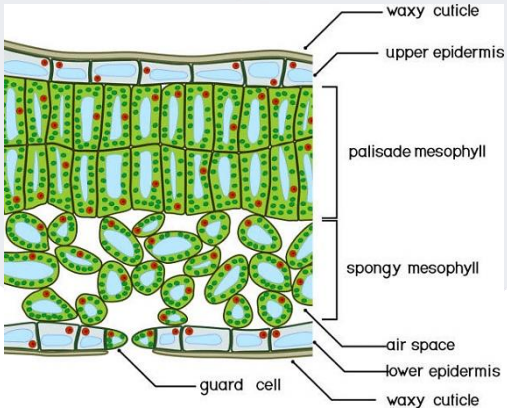
Stomata

- Stomata are minute openings present in the epidermal layers of leaves.
- They are responsible for gas exchange during photosynthesis.
- It also helps in transpiration.

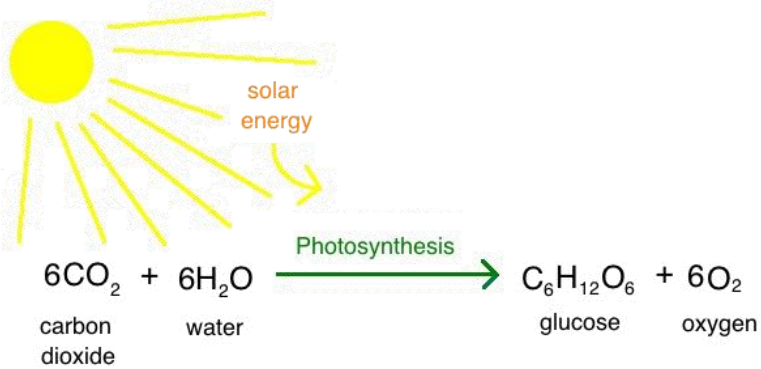


Process of Photosynthesis

- The **palisade layer** is the centre for photosynthesis. Light energy is trapped in the chlorophyll of the mesophyll cells in the palisade layer of leaves.



- The chemical equation for photosynthesis is



Light is absorbed by chlorophyll.

Light energy absorbed is converted into chemical energy.

At the same time photolysis of water takes place i.e. a water molecule is split into hydrogen and oxygen.

Carbon dioxide is converted into glucose by using ATP and NADPH produced during the light reaction.

Chlorophyll, light, carbon dioxide and water are necessary for photosynthesis

Heterotrophic Nutrition

- It is the mode of nutrition of organisms which cannot synthesise their own food, but they are dependent on other organisms for food.
- Organisms exhibiting heterotrophic nutrition are called **heterotrophs**.
- Examples: yeasts, fungi, bacteria, human beings, tiger, monkey, birds, lion, cow etc.

Types of Heterotrophic Nutrition

- **Saprotrophic Nutrition:** Organisms obtain their food from dead, decaying plants and animals and breakdown of food occurs outside the body of organisms. Example: Mushrooms, yeast,fungi
- **Parasitic Nutrition:** Organisms obtain their food from the bodies of other living organisms. Parasites usually harm the host while obtaining their food.

  Example: Leech, lice, cuscuta plant
- **Holozoic Nutrition:** It is a mode of nutrition in which organisms feed on solid food. The food is complex organic material which when ingested is broken down into simple inorganic substances by the process of digestion.

  Example: Humans, amoeba

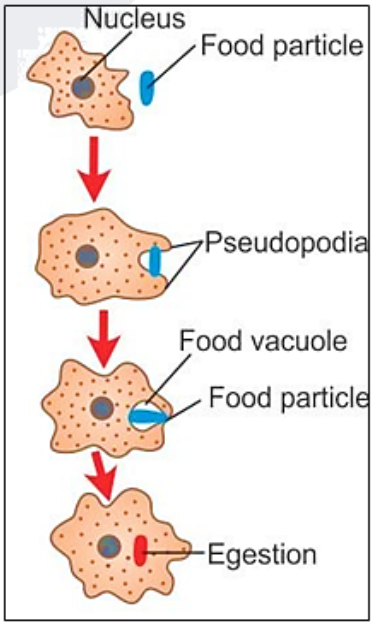
Nutrition in Amoeba

Amoeba engulfs its food by temporary finger-like projections of its body surface called pseudopodia.

When a pseudopodium fuses with the food particle, it forms a food vacuole.

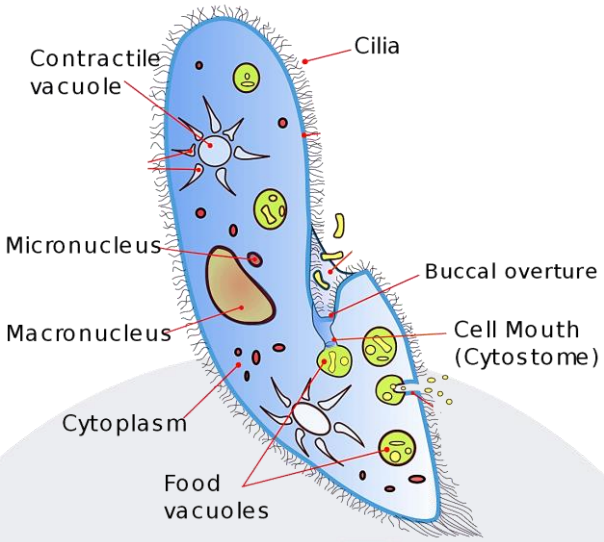
Complex substances are broken down into simple substances inside the food vacuole. These simple substances are then diffused into the cytoplasm.

The remaining unwanted material is transported to the cell surface and is thrown out.

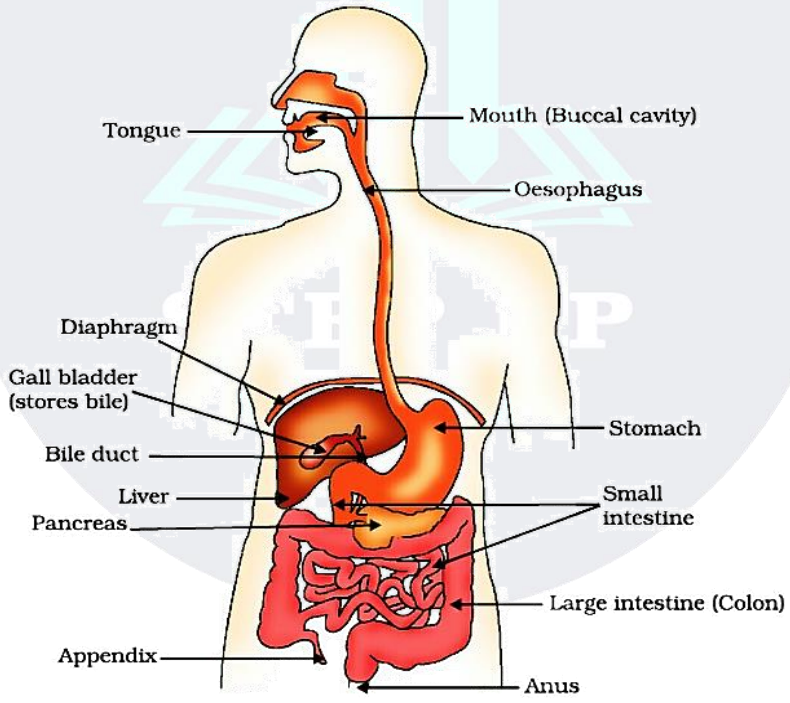


Nutrition in Paramecium

- The food is taken in at a specific spot, i.e. the oral groove.
- The food is brought close to the oral groove by the cilia present on the body surface of paramecium.



Nutrition in Human Beings



The alimentary canal is the long tube extending from the mouth to the anus

Mouth

- Food is chewed and mixed with saliva in the mouth with the help of tongue and teeth.
- Saliva which contains an enzyme i.e., salivary amylase acts on the starch present in food.
- Saliva is secreted by 3 pairs of salivary glands.
- The food is converted into smaller particles and made smooth by mixing it with mucus and saliva. It is now called bolus.
- The bolus moves down through the esophagus by peristaltic movements of the esophageal wall.

Stomach

- Once the bolus reaches the stomach, it is acted upon by HCl, mucus and pepsin.
- HCl creates an acidic medium for the action of pepsin and also kills the germs entering with food.
- Mucus prevents the lining of the stomach wall from the acidic environment.
- Pepsin converts proteins into peptides.
- The exit of food from the stomach is regulated by a sphincter muscle called the pyloric sphincter or pylorus which releases partially digested food into the small intestine.

Small intestine

- The small intestine is a very long tube found in the abdomen. It is about 6–7 metre in length and about 2.5–3 cm wide.
- Bile and pancreatic juices are secreted into the small intestine.
- Bile acts on the fat molecules and breaks them into small fat droplets. This eases the action of lipase on the fats. This process is called **emulsification** of fat.
- Pancreatic juices contain different enzymes such as trypsin, lipase, amylase which act on the food to convert it into simpler units of carbohydrates, proteins and fats.
  - typsin acts on proteins
  - amylase acts on carbohydrates
  - lipase acts on fats
- Intestinal glands also secrete intestinal juices which also contain enzymes, which act on the carbohydrates, proteins and fats.
- The digested food is then absorbed by the walls of the small intestine.
- Presence of brush-like borders called microvilli increase the surface area for absorption and also rich in blood supply which helps in absorption.

Large intestine

- The unabsorbed food is sent to the large intestine where water is absorbed into the blood stream.
- The left over material in the large intestine is sent to the rectum.
- It is excreted out through the anus.
- The opening of the anus is controlled by the anal sphincters.

Respiration

- Respiration is a catabolic process of releasing energy from the simple sugar glucose for carrying out various life processes.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \rightarrow \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} + \underset{\text{Energy}}{ATP}$$

The energy required for all cellular activities is obtained by the oxidation of glucose.

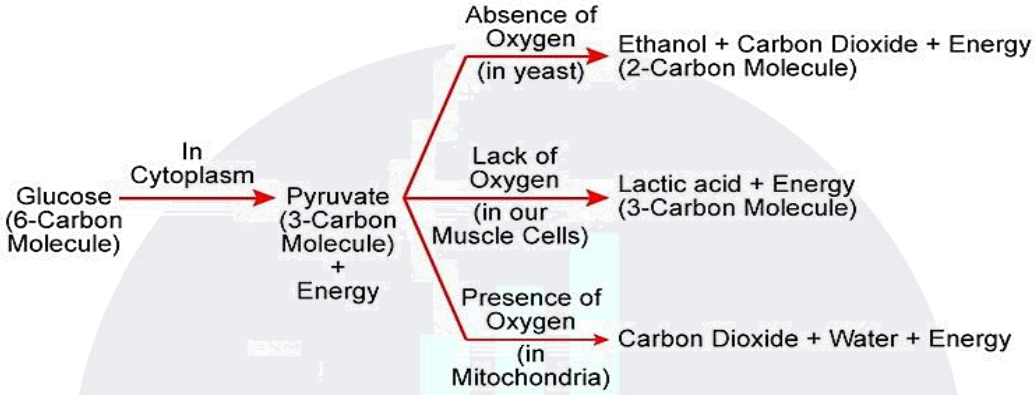
- If glucose is not available, then the cells may break down proteins and fats to produce glucose. This glucose is then oxidised further to fulfil the respiratory needs of the cell.
- The first step towards obtaining energy is that the six-carbon glucose is broken down into two molecules of three-carbon pyruvate. This process takes place in the cytoplasm.

Aerobic Respiration

- The breakdown of glucose in the presence of oxygen is called **aerobic respiration**.
- This takes place in mitochondria.
- The process of aerobic respiration releases carbon dioxide, water and energy.
- Most of the animals, plants, human beings, several bacteria and fungi are aerobic.

Anaerobic Respiration

- During heavy physical exercise such as cycling, running or lifting heavy weights, the body is often deprived of oxygen. The demand for energy is high, while the supply of oxygen to the body is limited. Therefore, muscle cells perform anaerobic respiration to fulfil the increasing energy demands of the body. In this case, glucose gets converted to lactic acid.
- The breakdown of glucose in the absence of oxygen is called **anaerobic respiration**.
- The process of anaerobic respiration results in the formation of ethanol (in plants) or lactic acid (in animals), along with the release of carbon dioxide and energy.
- Water is not released in this process.
- 2 ATPs are released during anaerobic respiration.



- Sometimes, lactic acid formed during anaerobic respiration in muscle cells gets accumulated, causing muscular cramps. This condition is called oxygen debt. In the presence of sufficient oxygen, lactic acid gets oxidised to carbon dioxide and water.

Respiration in Plants

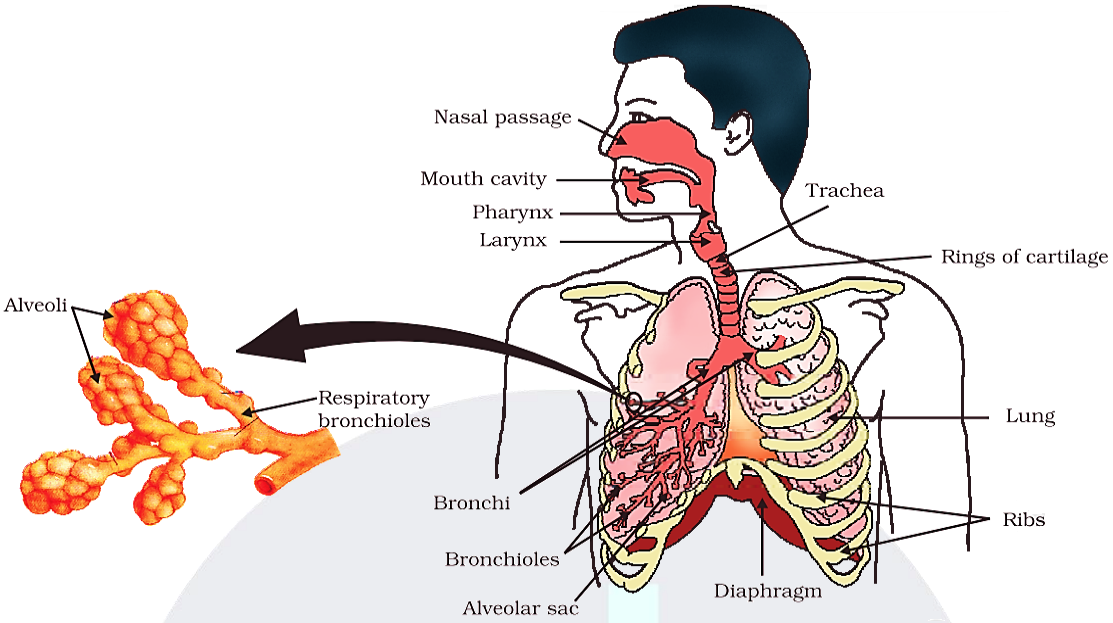
- Plants exchange gases by diffusion through the stomata.
- Oxygen from the air diffuses into a leaf and reaches all the cells for respiration.
- Carbon dioxide produced during respiration is released into the air through the stomata.
- In plants, respiration occurs during the day as well as during the night.
- During the day, oxygen produced during photosynthesis is used for respiration and the extra amount of oxygen is given out through the stomata.
- The roots of plants take up oxygen from the air present between the roots and soil particles.
- In stems, the exchange of gases occurs through either the stomata or lenticels.

Respiration in Animals

Different animals have evolved different respiratory organs:

Human Respiratory System

The respiratory system in human beings consists of the nose, pharynx, larynx, trachea, bronchi and lungs.



Air is taken in through the nostrils.

- Hairs present in the nostrils prevent the entry of dust particles inside the nose.
- Nostrils further continue into the nasal cavity.
- Nostrils humidify the air passing through it.
- There is a bony plate called the palate, which separates the oral cavity from the nasal cavity.
- Nasal cavity opens into the pharynx.
- The pharynx is a muscular chamber acting as a common passage for the windpipe or trachea and the food pipe or esophagus.
- It is connected to the larynx through a slit-like opening called the glottis.
- The larynx is also called the voice-box or Adam's apple.
- The larynx connects the pharynx to the trachea.
- The trachea shows the presence of c- shaped cartilaginous rings.
- The cartilaginous rings provide flexibility thus, facilitating continuous air flow and prevent its collapse
- The trachea divides into two branches or tubes called bronchi, one of which enters the right lung and the other enters the left lung.
- Each bronchus divides into fine secondary bronchi. These bronchi further divide into finer tertiary bronchi and finally divides into finer and smaller branches called bronchioles.
- The bronchioles further divide to form smaller terminal bronchioles.
- The bronchioles divide repeatedly to form a cluster of tiny air chambers called air sacs or alveoli.
- Alveoli have thin and moist walls which enable gaseous diffusion with blood capillaries.
- The lungs are a pair of spongy and elastic respiratory organs protected by a bony rib cage.
- The base of the lungs rests on the diaphragm.
- Each lung is covered by two membranes. The inner membrane is called the inner or visceral pleura and the outer membrane is called the outer or parietal pleura.
- The diaphragm is a curved, musculo-fibrous sheath which separates the thoracic cavity from the abdominal cavity.

- The diaphragm plays a major role during respiration.
- The intercostal muscles found between the ribs and the radial muscles of the diaphragm bring about the breathing movements.
- When we breathe in, the ribs are pulled upwards and the diaphragm becomes flat which results in an increase in the volume of lungs.
- When we breathe out, the ribs come back to their normal position, the diaphragm is relaxed, lungs attain their normal size and air is expelled out of the body through the nostrils.

Transportation

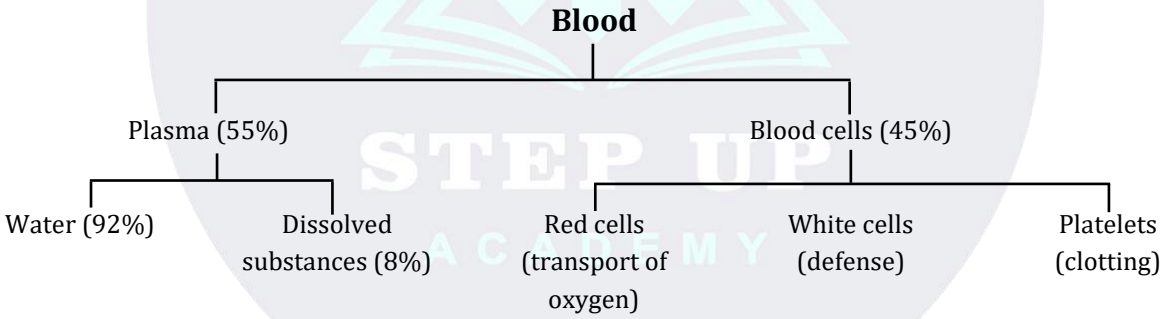
- All living organisms need a few necessary components like air, water, and food for their survival.
- On our regular basis, animals ensure these elements by breathing, drinking and eating.
- The required elements are transported to their body cells and tissues by a transportation system.
- In plants, the vascular tissue is responsible for transporting the substances.

Transportation in Human Beings

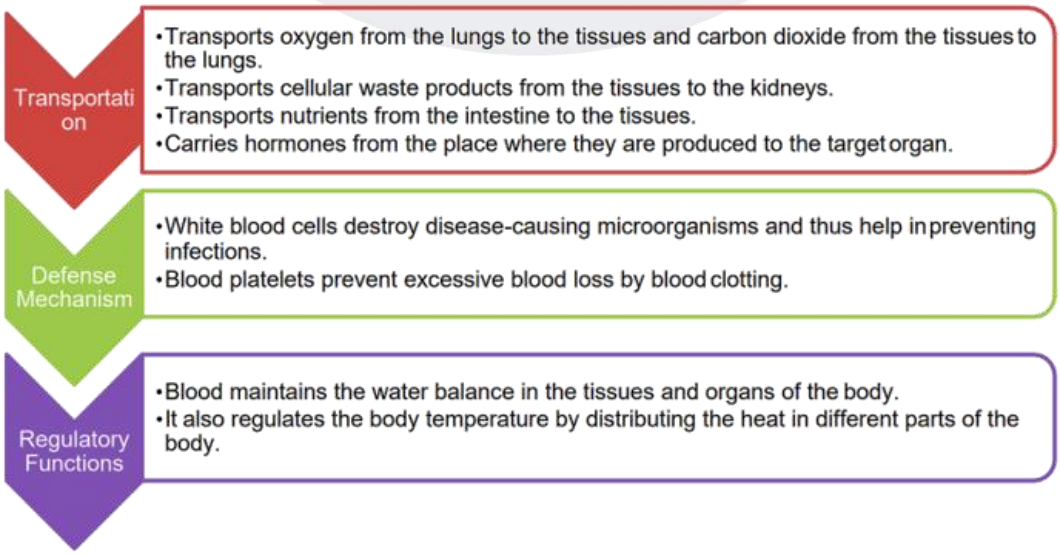
- Transportation in humans is done by the circulatory system.
- The circulatory system in humans mainly consists of blood, blood vessels and heart.
- It is responsible for the supply of oxygen, nutrients, removal of carbon dioxide and other excretory products.
- It also helps to fight the infections.

Blood

Blood being a fluid connective tissue. Blood consists of a fluid medium called plasma in which the cells are suspended.



Functions of Blood



Composition of Blood Plasma

- It is a light yellow-coloured or straw-coloured liquid.
- It constitutes 55% of the total blood volume.
- Plasma transports food, carbon dioxide and nitrogenous wastes in dissolved form.

Blood Cells

- Blood cells constitute 45% of the total blood volume.
- Three kinds of cells are found in the blood.

Red Blood Cells (RBCs/erythrocytes)

- RBCs are circular, disc-shaped and biconcave.
- They are produced in the bone marrow of long bones.
- Mature RBCs do not have nuclei.
- The lifespan of RBCs is 120 days.
- RBCs are made up of iron- containing respiratory pigment called hemoglobin. Hemoglobin transports oxygen from the lungs to tissues.

White Blood Cells (WBCs/leucocytes)

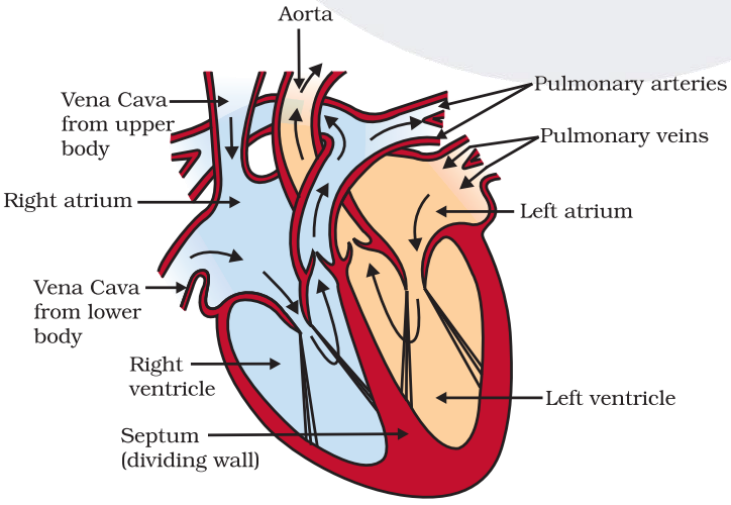
- Irregular, colourless, larger than RBCs. They have a large and lobed nucleus.
- WBCs are produced in the bone marrow, lymph glands and spleen.
- WBCs provide immunity.

Blood Platelets (Thrombocytes)

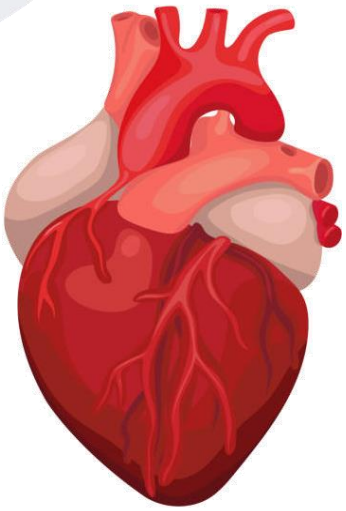
- Blood platelets are minute, oval or round, non- nucleated cells.
- Platelets are formed in the bone marrow.
- Blood platelets play an important role in blood clotting.

We thus need a pumping organ to push blood around the body, a network of tubes to reach all the tissues and a system in place to ensure that this network can be repaired if damaged.

Heart – The Pumping Organ



Schematic sectional view of the human heart



Human heart

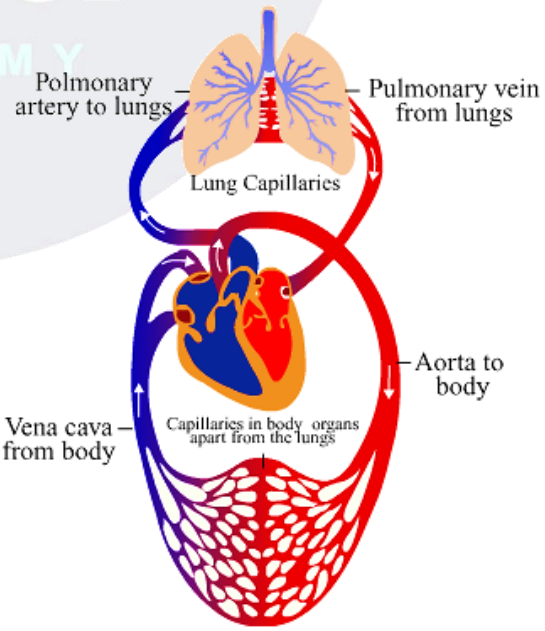
Location	• The heart is a muscular organ located in the chest cavity towards the left side.
Size	• In adult humans, it is about the size of one's fist.
Chambers of the heart	• Internally, the heart is divided into four chambers: ○ Two thin-walled upper chambers-left atrium and right atrium. ○ Two thick-walled lower chambers-left ventricle and right ventricle.
	• The superior vena cava brings deoxygenated blood from the upper part of the body, i.e. head, chest and arms, to the right atrium.
	• The inferior vena cava brings blood from the lower part of the body, including the abdomen and legs, to the right atrium.
	• The blood from the right atrium enters the right ventricle. • From the right ventricle, the blood is sent to the lungs through the pulmonary artery.
Blood vessels leaving the heart	• Four pulmonary veins carry oxygenated blood from the lungs to the left atrium. • From the left atrium, the blood enters the left ventricle.
	• From the left ventricle, oxygenated blood is sent to all parts of the body through the aorta.
Heart valves Heart valves prevent the backflow of blood or regulate the flow of blood in a single direction.	• The tricuspid valve which has three projections or cups is located between the right atrium and the right ventricle.
	• The bicuspid valve/mitral valve has two projections or cups and is located between the left atrium and the left ventricle.
	• The opening of the left ventricle into the aorta and the opening of the right ventricle into the pulmonary artery is guarded by semilunar valves.

Double Circulation

The heart receives deoxygenated blood from different parts of the body, and it pumps this blood to the lungs. The oxygenated blood from the lungs returns to the heart, which is pumped again into different parts of the body by the heart. Thus, the blood passes twice through the heart making one complete round through the body. This is called **double circulation**.

The pulmonary circulation pertains to lungs. The blood flows from the right ventricle to the lungs. Pulmonary veins collect oxygenated blood from the lungs and carry it back to the heart (left auricle).

The systemic circulation pertains to the major circulation of the body. The aorta receives the blood from the left ventricle and sends it to the various parts of the body. Veins collect the deoxygenated blood from the body parts and pour it back into the right auricle.



Blood Pressure

- **Blood pressure** is the pressure which the blood exerts on the walls of the blood vessels.
- The blood pressure in the arteries during ventricular systole is called **systolic pressure**, and the blood pressure in the arteries during the ventricular diastole is called **diastolic pressure**.

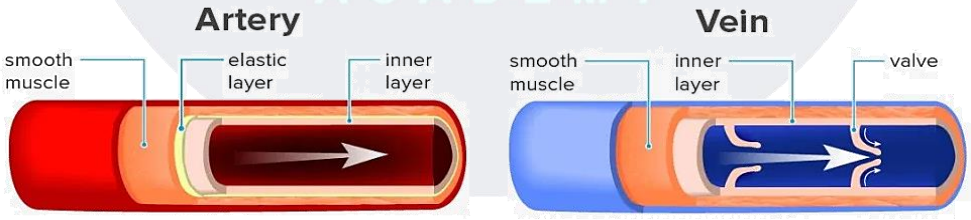
- A person's blood pressure is usually expressed in systolic pressure over diastolic pressure.
- The normal blood pressure for an adult human is 120/80 mm Hg.
- Blood pressure varies according to the age and health of a person.
- A sphygmomanometer is an instrument used to measure blood pressure.
- High blood pressure is also called hypertension, while low blood pressure is called hypotension.

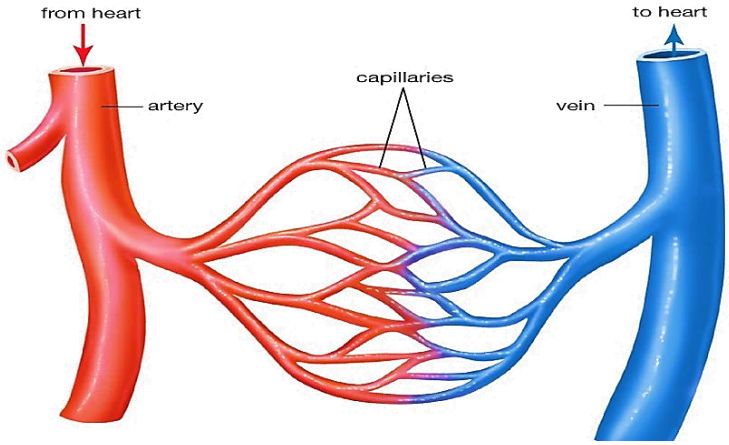
Blood Vessels

- The blood vessels are tubes from which blood from the heart is carried to all parts of the body and again brought back to the heart.

There are three types of blood vessels.

Artery	Vein	Capillaries
An artery is a blood vessel which carries blood away from the heart towards any organ.	A vein is a vessel which carries the blood away from an organ towards the heart.	A capillary is a very narrow blood vessel which is located within the tissue.
It has elastic and thick muscular walls.	It has thin muscular walls.	It has an extremely thin wall.
Narrow cavity through which the blood flows.	Broad cavity through which the blood flows.	-
-	The veins have valves which prevent the backflow of blood.	The arteries branch to form arterioles, and arterioles break up into capillaries.
The largest artery is the aorta.	The larges vein is vena cava	The capillaries gradually reunite to form venules. Venules further combine to form veins.
It carries oxygenated blood to different parts of the body	-it carries deoxygenated blood from different parts of the body	Capillaries allow the exchange of materials such as nutrients, metabolic wastes and respiratory gases between the blood and cells.





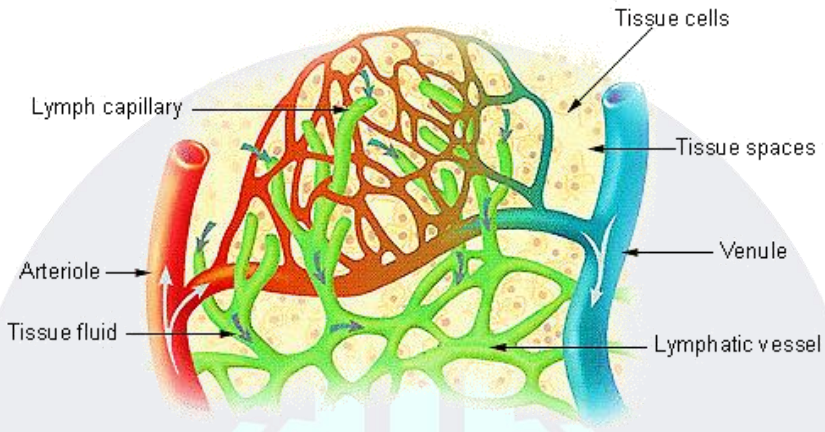
Maintenance by platelets

Naturally the loss of blood from the system has to be minimized. In addition, leakage would lead to a loss of pressure which would reduce the efficiency of the pumping system. To avoid this, the blood has platelet cells which circulate around the body and plug these leaks by helping to clot the blood at these points of injury.

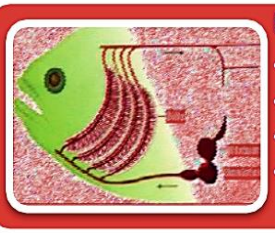
Lymph and Lymphatic System

- As the blood flows through capillaries, the water, dissolved substances and a few white blood cells pass through the capillary walls into the spaces between the cells, i.e. intercellular spaces. This fluid is called **tissue fluid**.
- White blood cells in the lymph protect the body against diseases.
- The lymphatic system carries excessive tissue fluid back to the blood.

Lymph Capillaries in the Tissue Spaces

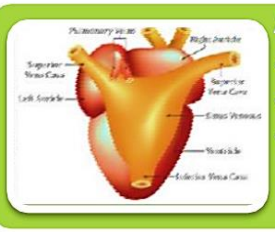


Heart in Other Vertebrates



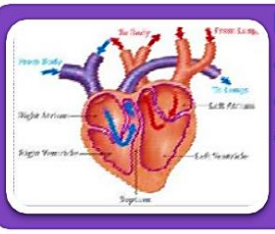
Fish

- Two-chambered heart.
- One atrium and one ventricle.
- The heart pumps deoxygenated blood to the gills for oxygenation.
- The oxygenated blood from the gills is supplied to all the body parts.



Amphibians and Reptiles

- Three chambered heart.
- Two atria and one ventricle.
- Due to incomplete division within the heart, oxygenated and deoxygenated blood mix to some extent.



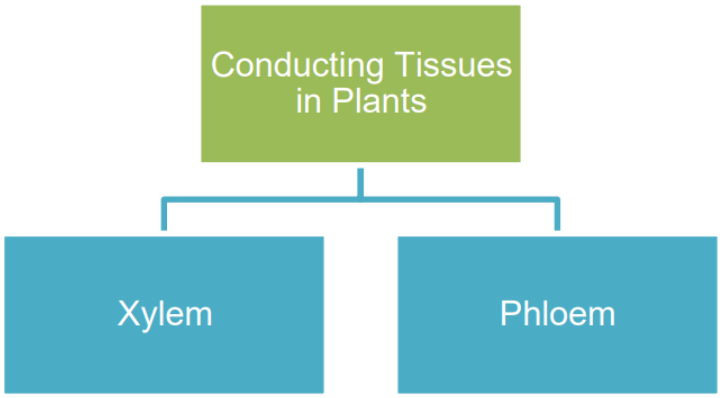
Birds

- Four-chambered heart.
- Two atria and two ventricles.
- The left side of the heart is completely separated from the right side of the heart to prevent mixing of oxygenated and deoxygenated blood.

Transportation in Plants

- **Transportation** in plants is the process by which a substance, absorbed or synthesized in one part of the plant, is transported to the other parts of the plant.

- Substances transported by the transport system are water, mineral and food prepared by plants.



1. Xylem

- It conducts water upwards in a plant.
- Xylem also provides strength to the stem and helps the plant to stand upright.
- It is located in the center of the plant body.
- Xylem mainly consists of tracheids and vessels.

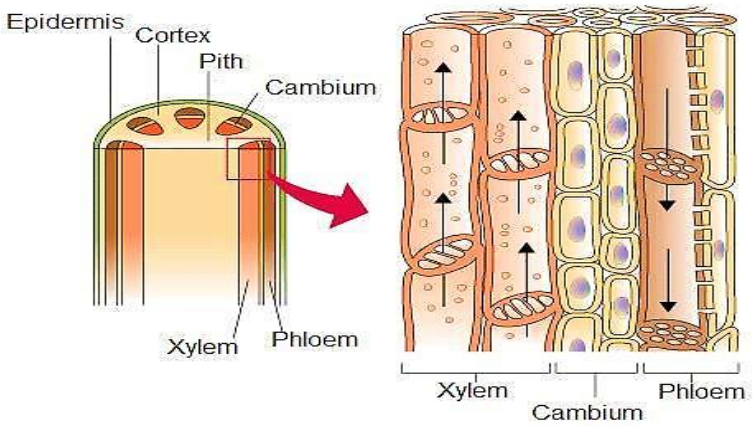
Mechanism of Transport of Water and Minerals

A.

- Water enters the root hair through osmosis, and mineral ions enter the root cells by active transport.
- Both water and minerals move upward from cell to cell through the cortex of the root by osmosis.
- From the cortex, water and minerals are brought to the xylem.
- The sap which contains water and dissolved minerals move upwards from the root cells to xylem. The upward movement of sap is called the ascent of sap.
- The xylem vessels of the roots are in continuation with the xylem vessels of the stem.

B.

- **Transpiration** is the loss of water in the form of water vapour from the aerial parts of a plant.
- It occurs through openings called stomata.
- Water loss through evaporation lowers the concentration of water inside the mesophyll cells.
- Due to this, water enters mesophyll cells from neighbouring xylem vessels through osmosis.
- As water evaporates from the leaves, a suction force is created. This force helps to draw more water up through the stem which causes the roots to absorb more water from the soil.
- Higher the rate of transpiration, greater the rate of absorption of water and solutes from the soil.
- Transpiration also helps in maintaining the temperature of the plant body.



2. Phloem

- It conducts manufactured food from the leaves to different parts of the plant.
- The food in the phloem can move in the upward and downward directions.
- Phloem mainly consists of sieve tube cells and companion cells.
- Sieve tubes are living cells of the phloem. They contain cytoplasm but no nucleus.
- The end walls of the cells form sieve plates.
- Sieve plates have small pores in them which allow food to pass through the phloem.
- Each sieve tube cell has a companion cell next to it.

Mechanism of Transport of Water and Minerals

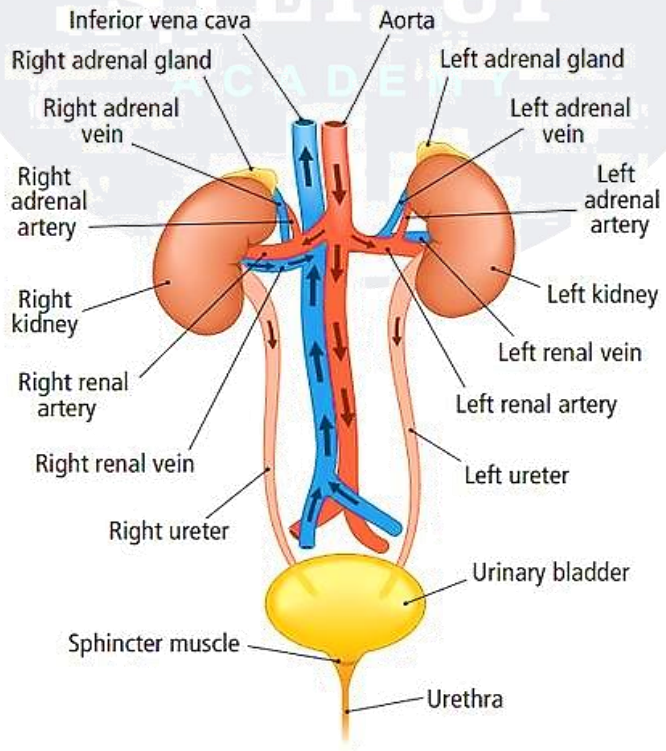
- Food synthesised during photosynthesis is loaded into sieve tubes through active transport.
- The presence of food inside the phloem develops the concentration gradient for water. Thus, water enters the phloem by osmosis.
- Osmosis develops high pressure inside the phloem which transports the food from the phloem to plant parts where the concentration of food is less.
- This process is called **translocation**.
- In spring, the sugar stored in the root or stem tissues is transported to the buds.
- Xylem and phloem constitute the conducting tissues and are known as vascular tissues.

Excretion

The biological process involved in the removal of these harmful metabolic nitrogenous wastes from the body is called excretion. Different organisms use varied strategies to do this. Many unicellular organisms remove these wastes by simple diffusion from the body surface into the surrounding water.

Excretion is the removal of harmful and unwanted substances, especially nitrogenous wastes, from the body.

Excretion in Human Beings

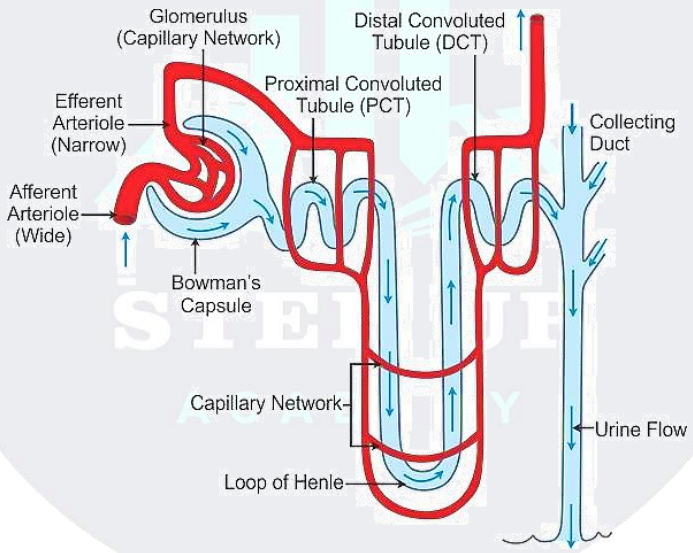


Human Urinary System

The human urinary system consists of-

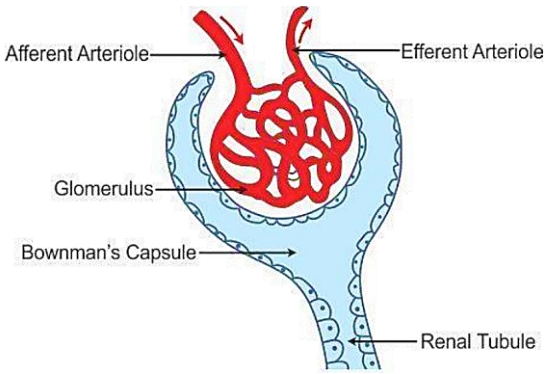
Pair of kidneys	• Dark red, bean-shaped, 10 cm long, 6 cm wide. • The right side of the kidney is slightly lower in position due to the presence of the liver.
Pair of ureters	• Ureters are tube-like structures which arise from the notch, i.e. the hilum of each kidney. • The ureters connect behind with the urinary bladder. • The ureters carry the urine produced to the urinary bladder.
Urinary bladder	• Muscular sac-like structure. • It stores urine temporarily. • Its opening is guarded by muscular sphincters. • The sphincters open at the time of micturition (urination).
Urethra	• Short muscular tube which expels urine out of the body. • The urethra is long in males and is very short in females. • The opening is guarded by sphincters which open at the time of urination.

Uriniferous Tubule



Uriniferous Tubule

- Each kidney is composed of an enormous number of uriniferous tubules.
- They are also known as nephrons, renal tubules or kidney tubules.
- Uriniferous tubules are the structural and functional units of the kidney.



Malpighian Tubule

- Each nephron has a Malpighian body and body of tubules.
- Malpighian body is nothing but a cup-shaped Bowman's capsule. In its cup-shaped depression, a tuft of blood capillaries called glomerulus is situated.
- The body of tubules contains proximal convoluted tubule (PCT), loop of Henle and distal convoluted tubule (DCT).

DCT opens into the collecting duct.

Approximately 2 million uriniferous tubules are present in both the kidneys.
Blood flow through the kidneys per minute = 1 litre Glomerular filtrate produced in 24 hours = 180 litre
Urine produced from the glomerular filtrate after reabsorption per day = 1-2 litre

Formation of Urine

The process of urine formation occurs in three major steps.

Ultrafiltration

- The blood flows through the glomerulus with a great pressure.
- So, the liquid part of the blood filters out from the glomerulus and passes into the Bowman's capsule.
- The glomerular filtrate consists of water, urea, salts, glucose and other plasma solutes.
- Blood corpuscles, proteins and other large molecules remain behind in the glomerulus

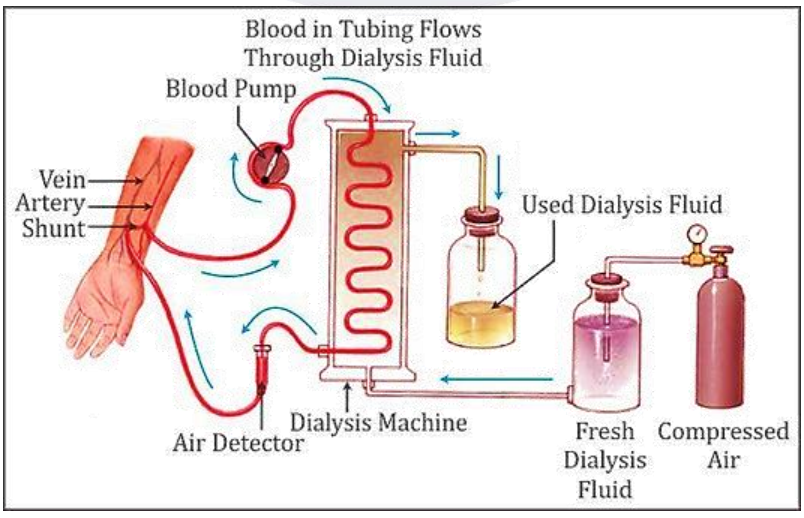
Reabsorption

- The glomerular filtrate entering the renal tubule contains many useful substances.
- Hence, as the filtrate passes down the tubule, water and other substances required by the body are reabsorbed.
- Nitrogenous waste potassium ions and creatinine remains in tube.

Tubular Secretion

- Tubular cells release hydrogen ions, potassium ions, and other ions into the filtrate. known as tubular secretion.
- The filtrate left after reabsorption and tubular secretion is called urine.
- The urine passes from the collecting duct into the pelvis of the kidney. From there it is sent to the urinary bladder through the ureters.
- By relaxing the sphincters present at the opening of the urethra, the urine is expelled from the body. This process is known as micturition or urination.

Artificial Kidney



If one kidney is damaged or removed, then the other kidney alone can fulfil excretory needs.

- However, the failure of both the kidneys allows urea and other wastes to accumulate in the blood.
- Such a patient undergoes dialysis.
- In dialysis, an artificial kidney is used.
- The artificial kidney contains tubes with a semi-permeable lining.
- These tubes are suspended in a tank filled with a dialysing solution.
- This fluid contains water and glucose in concentrations similar to those in blood.
- The patient's blood is led from the radial artery through the tubes of the artificial kidney where excess salts and urea are removed.
- The purified blood is returned through a vein in the same arm.
- The function of dialysis is similar to the function of the kidney, but the only difference is there is no reabsorption during dialysis.

Excretion in Plants

- Plants also produce several waste products during their life processes.
- The major waste products are water, carbon dioxide and oxygen produced during respiration and photosynthesis.
- These wastes are excreted through the stomata and lenticels.
- Plants store some waste products in leaves which fall off.
- Wastes such as gums and resins are stored in the old xylem.

Class : 10th Biology
Chapter-6 life processes

Life Processes

Nutrition

- Autotrophic nutrition in plants.
- Process Invilved is Photosynthesis

Various steps included in Heterotrophic nutrition in animals
- Ingestion
- Digestion
- Absorption
- Assimilation
- Egestion

Alimentary canal
- Mouth (saliva)
- Pharynx
- Oesophagus
- Stomach (HCl, Gastric Juice)
- Small Intestine
- Large Intestin
- Anus

Respiration in Animal (Human Beings)

Parts of Human Respiratory System
- Alveoli
- Bronchioles
- Trachea
- Lungs
- Bronchi
- Nostrils

Mechenism of Breathing
- **Inspiration**
- **Gaseous exhange**
- **Expiration**

Transportation

Circulatory system in Human
- Blood
- Heart
- Vlood Vessels

Transportation in Plants
- **Phleom (Transport of Food)**
- **Xylem (Transport of water)**

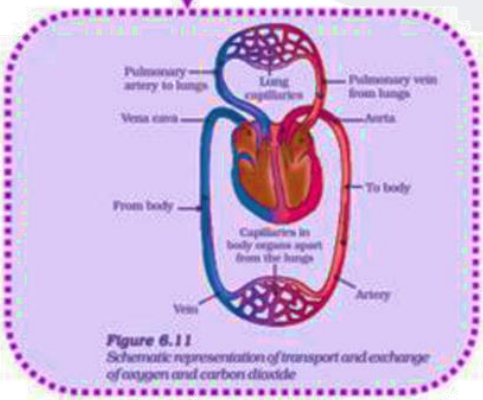


Figure 6.11
Schematic representation of transport and exchange of oxygen and carbon dioxide

Excretion

In Plants: Process involved is Transpiration

In Human: Kidney helps in formation of urine

In Human, basic unit of kidney-Nephron
Parts of Nephron
- Bowman's Capsule
- Glomerulus
- Proximal Convoluted Tubule
- Loop of Henle
- Distal Comvoluted Tubule

Important Questions

Multiple Choice Questions:

1. The autotrophic mode of nutrition requires:
   (a) carbon dioxide and water
   (b) chlorophyll
   (c) sunlight
   (d) all of the above
2. The largest gland in human body is:
   (a) liver
   (b) gastric glands
   (c) pancreas
   (d) salivary glands.
3. Number of salivary glands found in man are:
   (a) one pair
   (b) two pairs
   (c) three pairs
   (d) five pairs
4. Pancreatic juice helps in the digestion of:
   (a) proteins
   (b) proteins and fats
   (c) proteins and carbohydrates
   (d) proteins, carbohydrates, and fats
5. ATP and NADP 2H are produced in:
   (a) Mitochondria
   (b) Chloroplast
   (c) Peroxisomes
   (d) Lysosomes
6. Oxygen evolved during photosynthesis comes from:
   (a) water
   (b) CO_2
   (c) soil
   (d) atmosphere.
7. Rate of photosynthesis is high in:
   (a) orange light
   (b) green light
   (c) red light
   (d) yellow light
8. The ultimate source of all metabolic energy on our earth is:
   (a) green plants
   (b) the sun
   (c) O_2
   (d) O_2 and H_2O.
9. Light reaction takes place in:
   (a) grana
   (b) stroma
   (c) mitochondria
   (d) leucoplast.
10. Plants purify air by:
    (a) transpiration
    (b) photosynthesis
    (c) respiration
    (d) absorption of water

Very Short Question:

1. Name the term for transport of food from leaves to other parts of plants.
2. What process in plants is known as transpiration?
3. Name the tissue which transports soluble products of photosynthesis in a plant.
4. Name the tissue which transports water and minerals in a plant.
5. How do autotrophs obtain CO_2 and N_2 to make their food?
6. Which pancreatic enzyme is effective in digesting protein?
7. Which enzyme present in saliva breaks down starch?
8. What is the role of acid in our stomach?
9. What is the role of saliva in the digestion of food?
10. State the function of digestive enzymes.

Short Questions:

1. (a) Name two different ways in which glucose is oxidized to provide energy in various organisms.
   (b) Write any two differences between the two ways of oxidation of glucose in organisms.

2. What is the function of trachea? Why do the walls not collapse even when there is less air in it?
3. Name any two digestive enzymes secreted in the human digestive system and write their function.
4. How do they take up carbon dioxide and perform photosynthesis?
5. (a) What will happen to guard cells and the stomatal pore when water flows into guard cells.

   (b) How do plants transmit information from cell to cell?
6. What are the different ways in which glucose is oxidized to provide energy in various organisms?
7. What is excretion? How do unicellular organisms remove their wastes?
8. What is internal energy reserve in plants? Do the animals have the same energy reserve? Justify your answer.

Long Questions:

1. (a) List two differences between 'holozoic nutrition' and 'saprophytic nutrition. Give two examples each of these two types of nutrition.

   (b) State the roles of liver and pancreas.

   (c) Name the organ which performs the following functions in humans:
   - Absorption of digested food
   - Absorption of water.

   (d) Explain the statement, "Bile does not contain any enzyme but it is essential for digestion."
2. (a) Draw a diagram to show the human alimentary canal and label on it the following: Gall bladder, Stomach. Name the longest part of the alimentary canal.

   (b) Why is it necessary to separate oxygenated and deoxygenated blood in mammals and birds?
3. (a) List three events that occur during the process of photosynthesis. State in brief the role of stomata in this process.

   (b) Describe an experiment to show that sunlight is essential for photosynthesis.

Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true but R is false.
   d. A is false but R is true.

   Assertion: Ventricles have thicker walls than auricles.

   Reason: Ventricles have to pump blood into various organs with great pressure.
2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true but R is false.
   d. A is false but R is true.

   Assertion: Ureters are the tubes which carry urine from kidneys to the bladder.

   Reason: Urine is stored in the urethra.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   Heterotrophic nutrition is a mode of nutrition in which organisms obtain readymade organic food from outside sources. The organisms that depend upon outside sources for obtaining organic nutrients are called heterotrophs. Heterotrophic nutrition is of three types: saprophytic, parasitic, and holozoic nutrition.

   i. In which of the following groups of organisms' food material is broken outside the body and absorbed?
      a. Mushroom, green plants, Amoeba.
      b. Yeast, mushroom, bread mould.
      c. Paramecium, Amoeba, Cuscuta.
      d. Cuscuta, lice, tapeworm.

   ii. Which of the following is a parasite?
      a. Yeast
      b. Taenia
      c. Amoeba
      d. Earthworm

iii. Which of the following is an example of saprotroph?
   a. Grass
   b. Mushroom
   c. Amoeba
   d. Paramecium

iv. Heterotrophic nutrition involves:
   a. Production of simple sugar from inorganic compounds.
   b. Utilisation of chemical energy to prepare food.
   c. Utilisation of energy obtained by plants.
   d. All of these.

v. ln Paramecium, food enters the body through:
   a. Mouth
   b. Pseudopodia
   c. Cilia
   d. Cytostome.

2. Read the following and answer any four questions from (i) to (v).

All living cells need nutrients, O_2 and other essential substances. Also, the waste and harmful substances need to be removed continuously for healthy functioning of cells. So, a well-developed transport system is mandatory for living organisms. Complex organisms have special fluids within their bodies to transport such materials. Blood is the most commonly used body fluid by most of the higher organisms. Lymph also helps in the transport of certain substances.

i. Which of the following does not exhibit phagocytic activity?
   a. Monocytes.
   b. Neutrophils.
   c. Basophil.
   d. Macrophage.

ii. Amount of blood corpuscles in changed in dengue fever. One of the common symptoms observed in people infected with dengue fever is:
   a. Significant decrease in RBC count.
   b. Significant decrease in WBC count.
   c. Significant decrease in platelets count.
   d. Significant increase in platelets count.

iii. Why are WBCs called soldiers of the body?
   a. They are capable of squeezing out of blood capillaries.
   b. They are manufactured in bone marrow.
   c. They fight against disease causing germs.
   d. They have granular cytoplasm with lobed nucleus.

iv. Name the blood cells, whose reduction in number can cause clotting disorder, leading to excessive loss of blood from the body.
   a. Erythrocytes.
   b. Neutrophils.
   c. Leucocytes.
   d. Thrombocytes.

v. Which of the following is the correct feature of lymph?
   a. It is similar to the plasma of blood but is colourless and contains less proteins.
   b. It is similar to the WBCs of blood but is colourless and contain more proteins.
   c. It is similar to the RB Cs of blood and red in colour.
   d. It contains more fats.

Answer Key

Multiple Choice Answers:

1. (d) all of the above
2. (a) liver
3. (c) three pairs
4. (d) proteins, carbohydrates and fats
5. (a) Mitochondria
6. (a) water
7. (c) red light
8. (b) the sun
9. (a) grana
10. (b) photosynthesis

Very Short Answers:

1. **Answer:** Translocation of food.
2. **Answer:** It is loss of water in the vapour form from the exposed parts of a plant.
3. **Answer:** Phloem.
4. **Answer:** Xylem.
5. **Answer:** Autotrophs obtain CO_2 from air and N_2 as nitrate or ammonium ion from soil.
6. **Answer:** Trypsin.
7. **Answer:** Ptyalin or salivary amylase.
8. **Answer:** HCl of gastric juice disinfects the food and acidifies it for proper functioning of proteolytic enzyme pepsin.
9. **Answer:** Saliva moistens the ingested food with mucus, sterilizes it with lysozyme and partially digests starch part of food into sugar with the help of salivary amylase or ptyalin.
10. **Answer:** Digestive enzymes are hydrolytic enzymes which cause breakdown of complex and insoluble components of food into simple, soluble, and absorbable substances.

Short Answer:

1. Answer:

(a) Aerobic and anaerobic.

(b) Differences

2. **Answer:** Trachea is a tube that connects pharynx with lungs for carrying air to and from lungs. Trachea is lined by ciliated mucus secreting pseudostratified epithelium for trapping dust particles and microbes.

Trachea does not collapse in reduced air pressure due to support of C-shaped cartilaginous rings.

3. Answer:

(i) Salivary Amylase or Ptyalin

Starch $\xrightarrow{\text{Ptyalin}}$ Maltose + Dextrins

(ii) Pepsin (of Gastric Juice)

Protein $\xrightarrow{\text{Pepsin}}$ Peptones + Proteoses

4. **Answer:** Carbon dioxide is absorbed during night when stomata are open. It is fixed in malic acid from which the same is released during day time for performing Calvin cycle in light.

5. Answer:

(a) Guard cells swell up and a stomatal pore is created in between them.

(b) Information is transmitted from one plant cell to another through plasmodesmata and hormones.

6. Answer:

(i) Aerobic. $C_6H_{12}O_6 + 6O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ + Energy

(ii) Anaerobic,

(a) $C_6H_{12}O_6 \rightarrow$ 2 Ethanol + 2 CO_2 + Energy.

(b) $C_6H_{12}O_6 \rightarrow$ 2 Lactic acid + Energy

7. **Answer:** Excretion is the biological process of removal of harmful metabolic waste products from the body.

In unicellular organisms, excretion occurs through simple diffusion from the surface.

8. **Answer:** The major internal energy reserve in plants is starch (a complex carbohydrate). Animals do not have the same energy reserve. Instead, they possess glycogen (and fat).

Long Answer:

1. **Answer:**

(a) Differences between Holozoic Nutrition and Saprophytic Nutrition

Saprophytic Nutrition	Holozoic Nutrition
Organisms obtain their nutrients from dead and decaying organic matter.	It involves ingestion and digestion of food materials which are then absorbed and assimilated to produce energy.
It is seen in fungi and bacteria.	It is observed in higher organisms like vertebrates.
Dead and decaying organic matter is used.	Complex organic food material is used.
Such organisms do not have a complete digestive system.	Such organisms have a complete digestive system.
Nutrients are absorbed through the cell wall.	Nutrients are absorbed through the digestive system.

(b) **Role of Liver:** Decomposition of haemoglobin, formation and secretion of bile for emulsification of fat. Formation of urea, heparin fibrinogen and prothrombin. Detoxification of chemicals and elimination of pathogens.

Role of Pancreas: Secretion of pancreatic juice having lipase, trypsin and amylase; secretion of hormones, insulin and glucagon.

(c) Absorption of Digested Food. Ileum part of small intestine.

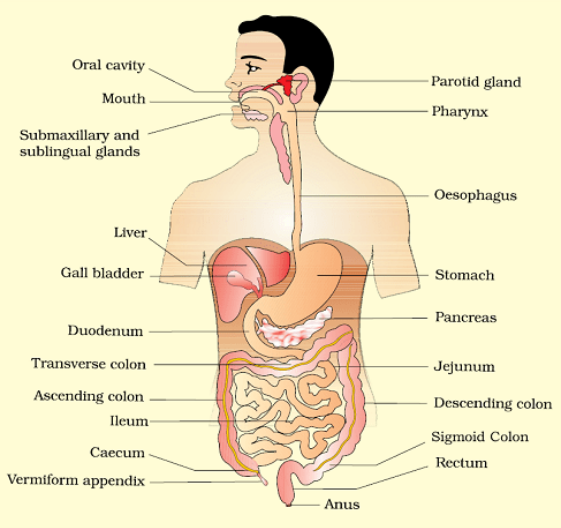
Absorption of Water. Large intestine.

(d) Role of Bile in Digestion.

Breaking of fat into fine globules or emulsification,

Neutralisation of acidity and making food alkaline for action of pancreatic and other enzymes.

2. **Answer:**



Human Alimentary canal

Longest Part. Small intestine (about 6 meters).

(b) Separation of Oxygenated and Deoxygenated Bloods in Birds and Mammals.

Energy needs of birds and mammals are higher due to thermoregulation of body and increased activity. They require regular and quicker supply of oxygenated blood for all body parts. This is possible only when there is complete separation of oxygenated blood and quicker oxygenation of deoxygenated blood.

3. **Answer:**

(a) **Three Events of Photosynthesis:** Information is transmitted from one plant cell to another through plasmodesmata and hormones.

Role of Stomata in Photosynthesis. Inward diffusion of carbon dioxide and outward diffusion of oxygen.

(b) **Sunlight is Essential for Photosynthesis:** It is the source of energy for photosynthesis. Light is visible part of the electromagnetic radiations. It has a wavelength of 390-760 nm. Photosynthetically active radiations or PAR are 400-700 nm. Natural source of light is sun but artificial light can also provide energy to plants for their photosynthesis. Plants absorb light mostly in violet-blue and red parts of visible light. Violet-blue light carries more energy as compared to red light. Plants growing under shade of others receive mostly green and some violet light. They have lower rates of photosynthesis.

Light has two functions, photolysis of water and excitation of chlorophyll to emit electrons. Photolysis of water produces oxygen, protons, and electrons. Electrons and protons (Hydrogen ions) help in producing ATP and NADPH2, popularly called assimilatory power.

Assertion Reason Answer:

1. (a) Both A and R are true, and R is correct explanation of the assertion.

Explanation:

Ventricles are larger and thick-walled chambers of the heart. These act as distribution chambers, as they supply blood to all parts of our body with high pressure.

2. A is true but R is false.

Explanation:

The bladder is a bag which stores urine till the time we go to toilet. The urine collected in the bladder is passed out from the body through the urethra.

Case Study Answer:

1. i (b) Yeast, mushroom, bread mould.

Explanation:

Yeast, mushroom, and bread mould have a saprophytic mode of nutrition which is

chemoheterotrophic in nature. They breakdown complex organic substances by secreting digestive enzyme outside their body and absorb simple molecules as nutrients.

ii. (b) Taenia

iii. (b) Mushroom

iv. (c) Utilisation of energy obtained by plants.

Explanation:

Heterotrophic nutrition is mode of nutrition in which an organism depends on other living organisms for food.

v. (d) Cytostome.

Explanation:

Feeding apparatus in Paramecium consists of peristome, vestibule, buccal cavity, cytostome (cell mouth) and cytopharynx.

2. i (c) Basophil.

Explanation:

Basophiles release heparin, serotonin, and histamine. They are like mast cells of connective tissue and are not phagocytic in nature.

ii. (c) Significant decrease in platelets count.

iii. (c) They fight against disease causing germs.

Explanation:

WBCs manufacture antibodies, which fight against disease causing germs and are responsible for immunity, thus called soldiers of the body.

iv. (d) Thrombocytes.

v. (a) It is similar to the plasma of blood but is colourless and contains less proteins.

Explanation:

Lymph is a colourless fluid, which contains blood plasma along with leucocytes and have fewer proteins.

Control and Coordination 2

For survival, an organism's body must respond correctly to various stimuli it receives.

Some important terms:

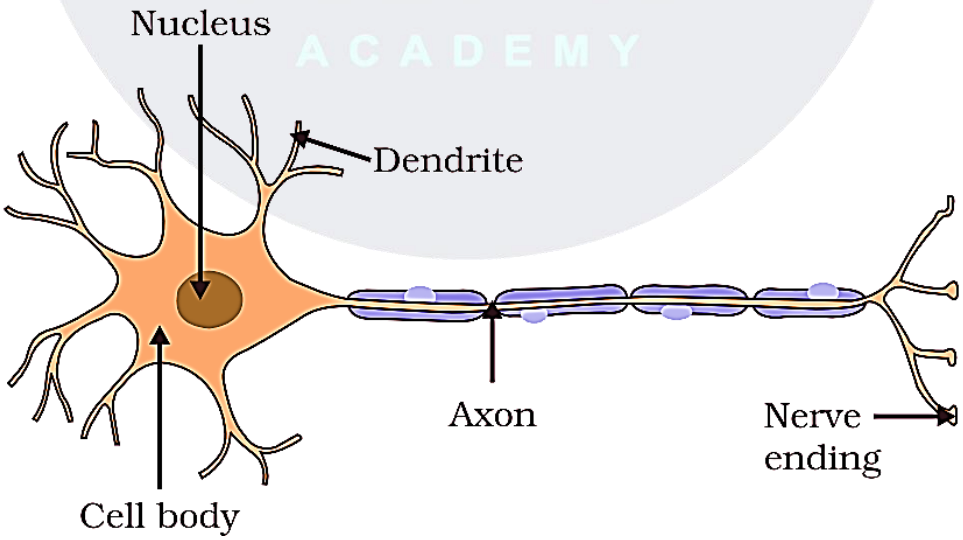
- **Stimulus:** An agent or sudden change in the external or internal environment which causes a change in an organism or any of its body parts.
- **Response:** The change in organisms resulting from a stimulus.
- **Receptors:** Nerve cells which initiate waves of impulses towards the central nervous system on receiving a stimulus.
- **Effectors:** Muscles or glands which contract or secrete substances on receiving an impulse from the brain or spinal cord.

Functions of the Nervous System

- Keeps us informed about the outside world through sensory organs.
- Controls and harmonise all voluntary muscular activities. Example- running and writing.
- Enables us to remember, think and reason.
- Regulates involuntary activities such as breathing and beating of the heart.

Neuron

A **neuron** is the structural and functional unit of the nervous system.

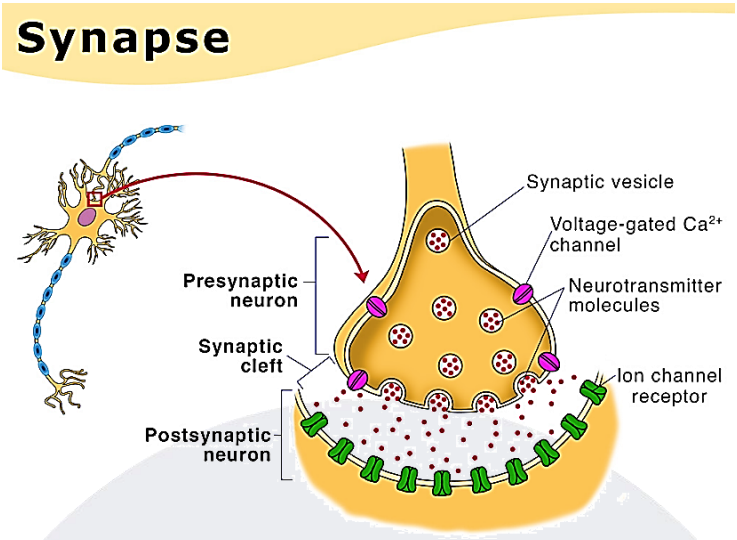


The three main parts of a neuron are:

- Cell Body- It has a well defined nucleus and granular cytoplasm.
- Dendrites- Dendrites are branched cytoplasmic projections of the cell body.
- Axon- It is a long process of the cell body. The end portions of the axons have swollen bulb-like structures which store neurotransmitters.

Synapse

- The **synapse** is the point of contact between the terminal branches of the axons.



- Axon terminals of a neuron and the dendrites of another neuron are separated by a fine gap, i.e. a synaptic cleft.
- The nerve impulse is sent across the synaptic cleft with the help of the neurotransmitter acetylcholine.

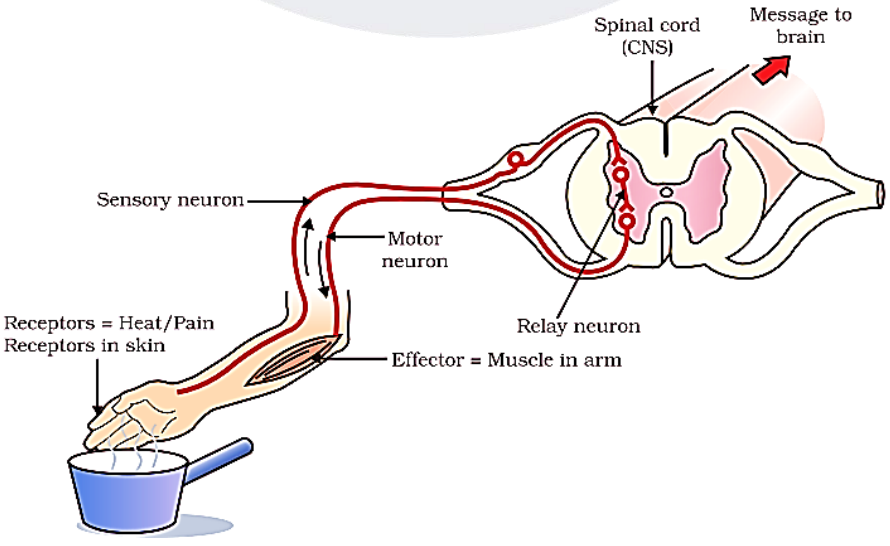
Reflex Action

- Involuntary actions in response to external or internal stimuli are termed as **reflex actions**.
- The peripheral nervous system and spinal cord are involved in controlling reflex actions.
- The path travelled by the impulse during a reflex action is called a reflex arc.
- A reflex arc can be represented as follows:

  Stimulus → Receptor in the sense organ → Afferent (sensory) nerve fibre → CNS (spinal cord) → Efferent (motor) nerve fibre → Muscle/Gland → Response

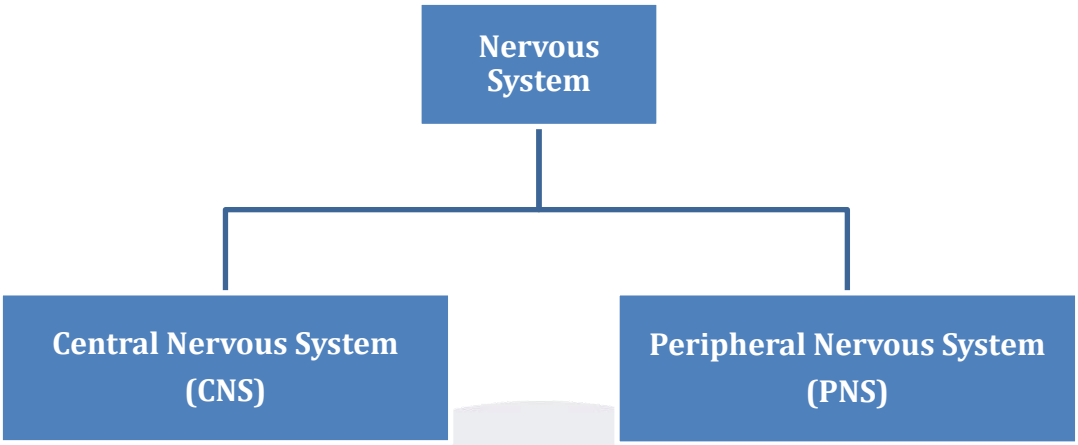
Examples of Reflex Arc

- When you touch a hot object, you withdraw your hand from it immediately.
- Shivering when it is too cold or sweating when it is too hot.
- Dilation of the pupils of the eye to look in the dark and *vice versa*.
- When you smell your favourite dish, your mouth waters.



Divisions of the Nervous System

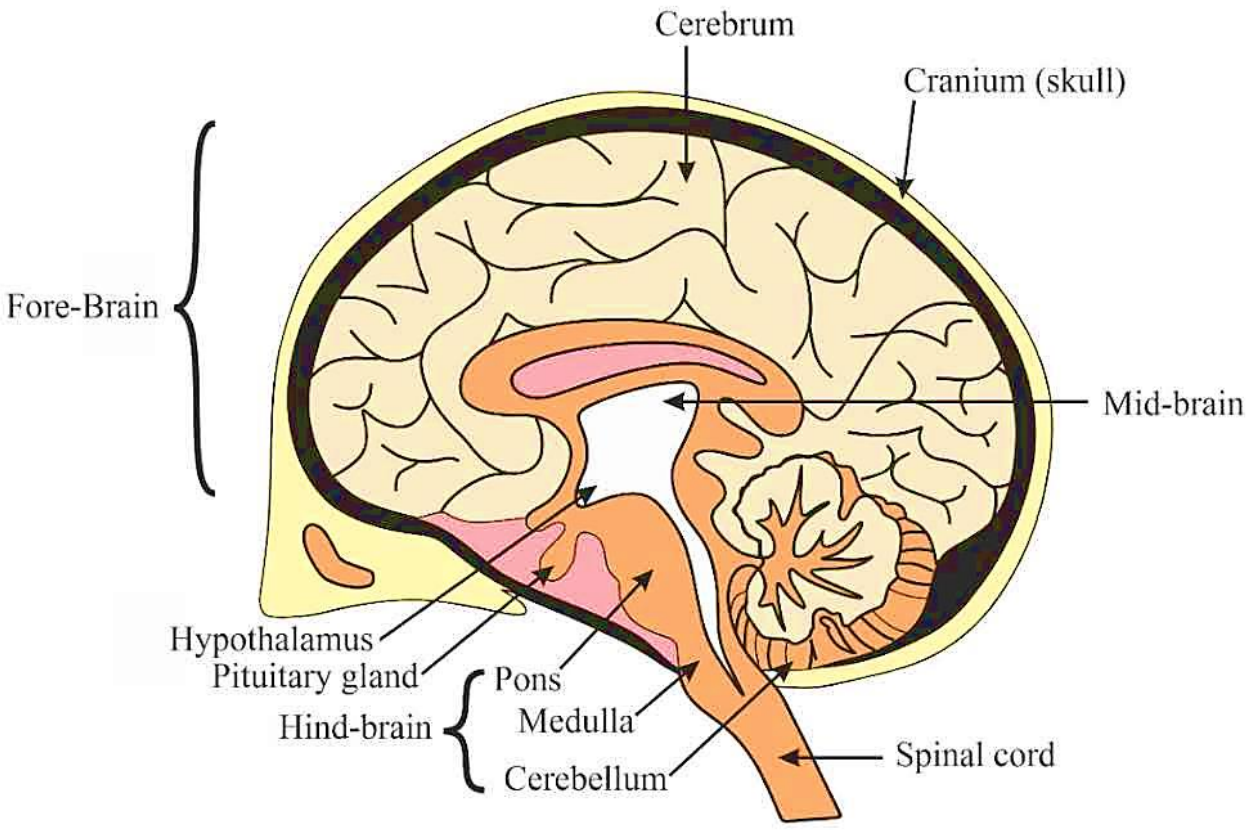
The Central Nervous System

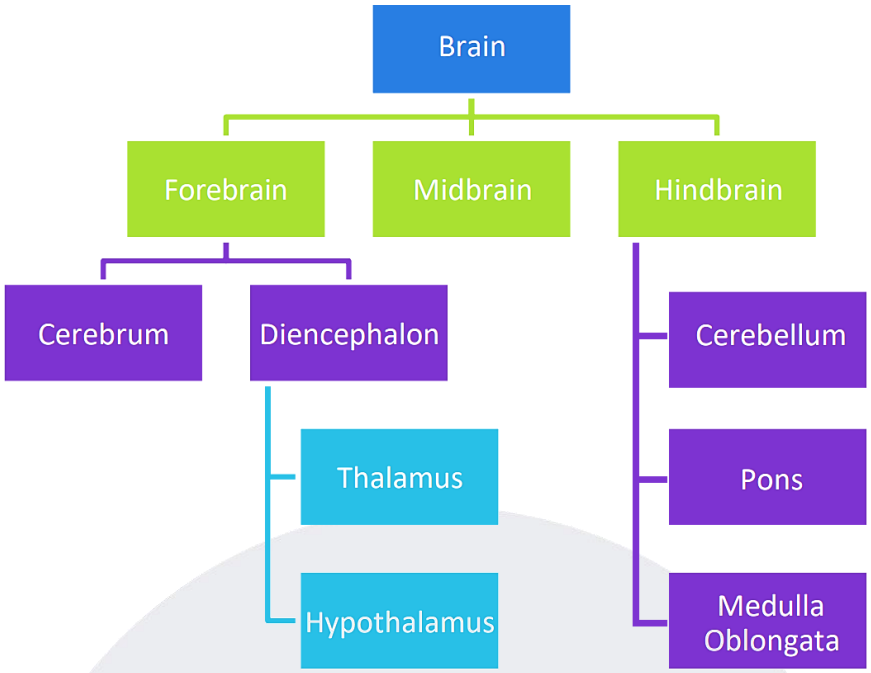


The central nervous system includes the brain and the spinal cord.

The Brain

- The human brain is the largest among all animals.
- It is well protected by the cranium or the skull.
- Three membranous coverings called meninges cover the brain.
- Inflammation of the meninges is called meningitis.
- The space between the covering membranes, central spaces of the brain and the central canal of the spinal cord is filled with **cerebrospinal fluid**.
- Three primary regions of the brain are forebrain, midbrain, and hindbrain.





Parts of the Brain

Forebrain-

1. **Cerebrum**
   - Large part of the brain. Controls reading hearing thinking vision learning emotions etc.
   - It receives information from sense organs like eyes, ears, skin, nose and tongue.
   - It changes our behavior on the basis of past experiences and memories.
   - It maintains a balance between stimulus and response.
2. **Thalamus** - it helps in relaying sensory information and transmitting motor information for coordination.
3. **Hypothalamus** - It controls appetite, body temperature, rate of heartbeat, blood pressure, mood and emotions and also controls the taste and smell. It synthesizes essential hormone.

Midbrain-

- It acts as a bridge and transmits signals from forebrain and hindbrain.
- It is mainly concerned with sense of sight and hearing.

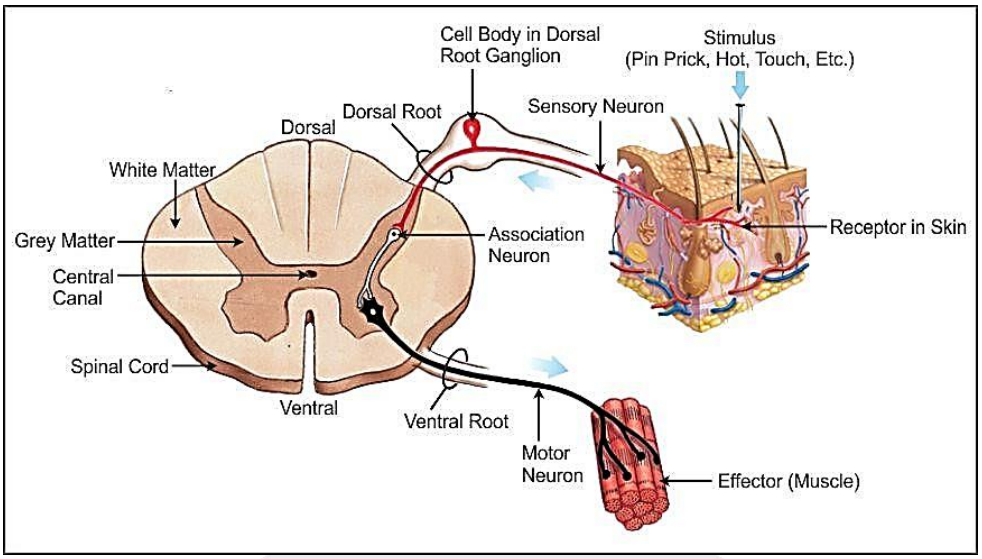
Hindbrain-

Hindbrain consists of cerebellum, pons and medulla oblongata

1. **The cerebellum** coordinates the movements and balance of the body and maintains posture.
2. **Pons** is concerned with regulating frequency of breathing rate, sleep cycle.
3. **Medulla oblongata** regulates heartbeat, blood pressure, coughing, salivation and vomiting and breathing.

The Spinal Cord

- Extends from the medulla oblongata down to almost the whole length of the backbone and ends at the second lumbar vertebra.
- The grey matter is on the inner side and white matter is on the outer side of the spinal cord.
- The spinal cord is responsible for reflexes below the neck.
- It conducts sensory impulses from the skin and muscles to the brain.
- It conducts motor responses from the brain to muscles of the trunk and limbs.



Peripheral Nervous System

- The Peripheral Nervous System consists of nerves which carry impulses to and from the central nervous system.
- The Somatic Nervous System is made up of 12 pairs of cranial nerves and 31 pairs of spinal nerves.
- Cranial nerves emerge from the brain and spinal nerves originate from the dorsal and ventral roots of the spinal cord.

Coordination in Plants

Nastic Movements

- The movement of a plant in response to an external stimulus, in which the direction of response is not determined by the direction of stimulus, is called **nastic movement**.
- Nastic movements are shown by flat parts of the plants such as leaves and petals.
- Example: Daisy flowers close at dusk and open at daybreak; this may be referred to as sleep movements.
- This response however should not be confused with thigmotropism as the folding of leaves always occurs in the same direction irrespective of the direction of the stimulus.
- Two types of nastic movements are:
  - **A.** **Photonasty** is a nastic movement to the light and dark phases of the day.

    Example- Flowers of primrose blossom during the evening but close during the day.
  - **B.** **Nyctinasty** is the movement in response to dark. Certain parts of a plant such as the leaves and flowers take up a different posture at night than that in the day.

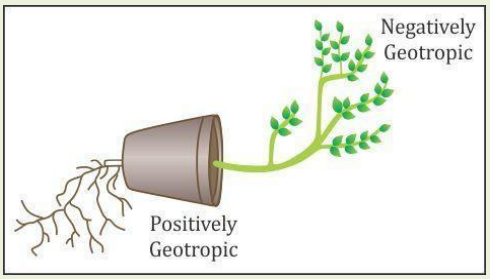
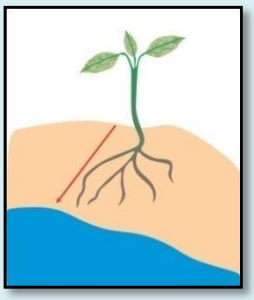
    Example- Leaves of the rain tree fold by nightfall.

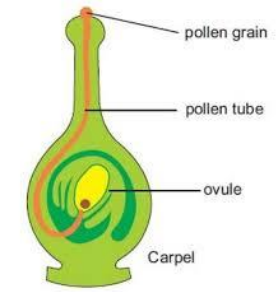
Movement Due to Growth

The movement of plant organs towards or away from a stimulus is known as **tropism**.

Since the tropic movements are slow, the stimulus needs to be continued for a longer time for the effects to be noticed.

The different types of tropic movements in plants are:

1. Phototropism	• The movement of plant parts towards or away from light is termed as phototropism.  • Because shoots of most plants grow towards the source of light, it is termed as positive phototropism. • Roots grow away from light and hence are negatively phototropic.
2. Geotropism	• The movement of plant organs in response to gravity is termed as geotropism.  • Roots are positively geotropic because they grow in the direction of gravity. • The shoot grows upwards, i.e. against gravity, and hence is negatively geotropic.
3. Thigmotropism	• The movement of plant organs in response to stimuli caused by physical contact with solid objects is termed thigmotropism.  • Weak-stemmed plants use twining stems and tendrils to climb on other plants/objects which provide them support. Hence, twining stems and tendrils are positively thigmotropic.
4. Hydrotropism	• The movement of plant organs in response to water is termed hydrotropism.  • Roots grow towards the source of moisture and hence are positively hydrotropic.

5. Chemotropism	• The movement of plant organs in response to a chemical stimulus is called chemotropism.  • When plant organs grow away from the chemical response it is called negative chemotropism. • When plant parts grow towards the chemical response it is called positive chemotropism. For example, pollen tubes grow towards the sugary substance secreted by the stigma of the flower.

Plant Hormones (Phytohormones)

Plant hormones control some aspects of the growth of plants such as cell division, cell enlargement and cell differentiation.

Phytohormones	Description
1. Auxins	• Promote growth of plants. • They are secreted by the cells present in the tip of stems and roots. • Synthetic auxins are used in horticulture.
2. Gibberellins	• Promote cell differentiation in the presence of auxins. • They break seed dormancy. • Stimulate elongation of shoots.
3. Cytokinins	• Promote cell division in plants. • Delay ageing of leaves. • Promote opening of stomata. • Promote fruit growth. • helps in cell division so mostly present in seed and fruits.
4. Abscisic Acid	• Acts as a growth inhibitor. • It promotes dormancy in seeds and buds. • Promotes closing of stomata. • Promotes wilting and falling of leaves. • Detachment of flowers and fruits from the plants is due to abscisic acid.
5. Ethylene	• Promotes ripening of fruit.

Hormones in Animals

Hormones	Functions	Disorders
1. Adrenaline Produced by the adrenal glands.	• Adrenaline prepares the body for the fight and flight mechanism.	

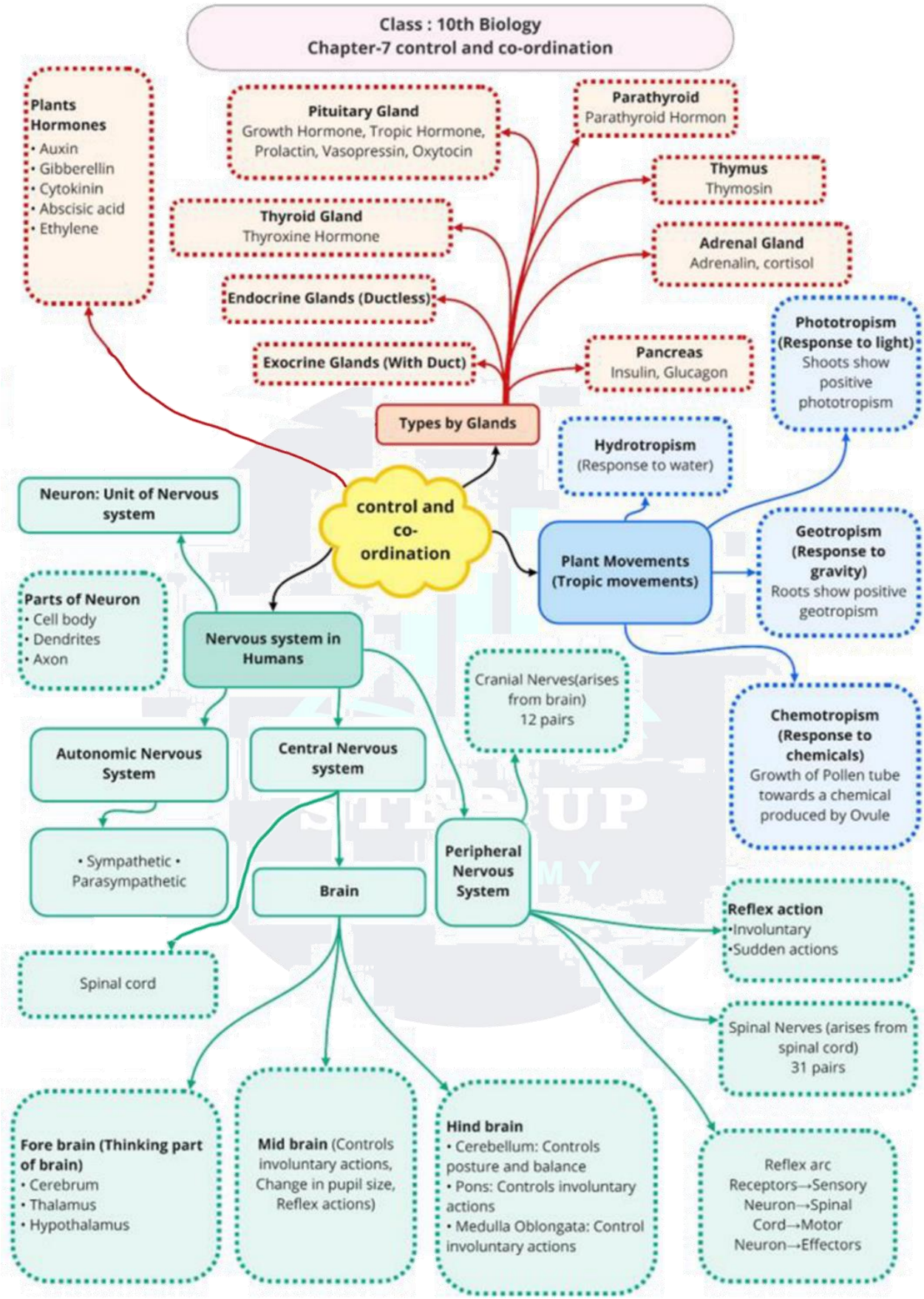
2. Thyroxine Secreted by the thyroid gland.	• Regulates carbohydrate, protein and fat metabolism. • It increases the basal metabolic rate (BMR). • It regulates body growth such as ossification of bones and mental development.	• Goitre
3. Growth Hormone Secreted by the anterior lobe of the pituitary gland.	• It is essential for normal growth.	• Dwarfism • Gigantism
4. Insulin Secreted by pancreas Glucagon	• Regulates the blood glucose (sugar) level. • Increase blood sugar level	• Diabetes Mellitus High concentration of sugar in blood (hyperglycemia).
5. Testosterone Secreted by the testes in males.	• Controls the development of sex organs in males. • Controls the development of secondary sexual characters during puberty.	
6. Oestrogen Secreted by the ovaries in females.	• Controls the development of female sex organs. • Controls the development of secondary sexual characters during puberty in females.	

Feedback Mechanism

- The body has mechanisms to maintain its normal state.
- Whenever there is a change in the normal state, messages are sent to increase secretions if there is a fall below the normal levels or to decrease secretions if there is a rise above the normal levels to restore the normal body state. Such a mechanism is called **Negative Feedback Mechanism**.

  Example- Blood sugar level

  The increase in blood sugar level stimulates the secretion of insulin so that the sugar level is maintained. If there is a fall in the blood sugar level below normal, it stimulates the secretion of glucagon. Glucagon stimulates the breakdown of glycogen to glucose, and thus the normal sugar level is maintained.


Class : 10th Biology
Chapter-7 control and co-ordination
Plants Hormones
• Auxin
• Gibberellin
• Cytokinin
• Abscisic acid
• Ethylene
Pituitary Gland
Growth Hormone, Tropic Hormone, Prolactin, Vasopressin, Oxytocin
Parathyroid
Parathyroid Hormon
Thymus
Thymosin
Thyroid Gland
Thyroxine Hormone
Adrenal Gland
Adrenalin, cortisol
Endocrine Glands (Ductless)
Exocrine Glands (With Duct)
Pancreas
Insulin, Glucagon
Types by Glands
Phototropism (Response to light)
Shoots show positive phototropism
Hydrotropism
(Response to water)
Neuron: Unit of Nervous system
control and co-ordination
Plant Movements (Tropic movements)
Geotropism (Response to gravity)
Roots show positive geotropism
Parts of Neuron
• Cell body
• Dendrites
• Axon
Nervous system in Humans
Cranial Nerves(arises from brain)
12 pairs
Chemotropism (Response to chemicals)
Growth of Pollen tube towards a chemical produced by Ovule
Autonomic Nervous System
Central Nervous system
• Sympathetic • Parasympathetic
Brain
Peripheral Nervous System
Reflex action
•Involuntary
•Sudden actions
Spinal cord
Spinal Nerves (arises from spinal cord)
31 pairs
Fore brain (Thinking part of brain)
• Cerebrum
• Thalamus
• Hypothalamus
Mid brain (Controls involuntary actions, Change in pupil size, Reflex actions)
Hind brain
• Cerebellum: Controls posture and balance
• Pons: Controls involuntary actions
• Medulla Oblongata: Control involuntary actions
Reflex arc
Receptors→Sensory Neuron→Spinal Cord→Motor Neuron→Effectors

Important Questions

Multiple Choice Questions:

1. The gap between two neurons is called a:
   (a) dendrite
   (b) synapse
   (c) axon
   (d) impulse
2. The brain is responsible for:
   (a) thinking
   (b) regulating the heart beat
   (c) balancing the body
   (d) all of the above
3. Which of the following is a plant hormone:
   (a) insulin
   (b) thyroxin
   (c) oestrogen
   (d) cytokinin
4. Which endocrine gland is called master gland:
   (a) pituitary
   (b) adrenal
   (c) thyroid
   (d) pancreas
5. Cartisons are secreted by:
   (a) pancreatic gland
   (b) adrenal gland
   (c) thyroid gland
   (d) pituitary gland
6. Female sex hormone is:
   (a) estrogen
   (b) androgen
   (c) insulin
   (d) adrenalin
7. Insulin is secreted by:
   (a) stomach
   (b) liver
   (c) pancreas
   (d) kidney
8. In case of emergency which structure becomes very active:
   (a) adrenal medulla
   (b) adrenal cortex
   (c) thyroid gland
   (d) pancreas
9. Growth, mental development and tissue differentiation is controlled by:
   (a) glucagon
   (b) parathormone
   (c) thyroxine
   (d) cortisol
10. Heartbeat is increased by:
    (a) thyroxine
    (b) adrenalin
    (c) gastrin
    (d) glucagon

Very Short Question:

1. Write the function of hormone thyroxine in our bodies.
2. Name the part of hind brain which takes part in regulation of respiration.
3. Which hormones helps in lowering the level of blood glucose in human beings?
4. We suddenly withdraw our hand when a pin pricks. Name the type of response involved in this action.
5. Which hormone is responsible for the development of moustache and beard in man?
6. Which type of glands in human body secrete hormones? State any one location for them.
7. Name the structural and functional units of human nervous system.
8. What is neuron?
9. What are phytohormones?
10. Name the largest cell present in human body.

Short Questions:

1. Name two hormones secreted by pancreas. Write one function of each hormone named.
2. Name the hormone responsible for regulation of
   - Metabolism of carbohydrates, fats and proteins
   - Balance of calcium and phosphate
   - Blood pressure
   - Water and electrolyte balance.
3. What is reflex action? Explain the mechanism of reflex action with a suitable example.

4. Name the three major regions of human brain. Which part of brain maintains posture and equilibrium of the body?
5. Maintenance of Posture and Equilibrium. Cerebellum.
   (a) Distinguish between voluntary and involuntary actions of our body.
   (b) Choose involuntary actions, amongst the following:

   Reading, Beating of heart, Salivation in the mouth on viewing tasty food, Talking.
6. Explain the cause of shoots of the plant bending towards light?
7. What are nastic and curvature movements? Give one example of each.
8. Draw a diagram of a nerve cell and label on it following:
   (a) Nucleus
   (b) Dendrites

Long Questions:

1. (a) What is reflex action? Give its two examples. Illustrate the pathway followed by a message from the receptor in a reflex arc.

   (b) Name the actions of sympathetic and parasympathetic systems on eye.
2. (a) What are "hormones"?

   (b) List four characteristics of hormones

   (c) Name the hormone required for the following:
   - Functioning of mammary glands
   - Regulation of calcium and phosphate
   - Lowering of blood glucose
   - Development of moustache and beard in human malc.
3. (a) What is
   - Phototropism and
   - Geotropism?

   With labelled diagrams describe an activity to show that light and gravity change the direction that plant parts grow in.

   (b) Mention the role of each of the following plant hormones:
   - Auxin
   - Abscisic acid.

Assertion Reason Questions:

1. **Following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:**
   (a) Both A and R are true, and R is the correct explanation of A.
   (b) Both A and R are true, but R is not the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false but R is true.

   Assertion(A): Insulin regulates blood sugar level.

   Reason (R): Insufficient secretion of insulin will cause diabetes.
2. **Following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:**
   (a) Both A and R are true, and R is the correct explanation of A.
   (b) Both A and R are true, but R is not the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false but R is true.

   Assertion(A): Animals can react to stimuli in different ways.

   Reason (R): All animals have a nervous system and an endocrine system involving hormones.

Answer Key

Multiple Choice Answers:

1. (b) synapse
2. (d) all of the above
3. (d) cytokinin
4. (a) pituitary
5. (b) adrenal gland
6. (a) estrogen
7. (c) pancreas
8. (a) adrenal medulla
9. (c) thyroxine
10. (b) adrenalin

Very Short Answers:

1. **Answer:** It controls basal metabolic rate and regulates metabolism of carbohydrates, fats and proteins.
2. **Answer:** Medulla oblongata.
3. **Answer:** Insulin.
4. **Answer:** Reflex action.
5. **Answer:** Testosterone.
6. **Answer:** Endocrine or ductless glands, e.g., thyroid in neck region around trachea.
7. **Answer:** Neuron.
8. **Answer:** Neuron or nerve cell is a structural and functional unit of nervous system that is specialized to receive, conduct and transmit impulses.
9. **Answer:** Phytohormones are chemical substances other than nutrients produced naturally in plants which regulate growth, development, differentiation and a number of physiological processes, e.g., auxin, gibberellins, abscisic acid, cytokinin's.
10. **Answer:** Neuron (length 90-100 cm).

Short Answer:

1. **Answer:**

   Insulin (secreted by (3-cells of islet of Langerhans)

   Recognition of glucose by cells for absorption and conversion of glucose into glycogen in liver and muscles.

   Glucagon (secreted by a-cells of islet of Langerhans)

   Formation of glucose from glycogen and other sources and its release into blood.

2. **Answer:**
   - Thyroxine
   - Parathormone (also calcitonin)
   - Adrenaline
   - ADH or vasopressin and aldosterone (a mineralocorticoid).

3. **Answer:**

   Reflex Action: It is an automatic nerve mediated response to a stimulus without consulting the will of the individual, e.g., withdrawal of hand on being pricked or coming in contact with hot surface.

   Mechanism: The stimulus for reflex action is picked up by a receptor located in the organ on which stimulus is acting. One or more sensory neurons carry the impulse from receptor to the central nervous system (e.g., spinal cord). CNS functions as modulator. It transfers the sensory nerve impulse to one or more motor neurons. The motor neurons carry the impulse to effectors which provide a proper response to the stimulus.

   Stimulus → Receptor → Sensory neurons → CNS → Motor neurons → Effectors → Response.

4. **Answer:** Major Regions of Brain

   Fore Brain: Olfactory lobes (2), Cerebrum (2 cerebral hemispheres) and diencephalon.

   Mid Brain: Cerebral peduncles (crura cerebri) and four quadrigemina.

   Hind Brain: Cerebellum, pons and medulla oblongata.

5. **Answer:**

   (a) Differences between Voluntary and Involuntary Actions

Voluntary Actions	Involuntary Actions
1. **Will.** They are under control of the will.	They are performed without consulting the will.
2. **Muscles.** The actions are performed with the help of straited muscles.	The actions are performed with the help of smooth muscles.
3. **Activities.** They are connected with the functioning of external organs.	They are connected with the functioning of internal organs.

   (b) Beating of heart, salivation in the mouth on viewing of tasty food.

6. **Answer:** Stems are positively phototropic and bend towards the direction of light. The movement is due to occurrence of more auxin on the darker side and lesser auxin on the illuminated side. As a result, there is more growth on the darker side which causes the stem to bend towards light.

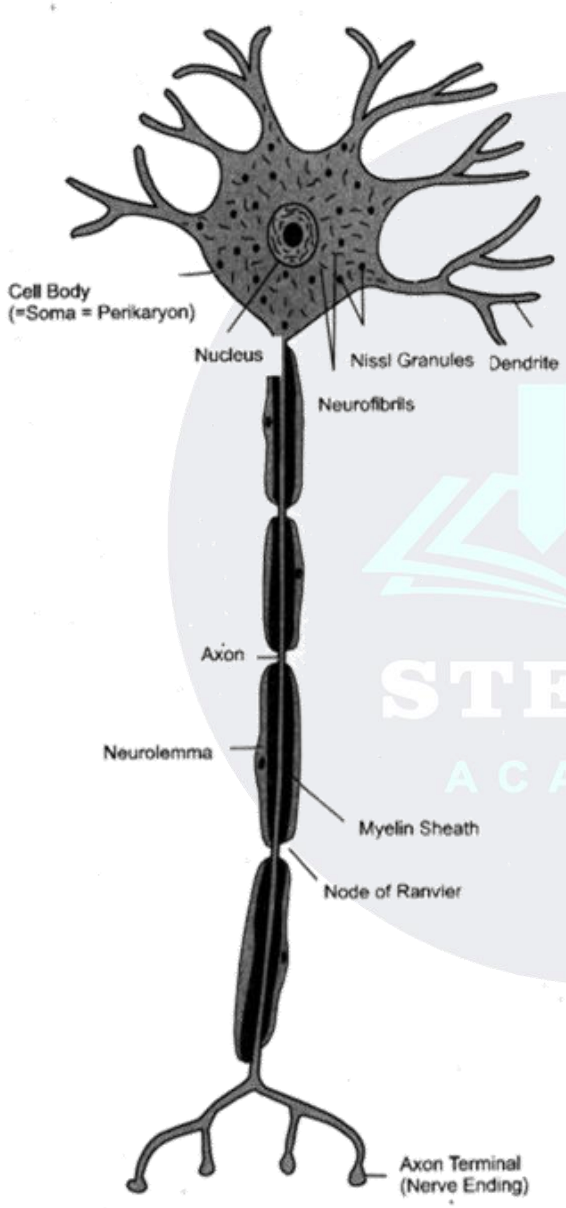
7. **Answer:**

   (a) **Nastic Movements:** They are non-directional curvatures movements of turgor or growth where the movements are determined by the structure of the responding organ irrespective of the direction of stimulus which is generally

diffuse. Ex. Drooping and folding of leaves in Sensitive Plant in response to shock (seismonasty).

(b) **Curvature Movements:** They are changes in orientation of some plant parts in relation to others caused by intrinsic or external stimuli. Ex. Sleep movement or nyctinasty of legume leaves, bending of stems towards light (or positive phototropism of stems).

8. **Answer:**



Long Answer:

1. **Answer:**

(a) **Reflex Action:** It is an automatic, spontaneous nerve mediated response to a stimulus without consulting the will of the individual.

e.g., withdrawal of hand on being pricked or coming in contact with hot surface.

(b) Effect on Pupil,

- Sympathetic - dilation
- Parasympathetic - constriction.

2. **Answer:**

(a) **Definition:** Hormones (Gk. hormein— to excite) are chemical messengers or informational molecules produced by ductless glands which are translocated by circulatory system to other body parts for inducing and coordinating their activities including growth. First hormone, secretin, was discovered by Bayliss and Starling (1902). The term hormone was coined by Starling (1905)

(b) **Characteristics:**

- Hormones are produced by endocrine or ductless glands.
- They are poured into circulatory system for passage to different body parts.
- Target Sites. Hormones act on specific cells, tissues and organs called target sites, generally away from the place of their synthesis.
- They function as chemical messengers or informational molecules that trigger specific chemical and physiological processes of target cells.
- Slow Action. Since hormones reach the target sites through blood, their effect appears after a lag period. They are slow acting with the exception of adrenaline.
- Chemical Nature. Hormones are small sized organic molecules which are of diverse origin— proteins, peptides, amino acids, amines and steroids.
- Non-nutrient Nature. Hormones are nonnutrient in nature. They have no role in providing energy or body building materials. Hormones take part in stimulation or inhibition of physiological processes.
- The hormones are effective in very low concentration, e.g., adrenaline one in 300 million parts.
- It is very specific. TSH acts only on

thyroid while thyroxine affects all body parts.

- Hormones are generally produced in response to specific stimuli.
- Hormones are ultimately broken down or consumed during their activity in target cells.
- Deficiency or Excess. Both deficiency and excess of hormone are harmful, often leading to serious disorders.

(c) The Hormone are Required:

- Functioning of Mammary Glands. Prolactin.
- Regulation of Calcium and Phosphate in Blood. Parathormone.
- Lowering of Blood Glucose. Insulin.
- Development of Moustache and Beard in Human Male. Testosterone.

3. Answer:

(a) **Definition of Phototropism:** It is directional growth movement of curvature which occurs in plants in response to stimulus of unilateral light.

Definition of Geotropism: It is directional growth movement of curvature which occurs in response to force of gravity. Main root shows positive geotropism while main stem shows negative geotropism.

Activity: Phototropism and Geotropism- Take two potted plants. Place one plant near a window. Keep the other pot tilted horizontally in the open. Water the plants on alternate days. Observe after a week. Potted plant kept near the window shows bending of young stems towards the window. They are positively phototropic. In the horizontal pot, the stem bends upward as it is negatively geotropic. Its root if taken out, shows downward bending indicating its positive geotropic nature.

(b)

- Role of Auxin. It promotes cell enlargement, fruit growth, apical dominance, rooting of cuttings, prevention of abscission and differential growth during tropic movements.
- Role of Abscisic Acid. It checks excessive activity of auxin and gibberellins, closes stomata in water deficiency, induces dormancy of buds and seeds.

Assertion Reason Answer:

1. (a) Both A and R are true, and R is the correct explanation of A.

(a) Both A and R are true, and R is the correct explanation of A.

How Do Organisms Reproduce 3

Reproduction

Reproduction is the ability of living organisms to produce living beings similar to themselves.

The two modes of reproduction, *i.e.* asexual reproduction and sexual reproduction can be seen in animals.

Importance of Variation

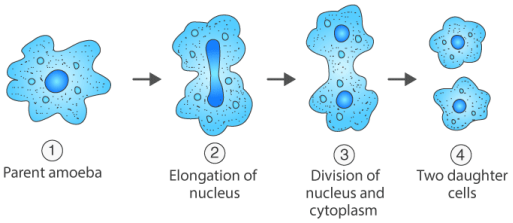
- Sexual reproduction provides great scope for variation.
- Variation is important for the survival of a species.
- Variation helps a species to adapt to different environmental changes.

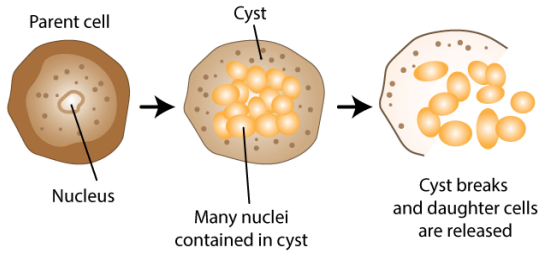
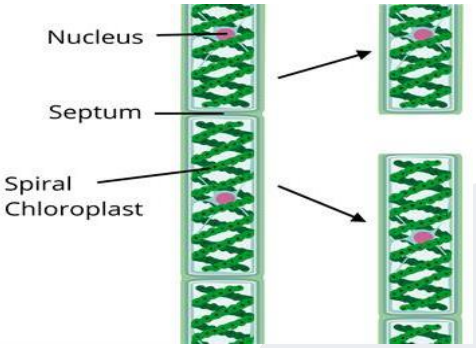
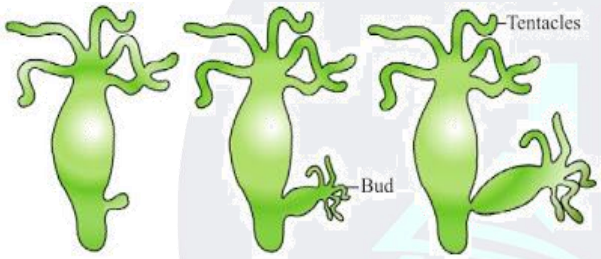
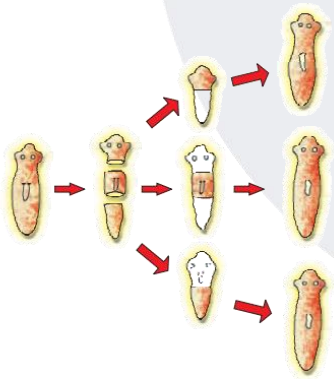
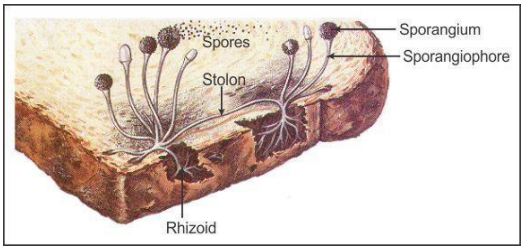
Reproduction and its Kinds

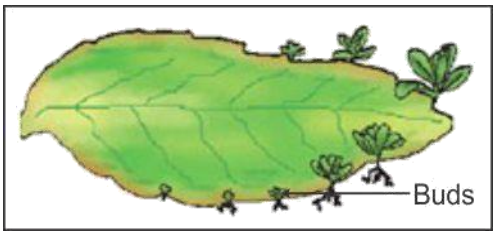
Sexual Reproduction	Asexual Reproduction
• In sexual reproduction two parents are involved	• In asexual mode of reproduction single parent is involved.
• It involves the formation of special reproductive cells called gametes.	• It does not involve the formation of gametes.
• Male and female gametes fuse to form the zygote which develops into a new individual.	• New organisms are formed either by the division of the parent body or by the differentiation of the parent body.

Modes of Asexual Reproduction

Plants and animals from lower classes reproduce by asexual methods.

Method	Description	Example
Binary Fission  	• Most common method in unicellular organisms. • It is division of the parent cell into two identical daughter organisms.	Amoeba, Paramecium, bacterium

Multiple Fission 	• Parent cell divides to produce many identical new individuals.	*Plasmodium vivax*, *Leishmania*
Fragmentation 	• Adult organisms, on maturation, break up into smaller fragments. Each fragment develops into a new individual.	Spirogyra
Budding 	• A small outgrowth called a bud arises on the parent body. • The bud grows by repeated cell divisions. • It then breaks off from the parent body and develops into a new individual.	Hydra, sponges, corals, yeast
Regeneration 	• Regeneration is the ability of organisms to generate lost or damaged body parts. • Regeneration is carried out by specialised cells. • These form a mass of cells which undergo changes to form cells specialized in different functions. • If planaria is cut into small pieces, then each piece develops into a new planaria.	Lizard, starfish, planaria, hydra
Spore Formation 	• Spores are special structures produced in sacs called sporangia. • When spores mature, sporangia burst and spores are carried by air or water to different places. • When spores fall on a suitable ground, they germinate and give rise to new plants.	Moss, Fern, Fungi

Vegetative Propagation  Vegetative propagation in *Bryophyllum*	• Several plants are capable of producing naturally through their roots, stems and leaves. Such type of reproduction is called vegetative propagation.	Sweet potato (by roots) *Bryophyllum* (by leaves) Ginger (by stem)

Different methods used to develop plants which can bears fruits and flowers by vegetative propagation are as follows:

- **Stem cutting:** This involves cutting a part of the stem and planting it in the soil to allow the growth of roots and buds into shoots.

  Examples: sugarcane, pear, china rose
- **Grafting:** In grafting, the stem or bud of two best quality plants is combined to form a new plant. Examples: guava, apple, mango
- **Layering:** In this, the lower branch of a plant is bent and covered with soil. Once new roots start developing on the branch, it is cut from the parent plant and allowed to grow as an individual plant. Examples: rose, jasmine

Tissue Culture

- Cells from the growing tip of a plant are separated and are grown on a nutrient medium containing all nutrients and hormones necessary for plant growth.
- These cells form a mass called callus.
- The callus develops plantlets.
- These plantlets are transferred to the soil and grow as new individuals.

Advantages of Vegetative Reproduction

New plants show the exact characteristics as those of the parent plant.

This method is faster and certain.

Plants not capable of producing sexually can be produced by this method.

Examples: Seedless bananas and grapes

Disadvantages of Vegetative Reproduction

There is no possibility of variation.

The new plant grows in the same area as the parent plant which leads to competition for resources.

Sexual Reproduction

- The sexual mode of reproduction involves two organisms, a male and a female to create a new organism or offspring.
- The sexual reproduction allows greater variations in a species as the two individuals involved in producing the offspring would have different patterns of variations. This process includes the combination of DNA of two different individuals and the resultant combination and variation would be unique.

- Hence this ensures a mixing of the gene pool of the species within a population and it also ensures the survival of the species as this process generates more variations due to the genetic recombination.
- The process of combining DNA of two different individuals during sexual reproduction will lead to an offspring with twice the amount of DNA than their previous generation.
- The solution to this lies in the fact that there are certain specialised cells in such organisms called germ cells or gametes. These have half the number of chromosomes and, therefore half the amount of DNA in comparison to the other non-reproductive cells. The combination of these germ cells from two different individuals during the process of sexual reproduction restores the original number of chromosomes and DNA content in the new offspring.
- The germ cells may be similar and not much different from each other in simple organisms. With the complexity of the organisms the germ cell also becomes specialised. One of the germ cells becomes large and stores food. This is known as the female gamete. The other germ cell which is small and motile is called the male gamete. These gametes lead to the differences in the bodies and reproductive systems of males and females.

Sexual Reproduction in Flowering Plants

A **flower** is the reproductive organ in angiosperms.

Stalk/Pedicel

- Point of attachment.

Thalamus

- It is an enlarged, flattened tip of the stalk.
- Petals and other parts arise from the thalamus.

Calyx

- Outermost whorl of the flower consisting of sepals.
- The calyx protects the inner parts of the flower in their bud stage.

Corolla

- Second whorl of the flower which is made up of petals.
- Helps flowers in attracting insects to carry out pollination.

Androcium

- Third whorl and the male organ of the flower.
- Consists of stamens.
- Each stamen is made of the filament and anther.
- Anthers store poll grains.

Gynoecium

- Innermost whorl and the female reproductive organ.
- Consists of pistils or carpels.
- Carpel is made of stigma, style and ovary.
- Stigma receives pollen grains
- Ovary has multiple ovules which has female germ cells.

Pollination

The process of sexual reproduction in plants starts with the transfer of pollen grains from the anther of the stamen to the stigma of the pistil. This process is termed as pollination.

This is facilitated by pollinating agents like wind, birds, animals, water etc. which transfer the pollen grains.

There can be two types of pollination as follows:

Self-pollination	Cross-pollination
This involves the transfer of pollen grains from the anther to the stigma of the same flower. Example - wheat, peanut, etc.	This type of pollination involves the transfer of the pollen grains from the anther of one flower to the stigma of another flower of the same species. **Example** - apples, pumpkin etc.

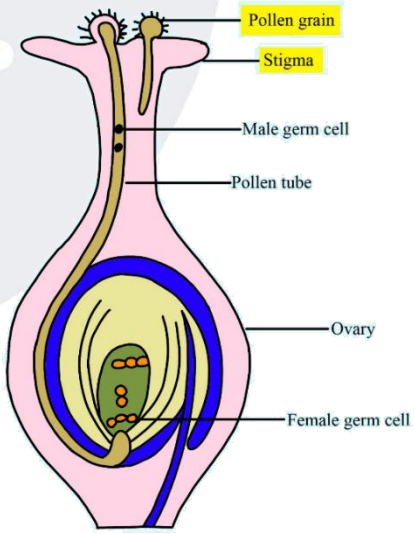
Different agents help to bring about cross pollination. They are insects, wind, water, etc.

Fertilisation

Through the process of pollination, the pollen is deposited on the stigma of the pistil. For the next process in reproduction, it needs to reach the female germ-cells which are present in the ovary. To facilitate this, a tube grows out of the pollen grain through the style and reaches the ovule in the ovary of the pistil. Here in the ovule the male germ-cell fuses with a female germ-cell to form a zygote. This process of fusion of the gametes is termed as **fertilization**. After the process of fertilization, the zygote thus formed, divides repeatedly to form an embryo inside the ovule. The ovule later develops into a seed. And meanwhile the ovary grows and ripens into a fruit and the other parts of the flower, namely the petals, sepals, stamens, style and stigma may be shed off. The seed present inside the fruit encloses the future plant in its embryo.

Fruit and Seed Formation

- The seed that contains the new plant or embryo develops into a seedling when the conditions are suitable. This process is termed as germination. Certain conditions like nutrients, water and proper temperature are necessary for the process of germination.
- The embryo gets its food from the reserve food material stored in the cotyledons. It also has a protective outer covering known as seed coat.



Reproduction in Human Beings

The mode of reproduction in human beings is sexual mode. The reproductive phase of an individual is that phase of life when the individual is ready to reproduce an offspring. Changes are noticed at every phase of growth right from birth.

But there are some changes that begin in the teenage age that start to prepare us for the reproductive phase of life. This period of adolescence leads to sexual maturation. The body needs to create specialised germ-cells to take part in the sexual reproduction. The period of maturation of the reproductive tissues in the body is termed as puberty.

Numerous changes are noticed in both boys and girls during this period. The boys start to have hair growth on their face and body, voice change, active functioning of sweat and sebaceous glands, enlargement of penis etc. The changes in the girls include growth of pubic hair, enlargement of breasts, oily skin leading to pimples, onset of menstruation etc. Both of them undergo changes in their body appearance and they become more conscious of these bodily changes.

Growth and Development

- Growth and development are gradual and irreversible processes.
- Size and complexity of the body increase gradually.
- Growth in humans is divided into the following stages:

Infant	• Children between 1 month and 1 year of age are called infants.
Toddler	• Children between 1 to 4 years of age. • Growth is fast. • Children learn to balance the body.
Adolescent	• Children between the ages of 11 to 19 years. • The period of transition from childhood to adulthood is called adolescence
Adulthood	• It is from the age of 18 years onwards. • An individual attains full growth and emotional stability. • Career and shouldering responsibilities are priorities.

Puberty is the period during which the reproductive system matures in boys and girls.

- In girls, puberty begins at the age of 11 years.
- In boys, it begins at the age of 12–14 years.
- Puberty continues till the age of 18 years.

Changes Which Occur at the Time of Puberty

Changes in Boys	Changes in Girls
Testes mature and start producing sperms.	Ovaries mature and start producing ovum. The menstrual cycle begins.
Pectoral girdle (shoulder girdle) grows.	Pelvic girdle (hip girdle) becomes broad.
Hair growth in the pubic region.	Hair growth in the pubic region.
The skin in the pubic region becomes darker.	The skin in the pubic region becomes darker.
Development of moustache and beard.	Enlargement of breasts.
Development of a deep voice.	The voice becomes shrill.

Problems Related to Adolescence

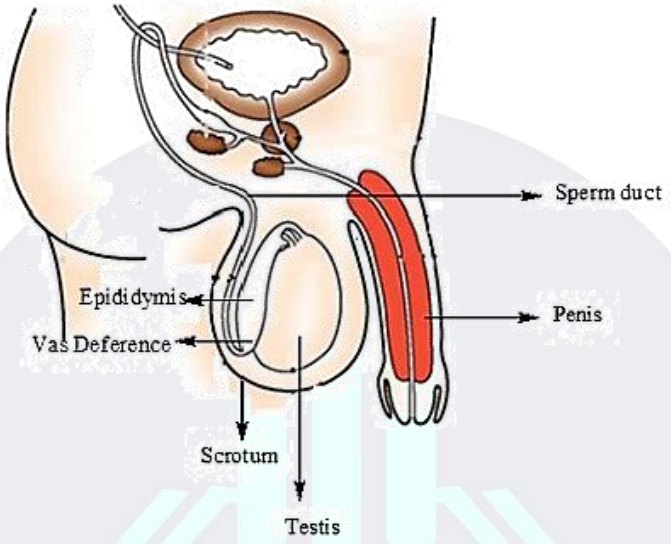
Adolescence is a period of physical, mental and emotional changes.

- The spurt of growth in certain body parts creates confusion in teenagers. They start worrying about it. They start feeling lonely and do not feel comfortable to share their problems with others.
- Teenagers become highly sensitive about someone's opinion.
- They tend to become angry or upset very easily.
- They prefer the company of persons their age.
- Due to hormonal changes, they experience depression.
- They feel the urge to become independent but are unsure about themselves.
- They have many questions about sex.
- This makes it important to counsel them in the right manner.

Menstrual Cycle

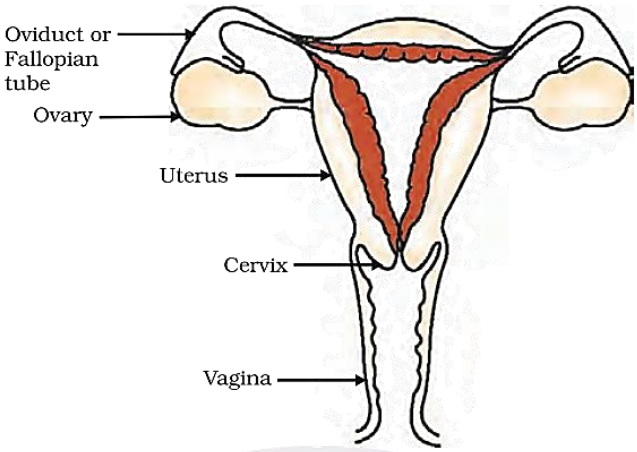
- Menstruation is the cyclic event of the release of the ovum from the ovary and its removal from the body when fertilization does not happen.
- During menstruation, the blood-rich endometrium of the uterus also breaks down while the ovum is being removed from the body.
- Two pituitary hormones, LH and FSH and two ovarian hormones, estrogen and progesterone, all have their roles in menstruation.
- In humans, the cycle repeats every 28 days.

Male Reproductive System



1. Testes (Testicles)	• A pair of testes is located below the abdomen in the scrotal sac or scrotum. • The testes produce male gametes or sperms (germ cells). • To maintain the temperature 2–3°C below the body temperature, the scrotum is located outside the body cavity.
2. Epididymis	• Tubes present in the testes join to form the epididymis. • The epididymis stores sperms temporarily.
3. Vas deferens (sperm duct)	• Each epididymis continues further as the sperm duct or vas deferens. • Each vas deferens unites with a tube coming from the urinary bladder on either side. • Thus, the urethra is the common passage for sperms and urine.
4. Seminal vesicles	• The seminal vesicles produce a secretion which is responsible for the transport of sperms.
5. Prostate gland	• It is a bilobed structure which surrounds the urethra. • It pours an alkaline secretion into the semen.
6. Cowper's gland	• These are two small ovoid glands. • They open into the urethra. • Their secretion serves as a lubricant.
7. Penis	• The urethra passes through the penis. • It carries either urine or semen at a time.

Female Reproductive System



1. OVARIES	• Two ovaries are present in the pelvic cavity, one on each side of the uterus. • Ovaries produce ova which are female gametes. • One ovum is released by one ovary every month.
2. OVIDUCTS (Fallopian tube)	• Two oviducts or fallopian tubes are present, each close to one ovary of its side. • When the egg is released by the ovary, it passes down to the uterus through the oviduct.
3. UTERUS (Womb)	• The uterus is a hollow pear-shaped, muscular organ. • The inner lining of the uterus protects and nourishes the developing embryo.
4. VAGINA (Birth canal)	• The uterus opens into the vagina. • The vagina is a muscular, narrow tube.
5. VULVA	• The vagina and urethra both open into the vulva.

Fertilisation

The process of fusion of the male gamete with the female gamete is called **fertilisation.**

The process of fertilization of a male and female gamete or sperm and egg starts when the sperm enters the female reproductive system through the vaginal passage during a sexual intercourse. From the vaginal passage they move up through the uterus towards the fallopian tubes.

The eggs are present in the fallopian tube, meet the sperm and get fertilized.

The fertilized egg, which is known as the zygote, starts dividing repeatedly and travels down the fallopian tube to the uterus.

The ball of cells or embryo gets implanted in the endometrial lining of the uterus and continues to grow into a foetus. The embryo gets its nourishment from the mother through a special tissue called the placenta which acts as a connection between the mother and the developing embryo. It helps to transport glucose and oxygen to the embryo and remove the wastes generated by the embryo.

It takes about nine months for the complete development of the child inside the mother's body. The child is born due to the rhythmic contractions of the uterine muscles through vagina (birth canal).

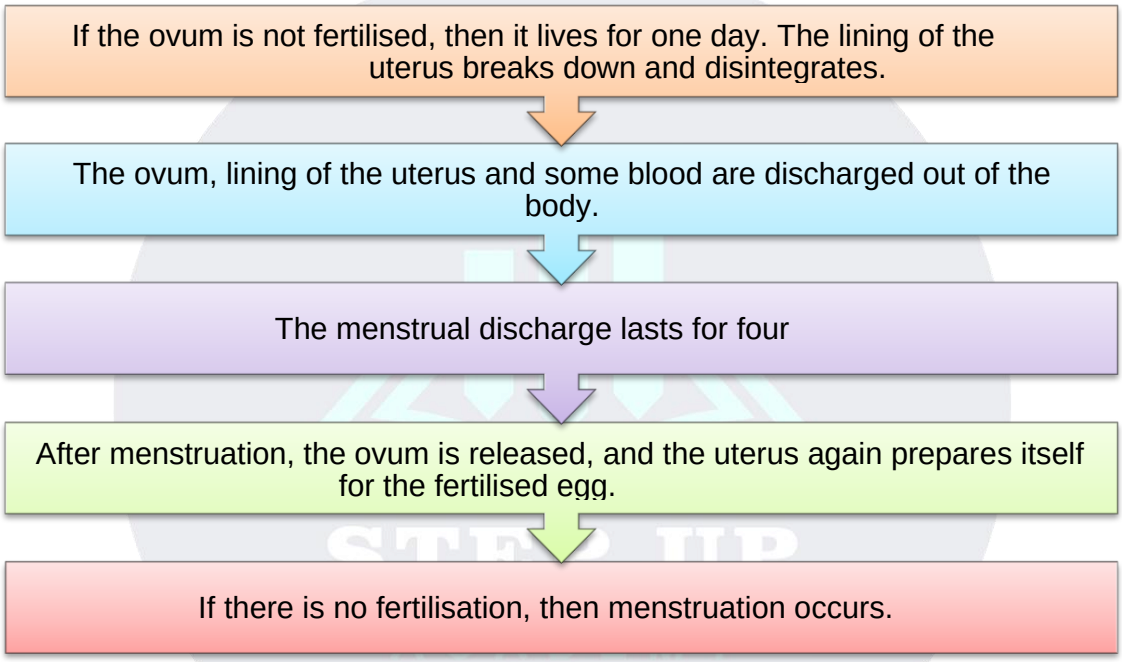
What Happens When the Egg is Not Fertilized?

An egg is released by the ovary every month in anticipation of it getting fertilised. In case the egg does not get fertilized, it can survive for only a day. Similar to the ovary releasing an egg every month, every month, the uterus too prepares itself for the fertilized egg by creating a thick and spongy lining in order to provide nourishment to the embryo.

When the fertilization does not occur, this lining too is not required and this lining and the egg is shed as blood and mucous through the vagina. This is called menstruation. This cycle occurs every month and lasts for about 2 - 8 days roughly.

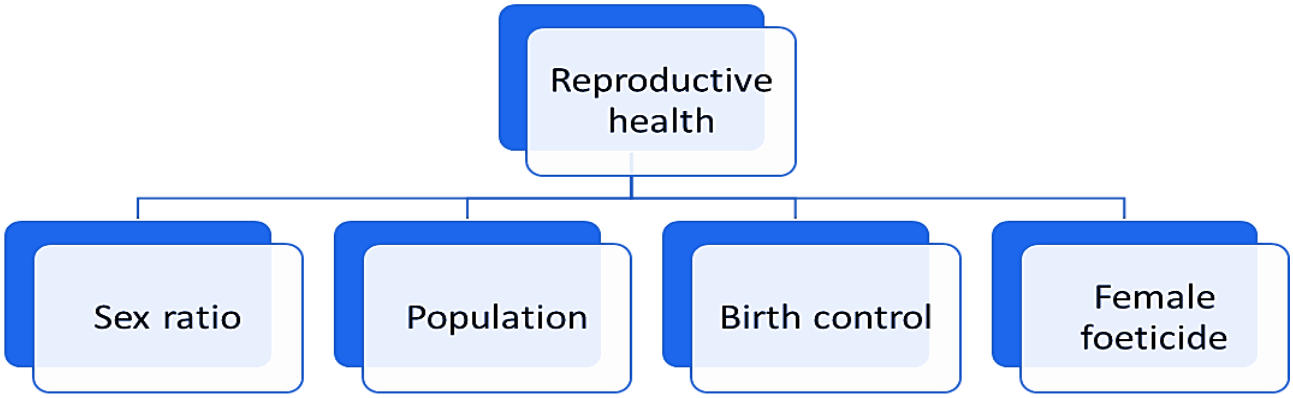
Implantation

- As soon as the zygote is formed, it starts developing.
- By the time it reaches the uterus, it is a mass of cells known as an embryo.
- It remains attached to the wall of the uterus throughout its development.
- The period of development of the embryo inside the uterus is called the **gestation period**.
- In humans, the gestation period is of 9 months, i.e. about 280 days.
- The embryo after completing three months of development is called the foetus.
- The placenta is a special tissue which provides food and oxygen to the foetus.



Reproductive Health

Reproductive health refers to the state of complete physical, mental and social well-being in all aspects related to the reproductive system



Sex ratio

Sex ratio is defined as the number of females per 1000 males in a given population. In a society that has males and females equal in number, the sex ratio is 1:1 or 1000 females for every 1000 males. Due to female foeticide sex ratio has declined. Therefore, determination of sex of child is prohibited by law.

Population

Population size is the number of individuals in a population. Birth rate and death rate are the two factors that determine the population size.

Birth control methods:

1. Hormonal Method: Various hormonal preparations come in the form of tablets or pills, commonly called contraceptive pills.
2. Barrier Methods: Condoms, diaphragms and spermicidals are used, Condoms are used by males while diaphragms and spermicidals are used by females. it not only prevent pregnancy but also prevent transmission of sexually transmitted disease as there is no direct contact of reproductive organs of male and female.
3. Intra-uterine Devices (IUDs): IUDs such as Lippe's loop and copper – T are fitted in the uterus. They prevent fertilisation.
4. Surgical Methods: In females, the fallopian tubes are ligated. This is called tubectomy. In males, the vas differentia are ligated. This is called vasectomy.
5. Induced Abortion: It is also known as Medical Termination of Pregnancy (MTP).

   If a woman becomes pregnant and the couple is not willing to have a baby, then the option of induced abortion is chosen.

Female foeticide

The killing of unborn girl child is known as female foeticide after the sex recognition tests like an ultrasound scan and amniocentesis. This has declined the sex ratio in certain society.

Sexually Transmitted Diseases

1. **AIDS (Acquired Immuno Deficiency Syndrome):** The most common and chronic sexually transmitted disease is AIDS. It is caused by HIV (Human Immunodeficiency Virus). Generally, the immune system is destroyed by HIV, and the body becomes weak. When a person is infected by AIDS, he is susceptible to various other diseases. Direct sexual contact is the most probable way of transmission of HIV.
2. The initial symptoms of HIV are headache, swollen lymph nodes, rashes, fever and chills, and nausea. No cure for AIDS has been found so far, but effective treatment can increase the lifetime of the patient for a few years. AIDS can be prevented by ensuring protective sexual intercourse.
3. **HPV (Human Papillomavirus):** As the name suggests, it is a viral disease. The most common symptoms include warts on the buccal cavity, throat, and external genitals. If left untreated, HPV may lead to other chronic diseases like cervical cancer, oral cancer, rectal cancer, etc. No treatment has been found for HPV so far.
4. **Gonorrhoea:** The bacteria, Neisseria gonorrhoeae, is the agent of this STD. In this disease, both males and females can be affected. The urogenital pathway, including the rectum, urethra, and cervix (in females only), are mostly affected. Gonorrhoea, like other STDs, is majorly transmitted through direct sexual contact. Oral and anal sex are also the ways through which gonorrhoea is transmitted.

   The symptoms of gonorrhoea are- discharge of pus from the penis, burning sensation during urination (in males), and similarly discharge of pus from the vagina, pelvic or abdominal pain (in females). Gonorrhoea can be prevented by protected sexual intercourse.
5. **Syphilis:** The bacteria, Treponema pallidum, is the causative agent of this STD. The bacteria find their path in the body through various wounds. Syphilis can also be transmitted from infected pregnant mothers to their children. The early symptoms include a sore that is termed as 'Chancre'. The other symptoms include headache, loss of weight, fatigue, rashes, fever, etc. In the later stages, it may lead to a complete stop of mental growth, loss of vision, heart disease, etc. Syphilis can be prevented by avoiding unprotected sexual contact and other steps as taken for any STD.

Class : 10th Biology
Chapter-8 How do Organisms Reproduce

How do organisms reproduce

Asexual reproduction

Budding
- Bulb like projection comes out of the cells
- Reproduction through buds
- eg. Yeast, Hydra

Fragmentation
- Breaking into two or more fragments
- Eg. Spirogyra

Reproduction through vegetative parts of Plants
- ThroughLeaves- Bryophyllum
- Through Eyes P-aotato
- Through stem-Rose
- Through Roots

Spore formation
- Convered by hard protective coat to withstand condition
- Fungus
- Spore germinates

Fission

Sexual reproduction in animals (Human Beings)

Male Reproductive System
- Sperm duct
- Testis (Release Sperm)
- Penis

Part of Sperm
- Head
- Middle piece
- Tail

Female Reproductive System
- Ovaries
- Oviduct
- Ova (egg)
- Uterus

- Fertilization: Ova (from ovaries) fuses with sperm (from testis) to from zygote
- Implantation of embryo in uterus
- develops into baby

Sexual reproduction in Plants

Through Seeds

- contains Embryo
- Ovary forms fruit and Ovules from seeds

Seed dispersal
- By Wind
- By Water
- By Animal

Through Flowers

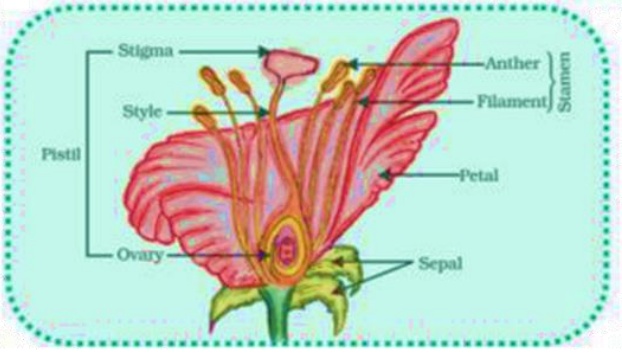
Fertilization

Fusion of male and female gametes develops into embryo

Pollination

Self Pollination
Pollen grains on stigma of same flower

Cross Pollination
Pollen grains on stigma of another flower



Important Questions

Multiple Choice Questions:

1. Binary fission is a method of asexual reproduction in:
   (a) amoeba
   (b) hydra
   (c) fern
   (d) none of these.
2. What is present in pollen Sac?
   (a) Calyx
   (b) Ovary
   (c) Ovule
   (d) Pollen grains
3. During the process of fertilization in plants, male gamete fuses with the egg and the second with the secondary nucleus. This is known as:
   (a) simple fertilization
   (b) double fertilization
   (c) fusion
   (d) all these.
4. Budding is found in:
   (a) Planaria
   (b) Hydra
   (c) Leishmania
   (d) All of these
5. In tissue culture method a small piece of tissue grows and forms:
   (a) callus
   (b) monocytes
   (c) synaps
   (d) homeostasis
6. During pregnancy menstruation is:
   (a) present
   (b) absent
   (c) intermittent
   (d) present with pain
7. Vegetative reproduction is possible by:
   (a) root
   (b) stem
   (c) leaves
   (d) all these
8. After fertilization which structure forms fruit:
   (a) calyx
   (b) corolla
   (c) stamen
   (d) ovary
9. How many male gametes are found in pollen tube:
   (a) one
   (b) two
   (c) three
   (d) four
10. In boys the puberty occurs at the age of:
    (a) 10-12 years
    (b) 12-14 years
    (c) 16-18 years
    (d) 20-22 years

Very Short Question:

1. Write the full expansion of HIV.
2. Write the full form of IUCD.
3. Name the type of fission carried out by Amoeba.
4. What is vegetative propagation?
5. List two functions performed by ovaries in a human female.
6. What is the effect of DNA copying which is not perfectly accurate in the reproductive process?
7. Name the hormone, secretion of which is, responsible for dramatic changes in appearance in girls when they approach 10-12 years of age.
8. Why is DNA copying an essential part of the process of reproduction?
9. Mention the common mode of reproduction found in
   - Amoeba
   - Planaria.
10. Name any two types of asexual reproduction.

Short Questions:

1. List any two differences between pollination and fertilization.
2. What is reproduction? Mention the importance of DNA copying in reproduction.

3. Define variations in relation to a species. Why is variation beneficial to the species?
4. Mention the information source of making proteins in the cell. What is the basic event in reproduction?
5. Name one sexually transmitted disease each caused by a bacterial infection and viral infection. How can they be prevented?
6. (a) In human body what is the role of
   - seminal vesicles and
   - prostate gland.

   (b) List two functions performed by testes in human beings.
7. Name the male and female gametes in animals. What is fertilization and where does it take place in human females?
8. What is reproduction? What are the two types? Which one of the two confers new characteristics on the offspring and how?

Long Questions:

1. Draw the diagram of a flower to show its male and female reproductive parts. Label the following in it;

   (a) Ovary

   (b) Anther

   (c) Filament

   (d) Stigma.

   What is the function of anther? How does fusion of male and female gametes take place in plants?
2. (a) Draw a diagram showing germination of pollen on stigma of a flower.

   (b) Label pollen grain, male germ cells, pollen tube, stigma, ovary and female germ cell in the above diagram.

   (c) How is zygote formed?
3. Draw a longitudinal section of a flower and label the following parts:
   - Part that produces pollen grains,
   - Part that transfers male gametes to the female gametes.
   - Part that is sticky to trap pollen grain,
   - Part that develops into a fruit.

Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true but R is false.

   d. A is false but R is true.

   Assertion: Internal fertilisation occurs in mammals and birds.

   Reason: External fertilisation occurs in reptiles, amphibians, and fishes.
2. For two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true but R is false.

   d. A is false but R is true.

   Assertion: Seeds are matured ovules.

   Reason: The part of seed which contains stored food for baby plant is called cotyledon.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   A married woman used a device X made of common metal for preventing pregnancy. This device was put into her uterus by some trained medical professional. Unfortunately, she got pregnant after two months of insertion of device. She was in shock to learn that her birth control device has failed.

   i. What is the name of birth control device used by the woman?
      a. Foam tablets.
      b. Copper T.
      c. Diaphragm.
      d. Both (a) and (b).

   ii. Which metal is commonly used for making device X?
      a. Iron.
      b. Copper.
      c. Silver.
      d. Gold.

iii. How does device X prevent pregnancy?
   a. It prevents ovulation.
   b. It prevents copulation.
   c. It suppresses fertilising capacity of sperm.
   d. None of these.

iv. Why do you think the woman got pregnant even after using device X?
   a. Device X might have got expelled without the knowledge of woman.
   b. Device X might be defective and was not working from the beginning.
   c. Device X could have been destroyed by the uterine fluid.
   d. None of these.

v. Select the correct statement regarding device X.
   a. Device X is very effective in preventing sexually transmitted diseases.
   b. Device X can be inserted in uterus by woman herself.
   c. Device X prevents menstrual cycle in women.
   d. Device X can cause heavy painful and longer duration periods or menstruation.

2. Read the following and answer any four questions from (i) to (v).

A newly married couple does not want have children for few years. They consulted a doctor who advised them barrier method and chemical method of birth control. Yet another couple who already have two children and are middle aged also consulted doctor for some permanent solution to avoid unwanted pregnancy. Doctor advised them surgical method of birth control.

i. What are the barrier methods of birth control?
   a. Condom.
   b. Diaphragm.
   c. Oral pills.
   d. Both (a) and (b).

ii. How physical barrier prevent pregnancy?
   a. They kill the sperms.
   b. They kill the ovum.
   c. They prevent sperms from meeting the ovum.
   d. They prevent intercourse.

iii. How chemical methods prevent pregnancy?
   a. Vaginal pills contain chemical called spermicides which kill the sperms.
   b. Oral pills prevent ovulation, so there will be no fertilisation.
   c. Oral pills stop menstruation in females.
   d. Both (a) and (b).

iv. Select the correct statement regarding surgical method of birth control.
   a. It involves termination of pregnancies in women particularly after eight weeks of conception.
   b. Small portion of sperm duct or vas deference in males is removed by surgical operation and both cut ends are ligated properly.
   c. Small portion of oviducts in females is removed by surgical operation and cut ends are ligated.
   d. Both (b) and (c).

v. Select the correct statement regarding birth control methods.
   a. Barrier method of birth control also protects the couple from sexually transmitted diseases.
   b. Some women experience unpleasant side effects on taking oral pills because of change in hormonal balance in body.
   c. Surgical method in males is called vasectomy and in females is called tubectomy.
   d. All of these.

Answer Key

Multiple Choice Answers:

1. (a) amoeba
2. (d) Pollen grains
3. (b) double fertilization
4. (a) Planaria
5. (a) callus
6. (b) absent
7. (d) all these
8. (d) ovary
9. (b) two
10. (b) 12-14 years

Very Short Answers:

1. **Answer**: Human immuno-deficiency virus.
2. **Answer**: Intra-uterine contraceptive device.
3. **Answer**: Binary fission.
4. **Answer**: It is the formation of new plants from vegetative parts (e.g., stem, leaf, root, bud) of a parent plant.
5. **Answer**: Formation of ova Secretion of hormones, estrogen and progesterone.
6. **Answer**: It produces mutations which give rise to useful, harmful and neutral variations in the progeny.
7. **Answer**: Estrogen (= oestrogen) produced by growing follicles inside the ovary.
8. Answer: Cell multiplication is essential for reproduction either as a means of multiplication in unicellular organisms or as a means of development of multicellular body from a single celled zygote. Cell multiplication cannot occur without DNA replication or DNA copying because each new cell must carry the full DNA complement.
9. **Answer**:
   - Amoeba Binary fission in any plane.
   - Planaria: Transverse binary fission.
10. **Answer**: Fission, Spore formation.

Short Answer:

1. **Answer**:

Pollination	Fertilization
1. **Definition.** It is transfer of pollen grains from anther to the stigma of a flower.	It is the fusion of male and female gametes.
2. **Step.** Pollination precedes fertilization.	Fertilization occurs only after pollination when the pollen grain has germinated and male gametes are carried into ovule.
3. **Purpose.** It carries the male gamete producing pollen grains to the female sex organ.	It actually brings about fusion of gametes.
4. **Process.** Pollination is a physical process.	Fertilization is a physico-chemical (biological) process.
5. **Occurrence.** It occurs only in seed plants.	It occurs in both plants and animals of various types.

2. **Answer**: Definition: Reproduction is the process of producing new young individuals of similar type by the mature individuals.

   Importance of DNA Copying.

   DNA carries hereditary information not only for controlling cellular functions but also all the structural and functional traits of organism. It is because of the latter that single celled zygote is able to form the whole multicellular organism. During reproduction there is formation of new cells which must carry the same amount and type of hereditary information as present in the parent cell. This is accomplished by DNA copying, which occurs prior to each cell division. DNA copying is not error proof. Errors give rise to variations.
3. **Answer**: Definition: Variation is differences in structure, physiology and other characters found in the individuals of the same organism.

Benefits of variations to species.

Many of the variations are pre-adaptations which have no immediate benefit to the individuals. However, they remain in the population. Whenever, environment undergoes a drastic change, the pre-adaptations present in some members of the population allow the latter to survive, grow and regain its former size. Therefore, it is not necessary that variations are beneficial to individuals developing them but can prove useful to the species.

4. **Answer**: Information Source: The information source of making proteins in a cell is its DNA.

Basic Event in Reproduction: The basic event in reproduction is replication of DNA, growth of cellular machinery and cell division.

5. **Answer**: Bacterial STD. Gonorrhoea caused by Neisseria gonorrhoeae. Viral STD. Genital warts caused by Human Papilloma virus.

Prevention. Avoiding multipartner sex, use of condoms and clean toilet habits.

6. **Answer**:

(a) **Seminal Vesicles:** They secrete 60-70% of semen plasma that is alkaline and viscous having fructose (for nourishing the sperms), fibrinogen, proteins and prostaglandins. Prostaglandins cause movements in the genital tract of the female. Sperms are also activated by secretion of seminal vesicles.

Prostate Gland: It produces 20-30% of semen plasma. The secretion is alkaline and viscous. It has clotting enzyme and chemical essential for sperm activity.

(b) Function of Testes,

Formation of sperms from germinal cells of seminiferous tubules.

Secretion of testosterone by Leydig cells present in the connective tissue in between the seminiferous tubules.

7. **Answer**:

Male Gamete: Sperm (= spermatozoan)

Female Gamete: Ovum.

Fertilization: It is the fusion of two compatible gametes (e.g., sperm and ovum) to form diploid zygote during sexual reproduction.

In human females fertilization occurs in fallopian tube.

8. **Answer**:

Reproduction: Reproduction is the process of producing new young individuals of similar type by the mature individuals.

Importance of DNA Copying.

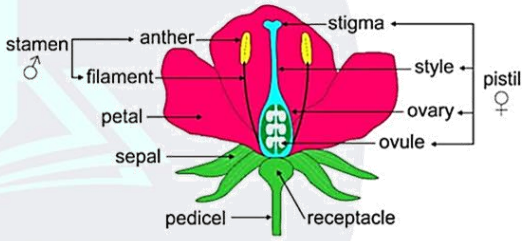
Types. Asexual reproduction and sexual reproduction.

New Characteristics: New characteristics appear only in sexual reproduction due to

- Chance separation of chromosomes during meiosis required for gamete formation,
- Crossing over during meiosis.
- Chance coming together of chromosomes during fertilization,
- Mutations or mistakes during DNA replication.

Long Answer:

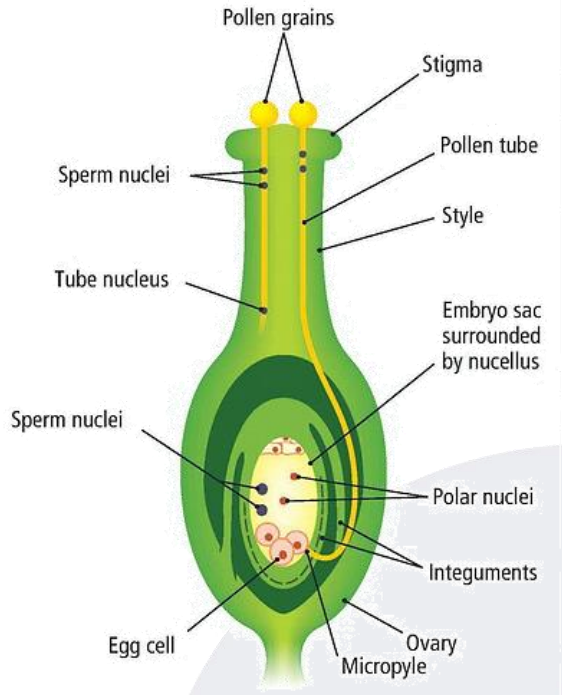
1. **Answer**:



Function of Anther. To produce haploid pollen grains which on growth form pollen tubes, each containing two male gametes.

Fusion of Male and Female Gametes. On germination over stigma, a pollen grain forms a long pollen tube carrying two male gametes. Pollen tube enters an ovule and bursts open in the embryo sac. One male gamete fuses with the egg to form diploid zygote. It is generative fertilization. The second male gamete fuses with diploid secondary nucleus of central cell to form triploid primary endosperm cell. It is vegetative fertilization. The phenomenon of two male gametes fusing with different cells in the same embryo sac to produce two different structures is called double fertilization.

2. **Answer**: (a)

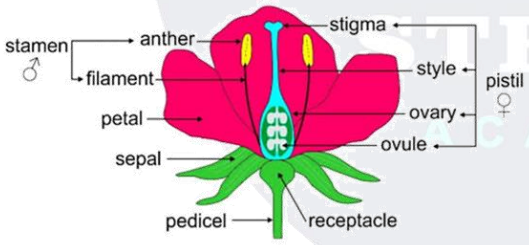


Fertilization in a flowering plant

(b) Label as required.

(c) Zygote or first diploid cell is formed by fusion of a male gamete (brought by pollen tube) with oosphere or egg inside the embryo sac.

3. **Answer**:



Labelling,

Anther—part that produces pollen grains.

Style—part that transfers male gametes to female gametes, by providing growth medium to pollen tubes.

Stigma—part that is sticky to trap pollen grain.

Ovary—part that develops into a fruit.

Assertion Reason Answer:

1. (c) A is true but R is false.

Explanation:

The fertilisation which occurs inside the female body is called internal fertilisation. Reptiles show internal fertilisation

2. (b) Both A and R are true, but R is not the correct explanation of the assertion.

Explanation:

Ovule is gradually converted into a seed. A seed is the reproductive unit of a plant. The seed contains a baby plant (or embryo) and food for the baby plant. The part of baby plant in seed which develops into shoot with leaves is called plumule and the part which develops into root is called radicle. The part of seed which contains stored food for the baby plant is called cotyledon.

Case study Questions:

1. i. (b) Copper T.

Explanation:

Intrauterine device is placed inside the uterus by a doctor or a trained nurse. Copper T is a common intra-uterine device.

ii. (b) Copper.

iii. (c) It suppresses fertilising capacity of sperm.

iv. (a) Device X might have got expelled without the knowledge of woman.

Explanation:

Intra-uterine devices are highly effective in preventing unwanted pregnancies. But they come with one disadvantage, that is they can get expelled anytime without the knowledge of women. Couple continue active sexual life thinking that their birth control device is still in action.

v. (d) Device X can cause heavy painful and longer duration periods or menstruation.

Explanation:

Intra-uterine devices do not protect against sexually transmitted diseases. Periods may become heavier, longer, and more painful and there are chances of pelvic infection.

2. i. (d) Both (a) and (b).

Explanation:

In barrier methods of preventing pregnancy, the physical devices such as condom and diaphragm are used. Condoms are rubber tubes used by males whereas diaphragm are rubber cups used by females.

ii. (c) They prevent sperms from meeting the ovum.

Explanation:

Physical barriers prevent the sperm from meeting the ovum by acting as a barrier between them.

iii. (d) Both (a) and (b).

Explanation:

Chemical methods of birth control include oral pills and vaginal pills. Oral pills are combination of estrogen and progesterone which prevent ovulation (release of egg during monthly cycle), so they prevent fertilisation. Vaginal pills are inserted in vagina before intercourse and release spermicides which kill sperms.

iv. (d) Both (b) and (c).

(d) All of these.

Heredity and Variation 4

Heredity and Variation

- Living organisms have certain recognisable heritable features such as height, complexion, colour of hair and eyes, shape of nose and chin etc. These are called **characters**.
- The alternative forms of a character are called **traits**. The inheritable characteristics or traits may be morphological, anatomical, physiological or reproductive.
- The transmission or passing of genetically based characters or traits from the parents to their offspring is called **heredity**.
- The occurrence of small differences or changes among the individuals of a species is called **variation**. Hereditary variations are of great importance in the process of **evolution** of a newspecies.
- Asexual reproduction results in a small amount of variation as compared to sexual reproduction.
- **Genes** are the specific parts of chromosomes or deoxyribonucleic acid (DNA) segments which determine hereditary characteristics.
- Every gene has two alternative forms for a character, each of which produces different effects in an organism. These alternative forms are called **alleles**. Example: In case of pea plants, the stem height is controlled by two alleles-one for tallness and the other for dwarfness.
- Of the two alleles of a gene, one is dominant, i.e. super ruling and the other is recessive, i.e. subordinate or submissive. A **dominant** allele is the allele which hides or masks the expression of its corresponding allele, which in turn becomes **recessive**.
- A contrasting pair of alleles constitutes an **allelomorph**.
- The genetic constitution of an organism is called its **genotype**. It is the description of genes present in an organism. The genotype of a tall plant could be TT or Tt, while that of a dwarf plant is tt.
- **Phenotype** refers to the observable characteristics or the expressed shown character of an organism. Example: Tall and dwarf are the phenotypes of a plant because these traits are visible to us.
- When two parents are crossed to produce progeny, their progeny is called the **first filial generation** or **F_1 generation**.
- When the first generation progeny or F_1 progeny is crossed amongst themselves to produce a second generation progeny, this progeny is called the **second filial generation** or **F_2generation**.
- A new form of plant resulting from a cross of different varieties of a plant is known as a **hybrid**.

Types of Variations

Somatic Variation

- It takes place in the body cell.
- It is neither inherited nor transmitted.
- It is also known as acquired traits.
- Examples: cutting of tails in dogs, boring of pinna etc.

Gametic Variation

- Takes place in the gametes/Reproductive cells.
- Inherited as well as transmitted.
- Also known as inherited traits.
- Example: human height, skin colour.

Rules for Inheritance of Traits

Mendel's work

Gregor Johann Mendel, known as 'Father of Genetics', who worked on pea plants to understand the concept of heredity.

He choose pea plant because they grow quickly, are easy to breed, and have a variety of traits

His work laid the foundation of modern genetics.

He made three basic laws of inheritance - The Law of Dominance, The Law of Segregation and The Law of Independent Assortment.

Traits	Shape of seeds	Colour of seeds	Colour of pods	Shape of pods	Plant height	Position of flowers	Flower colour
Dominant trait	Round	Yellow	Green	Full	Tall	At leaf junction	Purple
Recessive trait	Wrinkled	Green	Yellow	Flat, constricted	Short	At tips of branches	White

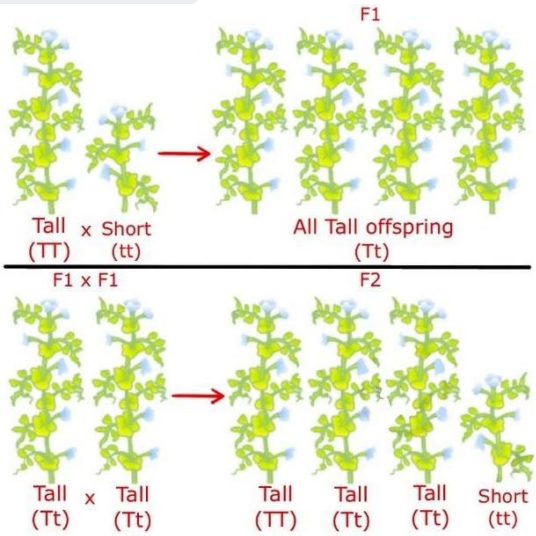
Seven pairs of contrasting traits in pea plant

Monohybrid Inheritance:

- A cross which involves only a single pair of contrasting characters is called a **monohybrid cross**. Example: A cross between a tall pea plant (TT) and a dwarf pea plant (tt).
- **Observations of Monohybrid Cross**
  - (i) All F1 progeny were tall, no medium height plant. (Half way characteristic)
  - (ii) F2 progeny ¼ were short, ¾ were tall.
  - (iii) Phenotypic ratio F2 – 3 : 1 (3 tall : 1 short)

    Phenotypic ratio: 3 : 1

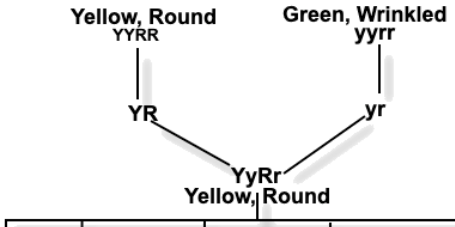
    Genotypic ratio: 1 : 2 : 1



- The results of the monohybrid cross enabled Mendel to formulate his first law of inheritance, which is called the **law of segregation**. It states that- 'The characteristics or traits of an organism are determined by internal factors, which occur in pairs. Only one of a pair of such factors can be present in a single gamete'.

Dihybrid Inheritance

- A cross which involves plants with two pairs of contrasting characters is called a **dihybrid cross**. Example: A cross of pea plants having round and yellow seeds (RRYY) and plants with wrinkled and green seeds (rryy).



	YR	Yr	yR	yr
YR	YYRR Yellow Round	YYRr Yellow Round	YyRR Yellow Round	YyRr Yellow Round
Yr	YYRr Yellow Round	YYrr Yellow wrinkled	YyRr Yellow Round	Yyrr Yellow wrinkled
yR	YyRR Yellow Round	YyRr Yellow Round	yyRR Green Round	yyRr Green Round
yr	YyRr Yellow Round	Yyrr Yellow wrinkled	yyRr Green Round	yyrr Green round

- **Observations**
  - (i) When RRYY was crossed with rryy in F1 generation all were Rr Yy round and yellow seeds.
  - (ii) Self pollination of F1 plants gave parental phenotype and two mixtures (recombinants round yellow and wrinkled green) seeds plants in the ratio of 9 : 3 : 3 : 1.

    Phenotypic ratio: 9 : 3 : 3 : 1

    Genotypic ratio: 1 : 4 : 1 : 1 : 1 :2 : 2 : 2 : 2
- The results of the dihybrid cross enabled Mendel to formulate his second law of inheritance, which is called the **law of independent assortment**. It states that- 'In the inheritance of more than one pair of traits in a cross simultaneously, the factors responsible for each pair of traits are distributed independently to the gametes'.
- **DNA** (Deoxyribonucleic acid) is a highly complex molecule with a spirally coiled, double helical structure which appears like a ladder.

How do These Traits Get Expressed?

The DNA present in the cell is responsible for making the proteins. A section of this DNA that provides information for one protein is termed the gene for that specific protein.

The proteins that are thus synthesized are essential in many of the biochemical reactions that are responsible for the expression of a trait and they are controlled by specific enzymes.

Any alterations in them will lead to a variation in that trait, and hence genes control the traits in such a way. If the traits are to be inherited independently from both the parents, then they need to be present separately.

Therefore each gene set is present as separate independent pieces that are called as chromosomes, with each cell having two sets, one each from both the parents.

When these two germ cells combine, they tend to restore the number of chromosomes and hence the DNA. Hence there are two genes for the expression of every trait.

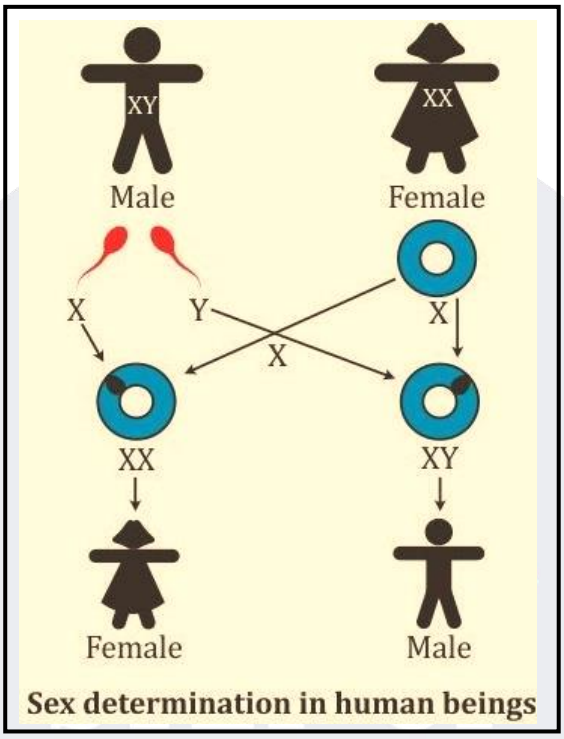
Sex Determination

- The phenomenon or process which determines whether a developing embryo will be a male or a female is known as **sex determination**.
- In most organisms, **environmental** and **genetic** or **chromosomal** mechanisms are mainly responsible for the determination of sex of an individual.

- Humans have 22 pairs of **autosomes** and 1 pair of **sex chromosome**.
- **Females** have similar sex chromosomes **XX**, whereas **males** have a dissimilar pair, i.e. **XY**. All eggs carry the X chromosome, while sperms may either carry an X or a Y chromosome.
- The sex of a child depends on whether the egg fuses with the sperm carrying an X chromosome (resulting in a **female**) or with the sperm carrying a Y chromosome (resulting in a **male**).

Evolution

- **Evolution** can be defined as the formation of more complex organisms from pre-existing simpler organisms over a certain period. It is a slow, but progressive, natural, sequential development or transformation of animals and plants from ancestors of different forms and functions.

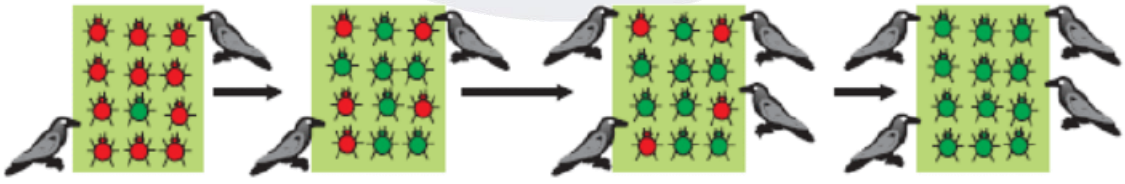


Sex determination in human beings

- Variation and **heredity** are the two basic factors of evolution. The selection of variants by environmental factors forms the basis of evolutionary processes.

An Illustration

Situation I (Group of red and green beetles)(Colour variation arises during reproduction)



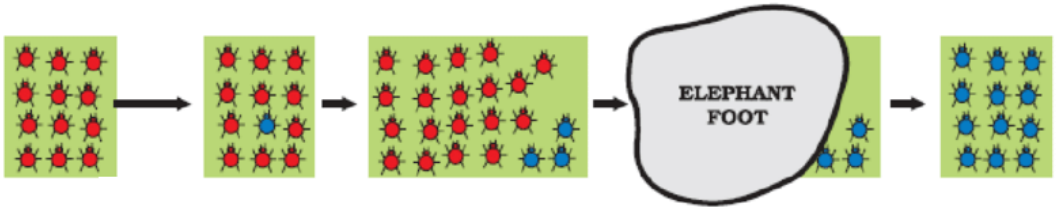
All beetles red except one that is green → Crows feed on red beetle → No. of beetles reduces

One beetle green → Progeny beetles green → Crows could not feed on green beetles as they got camouflaged (hide) in green bushes → Number of green bettles increases

Conclusion

- Green beetles got the survival advantage or they were naturally selected as they were not visible in green bushes.
- This natural selection is exerted by crows resulting in adaptations in the beetles to fit better in their environment.

Situation II (Group of red and blue beetles)

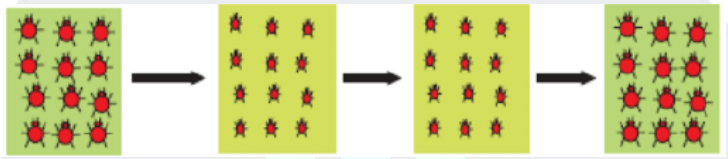


Reproduction in group of red beetles → All beetles are red except one that is blue → Number of red beetles increases as they reproduces → One blue beetle reproduces and no. of blue beetles also increases → Crows can see both blue and red beetles and can eat them → Number reduces but still red beetles are more and blue ones are few → Suddenly elephant comes and stamps on the bushes → Now beetles left are mostly blue

Conclusion

- Blue beetles did not get survivals advantage. Elephant suddenly caused major havoc in beetles population otherwise their number would have been considerably large.
- From this we can conclude that accidents can change the frequency of some genes even if they do not get survival advantage. This is called **genetic drift** and it leads to variation.

Situation III (Group of red beetles and Bushes)



Group of red beetles → Habitat of beetles (bushes) suffer from plant disease → Average weight of beetles decreases due to poor nourishment → Number of beetles kept on reducing → Later plant disease gets eliminated → Number and average weight of beetles increases again

Conclusion

No genetic change has occurred in the population of beetle. The population gets affected for a short duration only due to environmental changes.

Evidence for Evolution

A large amount of information has been collected over the last 200 years to support the theory of organic evolution. Such supporting information which helps us in accepting the theory is called **evidence**.

Morphological Evidence	• Morphological evidence of evolution reflects in the form of external features • or the appearance of an organism.
Anatomical Evidence	• Anatomical evidence of evolution is usually reflected in the form of structures, which appear quite similar in their organisation. • The similarities found in different groups of organisms indicate that these organisms must have had a common ancestor. • Different organisms have organs which perform a similar function. These organs which have a similar function but are different in structure and origin are called analogous organs. For example- tail fin of a lobster and flukes of a whale, wings of a fly and wings of a bird, eyes of arthropods and eyes of vertebrates, are all analogous organs. • There are some organs which are fundamentally similar in structure and origin but are modified to perform different functions in different organisms. They are called homologous organs. For example- forelimbs of man are adapted for handling, while forelimbs of bats and birds are adapted for flying, while those of whales and seals are adapted for swimming.

Vestigial Organs	• Organs which are found in a reduced or rudimentary condition and do not perform any function in the possessor are called vestigial organs or non- functional organs. For example- ear muscles, wisdom tooth, coccyx or reduced tail and plica semilunaris in man.
Study of Fossils	• Fossils are the preserved remains or traces of animals, plants and other organisms from the remote past. • The study of fossils is called palaeontology, which provides direct evidences in favour of organic evolution. • It helps us to compare the past with the present so as to establish the changes which have occurred in the course of evolution.
Embryological Evidence	• The study of development of an organism from the embryonic stage is called embryology. • The comparison of embryos states that in the course of development from the embryo to their adult form, animals go through stages which resemble or represent successive stages in the evolution of their remote ancestors.

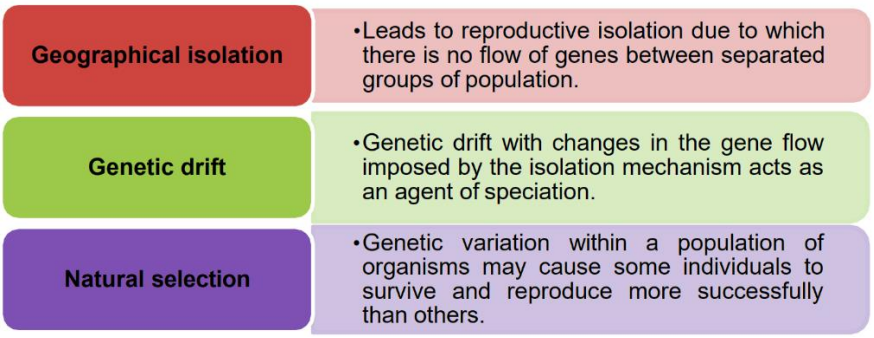
Differences between Inherited and Acquired Traits

Inherited Traits	Acquired Traits
1. Characteristics inherited from the previous generation.	1. Characteristics which develop in response to the environment and cannot be inherited.
2. Occur due to a change in genes or DNA.	2. No change in genes or DNA is involved.
3. Pass on from one generation to another.	3. Cannot pass on from one generation to another.
4. Examples: Red curly hair, brown eyes	4. Examples: Cycling, swimming

Darwin's Theory of Evolution

- According to **Darwin's Theory of Natural Selection**, organisms produce more offspring than they need for their existence. They compete among themselves and fight with the environmental factors for their various needs in life. In the struggle for existence, those with favourable variations continue to exist and those with unfavourable variations die out. Thus, a new species is formed by natural selection.
- A **species** is a population of organisms consisting of similar individuals which can breed together and produce fertile offspring.
- The process by which a new species develops from the existing species is known as **speciation**.

Important Factors which Contribute to Speciation



Evolution and Classification

- The principles of classification help us trace the evolutionary relationships of the species around us.
- In 1859, **Charles Darwin** first described this concept of evolution in his book ***The Origin of Species***.

- Certain groups of organisms have ancient body designs and are referred to as **primitive** or lower organisms. Some organisms have acquired their body designs relatively recently and are called **advanced** or higher organisms.
- There is a strong possibility that complexity within organisms increases with an increase in evolutionary time. Hence, we can say that older organisms are relatively simpler, while younger organisms are more complex.

Tracing Evolutionary Relationships

In the evolutionary relationships, the occurrence of common characteristics are the basis of classifying them into groups. These common characteristics can be identified as being of 2 types, namely:

Homologous characteristics: These are those characteristics that are present in different organism but look similar and they have a have a common ancestor. They may have the similar basic organ structures but with a different function in various organisms. Example - Mammals, birds, reptiles and amphibians have four limbs, but each serves a different purpose and are modified to perform that function.

Analogous characteristics: These are those characteristics that have the similar function in different organisms and they have evolved independently for different ancestors. Example: the wings of bats and of birds look similar as they serve to perform the same function of flying, but the wings of a bat are actually a fold of skin between the fingers.

Hence these different types of characteristics help in tracing the evolutionary relationships between species to a great extent.

Fossils:

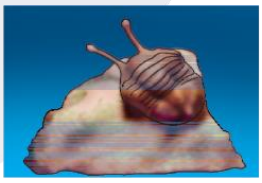
To study the evolutionary relationships, the current species as well as the species that are no longer in existence also needs to be considered.

The body of an organism usually decomposes when it dies, but due to some environmental conditions like hot mud or lava, their bodies may be buried in them, harden and eventually leave an impression of the body parts. This preserved traces of the living organisms that existed in a past geological period are termed as fossils.

The fossils help in determining the various evolutionary stages of the species. The process of conversion of an organism into a fossil is termed as fossilisation and its study is referred to as palaeontology.

Fossil – tree trunk

Fossil – invertebrate (Ammonite)



Fossil – invertebrate (Trilobite)

Fossil – fish (Knightia)

Fossil – dinosaur skull (Rajasaurus)

There are two ways to determine the age or dating of the fossils.

- **Relative dating:** This method involves the digging of the earth and excavating the fossils from the rocks. The more recent ones are found closer to the earth's surface.
- **Radiometric dating:** In this method, the fossils can be dated based on the radioactive elements present in the rocks and detecting the ratios of different isotopes of the same element in the material of the fossil.

Evolution by Stages

- The great variety of organisms existing on the Earth is due to changes which have occurred gradually in stages and have resulted in the evolution of a new species.
- The occurrence of different stages of evolution in a species is not because of a single DNA change.

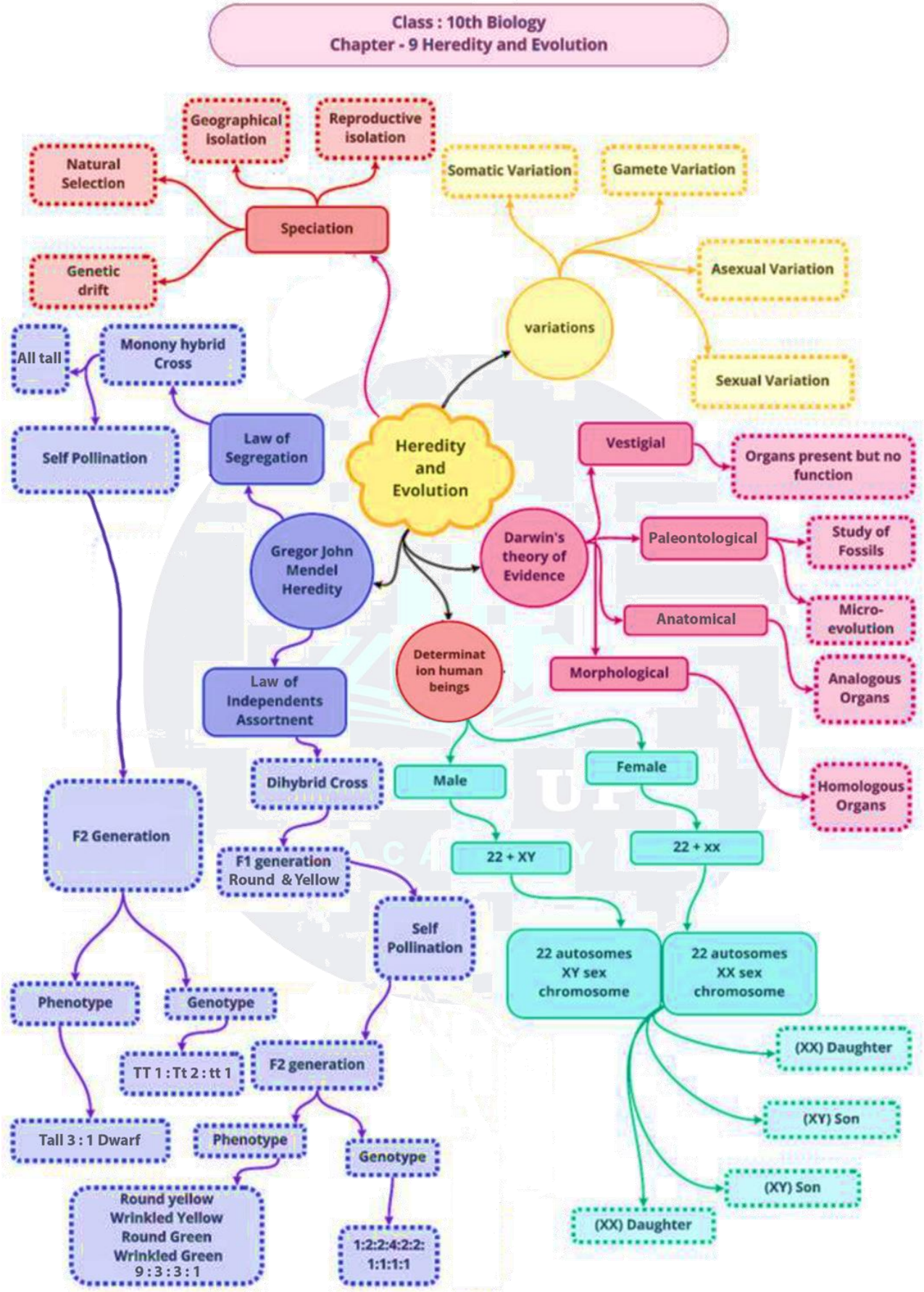
Evolution of Eyes	• Primitive organisms which existed on the Earth were slow moving and small in size. They did not require a specialised organ for observing any object. • As evolution progressed, comparatively larger and mobile organisms evolved. Most of them were predators and required better vision for predation. • Hence, from the basic design of eyes, more complex forms evolved.
Evolution of Feathers	• Birds make use of their feathers for flying. • However, feathers did not evolve for flight. They evolved as a means of providing insulation to the body in cold weather.
Evolution by Artificial Selection	• Artificial selection is the process in which human preferences have a significant effect on the evolution of a particular species. • Humans cultivate wild cabbage as a source of food and have produced different varieties of it by artificial selection. Common vegetables such as cabbage, kale, broccoli, cauliflower and kohlrabi are descendents of wild cabbage. • Artificial selection has helped in creating diversity in plants and animals.

Evolution Should Not Be Equated with Progress

- Evolution has resulted in the generation of new varieties of species. It results in the production of diverse life forms subjected to environmental selection. The only progress which has occurred due to evolution is the emergence of more complex body designs of organisms.
- When we consider the evolutionary history of man, we often say that human beings evolved from chimpanzees. However, this is not the case. In fact, both **chimpanzees** and **human beings** had a common ancestor a long time ago. The two offspring of that common ancestor evolved differently to form the modern day chimpanzees and human beings.

Human Evolution

- Human evolution has been studied using various tools of tracing evolutionary relationships such as excavating, carbon-dating, studying fossils and determining DNA sequences.
- Research reveals that the early members of *Homo sapiens* came from Africa. About hundred years ago, some of our ancestors left Africa, while others stayed back. So irrespective of where we live, all human species are natives of Africa. The earliest fossils of human beings include the genus ***Australopithecus***, followed by ***Homo habilis***, ***Homo erectus***, ***Homo heidelbergensis*** and finally modern day man ***Homo sapiens***.


Class : 10th Biology
Chapter - 9 Heredity and Evolution
Heredity and Evolution
Speciation
Geographical isolation
Reproductive isolation
Natural Selection
Genetic drift
variations
Somatic Variation
Gamete Variation
Asexual Variation
Sexual Variation
Law of Segregation
Monony hybrid Cross
All tall
Self Pollination
Gregor John Mendel Heredity
Law of Independents Assortnent
Dihybrid Cross
F1 generation Round & Yellow
F2 Generation
Phenotype
Genotype
TT 1 : Tt 2 : tt 1
Tall 3 : 1 Dwarf
F2 generation
Phenotype
Genotype
Round yellow
Wrinkled Yellow
Round Green
Wrinkled Green
9 : 3 : 3 : 1
1:2:2:4:2:2:1:1:1
Self Pollination
Darwin's theory of Evidence
Vestigial
Organs present but no function
Paleontological
Study of Fossils
Micro-evolution
Anatomical
Analogous Organs
Morphological
Homologous Organs
Determinat ion human beings
Male
Female
22 + XY
22 + xx
22 autosomes XY sex chromosome
22 autosomes XX sex chromosome
(XX) Daughter
(XY) Son
(XY) Son
(XX) Daughter

Important Questions

Multiple Choice Questions:

1. Human offspring's sex is determined
   (a) through father's sex chromosomes.
   (b) through mother's sex chromosomes.
   (c) by hormones.
   (d) by enzymes.
2. Wing of a bird and wing of an insect are
   (a) Homologous organs
   (b) analogous organs
   (c) vestigial organ
   (d) both (a) and (b)
3. Which concept was not included in Charles Darwin's theory of Natural Selection?
   (a) Struggle for existence
   (b) Punctuated equilibrium
   (c) Survival of the fittest
   (d) Overproduction of offspring.
4. The remaps (or impressions) of dead animals or plant? that lived in the remote past are known as
   (a) extinct species
   (b) fossils
   (c) naturally selected species
   (d) none of the above
5. Natural selection is called 'survival of the fittest'. Which of the following statements best describes an organism?
   (a) How strong it is compared to other individuals of the same species.
   (b) How much food and resources it is able to gather for its offspring.
   (c) The ability to adapt to the environment in the niche it occupies.
   (d) The number of fertile offspring it has.
6. The process by which new species develop from the existing species is known as
   (a) Evolution
   (b) Natural selection
   (c) Artificial selection
   (d) Speciation
7. The more characteristics two species have in common :
   (a) More closely they are related and more recently they had a common ancestors.
   (b) More distantly they are related and more recently they have common ancestors.
   (c) More closely they are related and more distantly they have common ancestors.
   (d) More distantly they are related and more distantly they have common ancestors.
8. A cross between two individuals results in a ratio of 9 : 3 : 3 : 1 for four possible phenotypes of progeny. This is an example of a
   (a) Monohybrid cross
   (b) Dihybrid cross
   (c) Test cross
   (d) F1 generation
9. Two pink colored flowers on crossing results in 1 red, 2 pink and 1 white flower progeny. The nature of the cross is:
   (a) cross fertilization
   (b) self-pollination
   (c) double fertilization
   (d) no fertilization
10. Differences between organisms in a species are described as variation. Which of the following would you describe as continuous variation?
   (a) Hair colour
   (b) Eye colour
   (c) Weight
   (d) Sex

Very Short Question:

1. Who proposed the theory of inheritance of acquired characters?
2. Give an example of a vestigial organ present in human body.
3. Who proposed the theory of natural selection?
4. In terms of evolution, what is the significance of homology between a human hand and a wing of a bird?
5. Name the scientist who established the laws of inheritance.

6. Define inheritance.
7. What is the function of genes in an organism?
8. What is gene?
9. What is speciation?
10. List any two factors that could lead to speciation.

Short Questions:

1. What are fossils? How do they tell us about process of evolution?
2. Describe briefly four ways in which individuals with a particular trait may increase in population.
3. "Variations that confer an advantage to an individual organism only will survive in a population." Justify.
4. "The sex of the children are determined by what they inherit from their father and not the mother." Justify.
5. Give one example of each of the characters that are inherited and the ones that are acquired in humans.

   Mention the difference between the inherited and the acquired characters.
6. (a) Write foil form of DNA.

   (b) Why are variations essential for the species ? (CCE 2011)
7. How do sexual and asexual reproduction lead to speciation? Give one point for each.
8. List four tools used to study evolutionary relationships.

Long Questions:

1. What is genetics?
   - Give the common name of the plant on which Mendel performed his experiments.
   - What for did Mendel use the term factors and what are these factors called now?
   - What are genes? Where are the genes located?
2. What are chromosomes? Where are they seated?
   - What is a sex chromosome?
   - Explain the mechanism of sex determination in human beings.
3. (a) What is geographical isolation?

   (b) Illustrate formation of a species with the help of an example where individuals are very different from each other and are capable of reproduction among themselves.

Assertion Reason Questions

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true but R is false.
   d. A is false but R is true.

   Assertion: ln grasshoppers, females are hetero gametic and males are homo gametic.

   Reason: ln grasshoppers, male has only one sex chromosome (XO) whereas the female has sex chromosomes (XX).
2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true but R is false.
   d. A is false but R is true.

   Assertion: A child which has inherited X chromosome from father will develop into a girl child.

   Reason: Girl child inherits X chromosome from father and Y chromosome from mother.

Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   Sex determination is the method by which distinction between males and females is established in a species. The sex of an individual is determined by specific chromosomes. These chromosomes are called sex chromosomes or allosomes. X and Y chromosomes are called sex chromosomes. The normal chromosomes other than the sex chromosomes of an individual are known as autosomes.

   i. ln XX-XO type of sex determination:
      a. Females produce two different types of gametes.

b. Males produce two different types of gametes.
c. Females produce gametes with Y chromosome.
d. Males produce gametes with Y chromosome.

ii. A couple has six daughters. What is the possibility of their having a girl next time?
a. 10%
b. 50%
c. 90%
d. 100%

iii. Number of autosomes present in liver cells of a human female is:
a. 22 autosomes.
b. 22 pairs.
c. 23 autosomes.
d. 23 pairs.

iv. XX-XO type of sex determination and XX-XY type of sex determination are the examples of:
a. Male heterogamety.
b. Female heterogamety.
c. Male homogamety.
d. Both (b) and (c).

v. Select the incorrect statement.
a. ln male grasshoppers, 50% of sperms have no sex chromosome.
b. Female fruit fly is heterogametic.
c. Human male produces two types of sperms 50% having X chromosome and 50% having Y chromosomes.
d. In turtle, sex determination is regulated by environmental factors.

2. Read the following and answer any four questions from (i) to (v).

In human, the allele for brown eyes (B) is dominant over that for blue eyes (b). A brown eyed woman marries a blue-eyed man, and they have six children. Four of the children are brown eyed and two of them are blue eyed.

i. What is the genotype of blue-eyed offspring?
a. BB
b. Bb
c. bb
d. Cannot be determined.

ii. What is the woman's genotype?
a. BB
b. Bb
c. bb
d. Cannot be determined.

iii. The ovum, produced by the mother carries the gene regarding eye colour is:
a. BB
b. Bb
c. B or b
d. B only.

iv. The ratio of brown eyed children to blue eyed children in this family is 2 : I, which deviates from typical phenotypic ratios for monohybrid inheritance. What might be the reason?
a. Gametes carrying the brown eyed allele are more viable than those with the blue-eyed allele.
b. A different pattern of inheritance other than monohybrid inheritance is involved.
c. Not all of their babies survived childbirth, thus causing a distortion in the actual ratio.
d. The actual ratio differs from the expected ratio because the sample size is too small.

v. What is the gene carried by of the man's spenn regarding the eye colour?
a. BB
b. Bb
c. b only
d. b or B.

Answer Key

Multiple Choice Answers:

1. (a) through father's sex chromosomes.
2. (a) Homologous organs
3. (b) Punctuated equilibrium
4. (b) fossils
5. (c) The ability to adapt to the environment in the niche it occupies.
6. (d) Speciation
7. (a) More closely they are related and more recently they had a common ancestor.
8. (b) Dihybrid cross
9. (a) cross fertilization
10. (c) Weight

Very Short Answers:

1. **Answer**: Jean Baptiste Lamarck (1809).
2. **Answer**: Vermiform appendix.
3. **Answer**: Charles Darwin (1859) proposed the theory of natural selection.
4. **Answer**: Homology indicates that there is common ancestry between a human hand and a wing of a bird. They have the same fundamental structure but are different in external morphology and functions.
5. **Answer**: Gregor Johann Mendel.
6. **Answer**: The transmission of characters from parents to offspring is known as inheritance.
7. **Answer**: Genes are the carrier of the genetic information for body functions and passage from one generation to another.
8. **Answer**: Gene is a unit of inheritance which consists of a linear segment of chromosome or DNA that takes part in expressing a particular character.
9. **Answer**: Speciation: It is the formation of newer species from the pre-existing ones due to accumulation of variations through various processes like isolation, stoppage of gene flow, genetic drift, and natural selection that lead to inability to interbreed.
10. **Answer**: It is the formation of newer species from the pre-existing ones due to accumulation of variations through various processes like isolation, stoppage of gene flow, genetic drift, and natural selection that lead to inability to interbreed.

Short Answer:

1. **Answer**: Fossils: They are remains or impressions of past organisms that lie hurried in the rocks and other structures belonging to various ages.

   Fossils Indicate Evolution

   - Different types of organisms appeared in different ages. Many of them have later on disappeared. Some gave rise to other organisms while a few are persisting even now.
   - Early forms were simple. Most of the later forms became more and more complex.
   - Fossils of different ages indicates the path of evolution,

   e.g., fishes → amphibians → reptiles → Birds / Mammals

   - Some fossils have characteristics intermediate between two groups, e.g., Archaeopteryx between reptiles and birds. They indicate the path of evolution.
   - Phylogeny of some organisms has been worked out with the help of fossils e.g., Horse.

2. **Answer**:

   The individuals with a particular trait will increase in number if the trait provides:

   More Food: The trait helps in obtaining more food that leads to increased growth and reproduction.

   Useful Variations: The trait helps the individuals to adapt to environment and achieve greater success in struggle for existence.

   Genetic Drift: It causes genetic fixation of a trait which, therefore, occurs, in whole of the progeny.

   Differential Reproduction: The trait gives extra benefit to the individuals in survival and reproduction.

3. **Answer**: Useful variations give advantage to individuals in obtaining more food, adaptation to environmental changes and higher success in the struggle for existence. They give benefit in survival and reproduction. Differential reproduction increases the useful variations in the populations. Other individuals with harmful variations will be eliminated. For example, some bacteria have ability to tolerate high temperature. In warm environment non-tolerant bacteria will be killed. Others with tolerance to high temperature will survive and multiply.

4. **Answer**: Ovum produced by would-be-mother is always of one type (22 + X). Sperms produced by would-be father are of two types, gynosperms (22 + X) and androsperms (22 + Y). If gynosperm (22 + X) fertilizes the ovum (22 + X), the sex of the child will be female (44 + XX). If androsperms (22 + Y) fuses with the ovum (22 + X), the child born will be boy (44 + XY). Therefore, only father is responsible for the sex of the children.

5. **Answer**:

   Inherited Trait: Fused and Free ear lobes.

   Acquired Trait: Muscular body of a wrestler.

   Difference: Acquired trait develops during the life time of an individual which affects somatic parts and dies with the death of the individual. Inherited trait is obtained from the parents, influences genes or germ cells and is passed on to the next generation.

6. **Answer**:

   (a) DNA. Deoxyribose nucleic acid.

   (b) Many of the variations have no immediate benefit to the species. They function as preadaptation's which can be beneficial under certain environmental conditions like heat tolerance variation if the temperature of the area rises.

7. **Answer**:

   Sexual reproduction produces a lot of variations due to reshuffling of chromosomes and crossing over.

   Variations help in natural selection and speciation.

   Asexual reproduction also develops variations occasionally due to errors in DNA replication. These variations help in natural selection and speciation.

8. **Answer**:

   Study of fundamental and correlated characters.

   Study of homologous organs.

   Study of fossil ancestors.

   Molecular phylogeny.

Long Answer:

1. **Answer**:

   - Genetics: It is the branch of biology that deals with the study of heredity and variations.
   - Garden or Edible Pea.
   - Factors: They are particulate inheritable entities which control the expression of traits of a character, e.g, T for tallness, t for dwarfness. The factors are now called genes.
   - Genes: They are units of inheritance that take part in expression of particular characters. Genes are located over the chromosomes as linear segments.

2. **Answer**:

   - In case of asexually reproducing organisms, there is no gametogenesis and fertilization. Chance separation and chance pairing of genes and their chromosomes are absent. Therefore, asexually developed individual carries the same genes and their chromosomes as are present in its parent.
   - Allosomes (Gk. alios— other, soma—boay) or sex chromosomes are those chromosomes which determine the sex of the individual in unisexual organisms. Human beings have 23 pairs of chromosomes.
   - Establishment of male and female individuals through differential development of their sex organs is called sex determination. In some organisms sex is determined by environmental conditions. In others including human beings, it is determined genetically.

   Environmental Determination of Sex:

   - Crepidula (marine mollusc) and Bonellia (marine worm) develop into females if growing alone. In the company of a female, they develop into males.

- In turtle, Chrysema picta an incubation temperature above 33°C produces females while a temperature below 28°C produces only males.
- In lizard, Agama agama, high incubation temperature produces male offspring.
- Annelid Ophryotrocha is male in young state and female later on. Snails are also known to change sex.

3. **Answer**:

(a) Geographical Isolation. Prevention of mating between breeding groups due to geographical or physical barriers (e.g., Valley, Mountain, Water body) is called geographical isolation. The isolated populations develop different variations and changes in physiology and behaviour to form new species.

(b) Over 160 breeds of dogs have come up due to selective breeding and artificial selection. Similarly, there are about 800 breeds of cattle. They differ in size, height, features, behaviour, colour and other traits. However, all dogs belong to one species of Canis familiaris while all cattle belong to one species of Bos indiens. Despite their structural and behaviour differences all the breeds belonging to the same species can interbreed and produce fertile offspring. However, if interbreeding is prevented by spatial isolation these different breeds can develop reproductive isolation and form new species, e.g., Porto Santo rabbits, Galapogos finches.

Assertion Reason Answer:

1. (d) A is false but R is true.

Explanation:

ln grasshoppers, the male has only one sex chromosome (XO) whereas the female has two sex chromosomes i.e., homo gametic. This type of sex determination mechanism is called XX-XO mechanism.

2. (c) A is true but R is false.

Explanation:

Father produces two types of sperms, one with X and one with Y chromosome, whereas mother produces all egg with X chromosome. Zygote that inherits X chromosome from father has XX chromosomes and develops into baby girl, whereas zygote which inherits Y chromosome from father has XY chromosomes and develops into baby boy.

Case Study Answer:

1. i. (b) Males produce two different types of gametes.

Explanation:

ln XX-XO type and XX-XY type of sex determining mechanisms, males produce two different types of gametes, either with or without X-chromosome (XO type), or some gametes with X-chromosome and some with Y-chromosome (XY type). Such type of sex determination mechanism is designated to be the example of male heterogamety. In both, females are homogametic and produce X type of gametes in both the cases and have XX genotype.

ii. (b) 50%

Explanation:

The possibility of having a girl or boy child is equal i.e., 50%, as 50% male gametes are Y type and 50% are X type. Fusion of egg with X type sperm will produce a girl child.

iii. (b) 22 pairs.

Explanation:

ln humans, number of autosomes are 2n = 44 or 22 pairs regardless of the sex.

iv. (a) Male heterogamety.

v. (b) Female fruitfly is heterogametic.

Explanation:

Male fruitflyis heterogametic whereas female fruitfly is homogametic.

2. i. (c) bb

ii. (b) Bb

Explanation:

According to the given passage some children show recessive trait, i.e., homozygous. So, the woman must be heterozygous.

iii. (c) B or b

Explanation:

Human ova are haploid; hence they only contain one copy of each gene. Since the woman has a Bb genotype her ova would contain either B orb allele.

iv. (d) The actual ratio differs from the expected ratio because the sample size is too small.

Explanation:

According to the given passage, within a single family, the sample size of offspring in each generation is very small. Hence, the actual phenotypic and genotypic ratios often deviate from expected ratios. It is only when sample sizes of offspring is large that actual ratios approach theoretical or expected ratios more closely.

v. (c) b only

Explanation:

Human sperm is haploid; hence they only contain one copy of each gene. Since the man has a bb genotype, his sperm would contain allele b only.

Our Environment 5

Our Environment

Everything that surrounds us is environment. It includes both living (biotic) and non-living (abiotic) components.

Interaction between these biotic and abiotic components form an ecosystem.

In an ecosystem living components depend on each other for their food which give rise to food chains and food webs in nature.

Human activities lead to environmental problems such as depletion of ozone layer and production of huge amount of garbage.

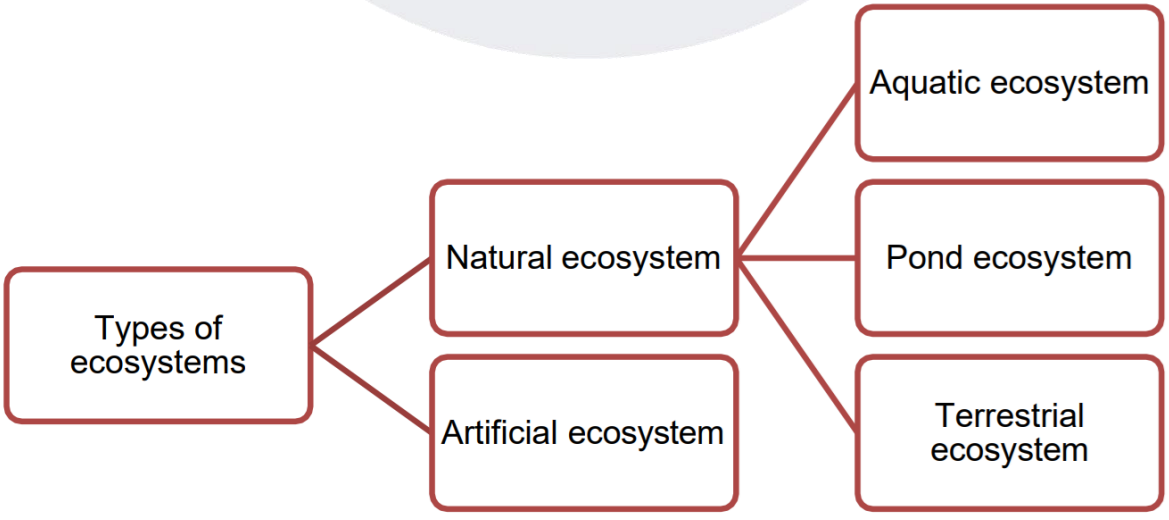
Biodegradable and Non-Biodegradable Wastes

BIODEGRADABLE WASTES	NON-BIODEGRADABLE WASTES
• They can be broken down into non-poisonous substances by the action of microorganisms. • They change their form and structure over time and become harmless. • They do not pollute the environment. • Examples: Spoilt food, vegetable peels, paper, leather etc.	• They cannot be broken down into harmless substances by any biological processes. • They remain unchanged over a long period of time. • They continue to pollute the environment. • Examples: Glass bottles, metal cans, polythene bags, synthetic fibres etc.

Ecosystem

An **ecosystem** is a self-contained area composed of different kinds of organisms which interact with each other as well as with the physical conditions such as sunlight, air, water, soil and climatic factors prevailing in the area.

Types of Ecosystem



Components of an Ecosystem

An ecosystem consists of two main components: biotic components and abiotic components.

Biotic Components The biotic components are the living components of an ecosystem. They constitute the food- obtaining steps or trophic levels of the ecosystem.	
Trophic level I (Green plants/Autotrophs)	• They produce food through the process of photosynthesis. • These include trees, bushes and grasses.
Trophic level II (Herbivores/ Primary consumers)	• They directly eat plants or their products such as leaves, grains, etc. for food or suck plant sap from their leaves or stems. • These include animals such as deer, rabbits, parrots, grasshoppers, bees etc.
Trophic level III (Carnivores/ Secondary consumers)	• They capture their prey and eat it. • These include frogs, lizards, certain birds etc.
Trophic level IV (Large carnivores/ Tertiary consumers)	• They capture smaller carnivores and eat them. • These include peacock, eagle etc.
Parasites	• They live inside or on the body surface of another organism, called the host, and obtain their food or nourishment from the host. • Worms which live in the guts of animals and fleas which live on the skin of animals such as dogs are examples of parasites.
Decomposers/ Microconsumers/ Detritivores	• They breakdown the complex organic compounds present in these dead organisms into simpler substances. • These include certain bacteria and fungi, vultures, kites, crows, some insects etc.
Abiotic Components The abiotic components are the non-living components of an ecosystem.	
Sunlight	• The energy obtained from sunlight is essential for the production of food by photosynthesis.
Air	• Oxygen from the air is essential to animals for respiration. • Carbon dioxide is useful to plants for photosynthesis.
Water	• Water is the chief constituent of protoplasm in cells. • It is required for various biochemical reactions which occur in organisms.
Temperature	• Temperature affects the distribution of living organisms in the environment. • It affects the enzymatic activities in organisms.
Soil	• Soil provides the substratum for the growth of plants. • It contains water and mineral nutrients such as sodium and potassium required by plants.

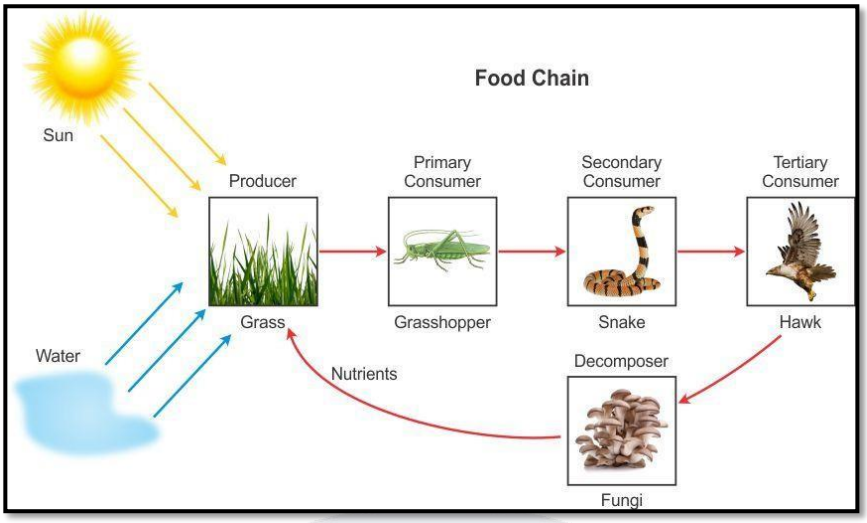
Food Chain

- The sequential process of eating and being eaten is called a **food chain**.
- A food chain represents the unidirectional transfer of energy.

  Food chain is a series of organisms in which one organism eats another organism as food.

  For **example:** Grass → Deer → Lion

  In a food chain various steps where transfer of energy takes place is called a trophic level.



Energy Flow in a Food Chain

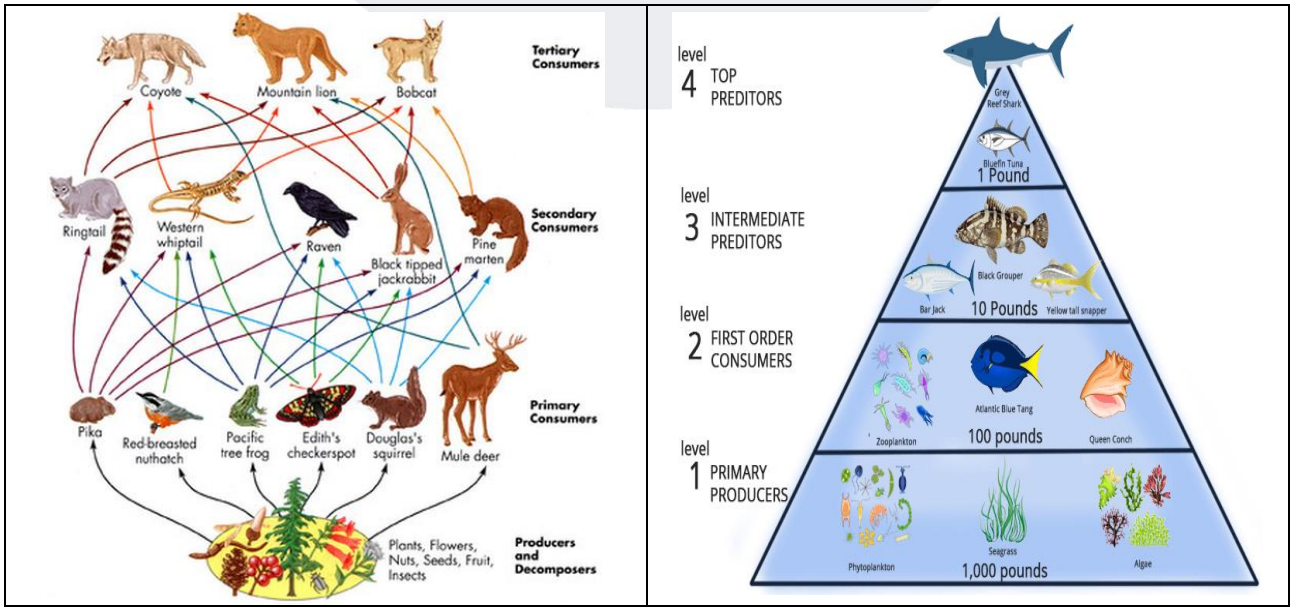
- In a food chain, along with food, transfer of energy also occurs from one trophic level to the other. The flow of energy which occurs along a food chain is called **energy flow**.
- All the energy used by a living organism is obtained from the Sun. Solar energy enters the living components through the autotrophs or green plants. However, only 1% of the total energy is actually captured by green plants.
- The amount of energy gradually declines as one moves up to the next higher trophic level, because at each level, energy is lost in the form of heat.
- The loss of energy in food chains and the transfer of energy from one trophic level to the other can be explained by the **Ten Percent Law** which states that, 'Only 10% of the energy entering a particular trophic level of organisms is available for transfer to the next higher trophic level'.

Significance of Food Chain

- Food chain maintains a check on the population and a balance in the ecosystem.
- Energy in the form of food is continuously transferred between different food chains. This helps to maintain the equilibrium in an ecosystem.
- Food chains help us to understand the interaction and the interdependence of different organisms in an area.

Food Web

A network of interconnecting food chains in a natural community of different organisms is called a **food web**.



Significance of Food Web

- Food webs permit alternative foods.
- They ensure a better chance of survival for an organism if any of its food sources is scarce.

Food Pyramid

- A graphical representation of various trophic levels of a food chain in an ecosystem is called an ecological pyramid or a **food pyramid**.
- Ecological pyramids are of three types:
  - Pyramid of numbers
  - Pyramid of biomass
  - Pyramid of energy

Significance of Food Pyramid

- The trophic levels in a food chain can be explained by a food pyramid.

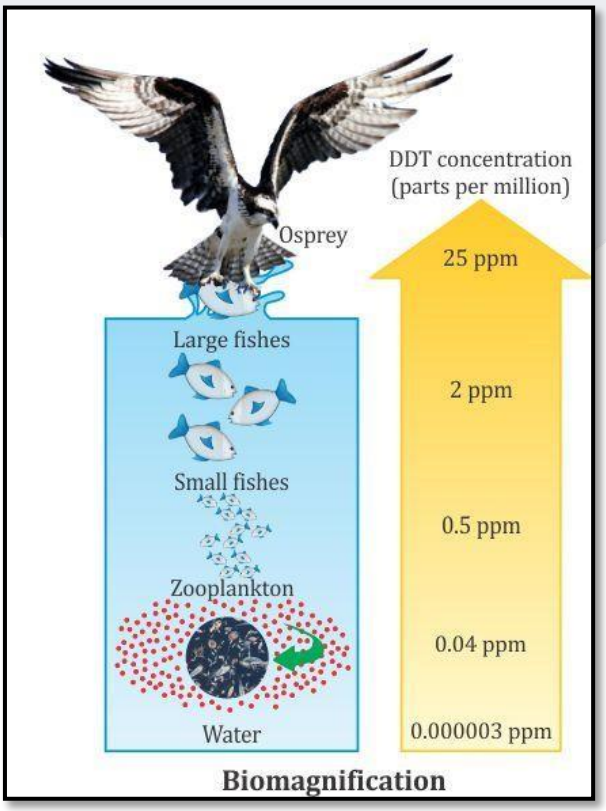
  The ecological pyramids help us to understand the structure, functional diversity and energy conversion efficiency of ecosystems.

Biomagnification

- **Biomagnification** or food chain magnification is the phenomenon of increase in the concentration of toxic substances in the bodies of living organisms at each trophic level of a food chain.
- Dichlorodiphenyltrichloroethane (DDT), an organochlorine pesticide, cannot be removed by washing or by other means and tends to a accumulate in the environment causing biomagnification.

Environmental Problems

Depletion of the Ozone Layer



About the Ozone Layer
• Ozone is a product of ultraviolet radiations acting on the oxygen molecule and splitting it into free oxygen atoms. These atoms combine with molecular oxygen to form ozone. • The ozone layer extends to about 16–50 km above the Earth's surface.
Reasons for Ozone Depletion
• The drop in ozone levels is due to certain synthetic chemicals such as chlorofluorocarbons (CFCs), which are used as refrigerants and in air conditioners and fire extinguishers.
Effects of Ozone Depletion
• In the absence of the ozone layer, the ultraviolet rays reach the Earth's surface. They are highly harmful to organisms and can even cause skin cancer and other diseases in human beings.
Control Measures for Ozone Depletion
• As per the agreement, The United Nations decided to freeze the production of CFCs at levels which existed in 1986.

Disposal of Wastes

Disposal of waste means to get rid of waste.

Recycling
• Solid wastes such as paper, plastic and metals can be sent to paper mills, plastic processing factories and metal industries respectively. • They can be recycled and used again.
Composting
• Household garbage such as fruit and vegetable peels, egg shells, waste food, tea leaves as well as farmland wastes such as dried leaves, husk and parts of crop plants from fields after harvesting can all be converted into useful compost by rotting. • The use of compost improves the fertility of soil as it provides nutrients to the soil.
Incineration
• Hazardous bio-medical wastes such as discarded medicines, toxic drugs, human anatomical wastes, blood and pus, microbiological and biotechnological wastes are usually disposed of by incineration by burning at very high temperatures. • Electricity can be generated from the heat released during burning.
Landfills
• Large-scale disposal of solid waste can be done by putting it in low areas of the ground and then covering it with Earth.
Sewage Treatment
• Waste water or sewage from houses, offices and hospitals enters a channel of pipelines which finally reach the wastewater treatment plant. • Physical, biological and chemical processes are carried out for the treatment of sewage.

Role of an Individual in Management of Wastes

In order to save our environment and maintain ecological balance in nature, the **3R approach** should be implemented while using resources. The 3R's imply reduce, reuse and recycle.

Reduce

- We have to reduce the excess use of resources, when not required, in order to avoid their wastage.

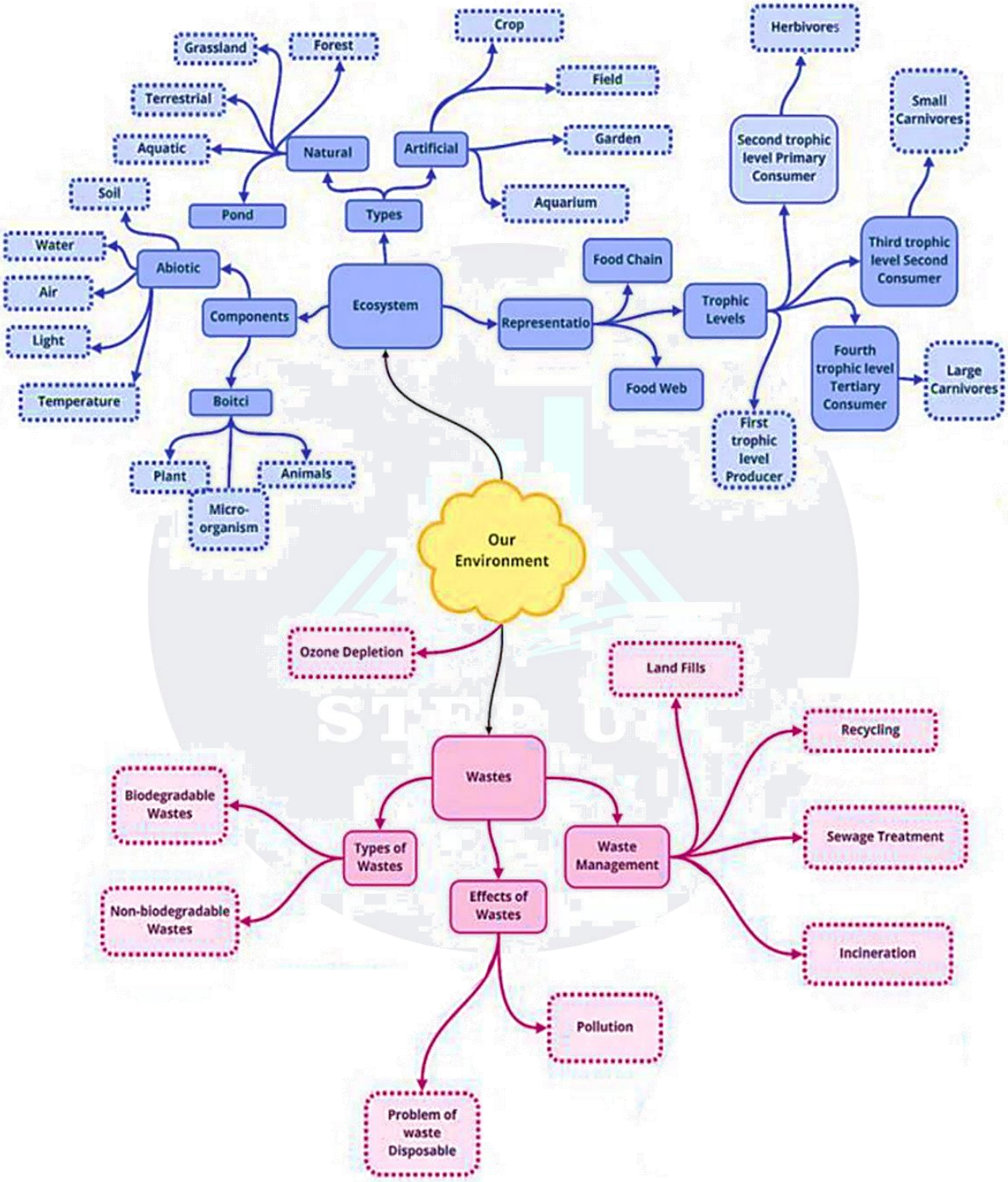
Reuse

- We have to use the same resources again and again so that the demand for new resources is reduced and it will also conserve the resources.

Recycle

- We have to recycle the used resources rather than throwing them away.

Class : 10th Biology
Chapter-15 : Our Environment



Important Questions

Multiple Choice Questions:

1. The percentage of solar radiation absorbed by all the green plants for the process of photosynthesis is about-
   (a) 1%
   (b) 8%
   (c) 5%
   (d) 10%
2. The second trophic level is always of-
   (a) herbivores
   (b) autotrophs
   (c) carnivores
   (c) producers
3. The decomposers in an ecosystem-
   (a) convert organic material to inorganic forms
   (b) convert inorganic material to simpler forms
   (c) convert inorganic material into organic compound
   (d) do not break down organic compound
4. Which of the following is an abiotic component of an ecosystem?
   (a) Humus
   (b) Bacteria
   (c) Plants
   (d) Fungi
5. What will happen if all the deer are killed in the given food chain?

   Grass → Deer → Lion

   (a) The population of grass decreases.
   (b) The population of lions increases.
   (c) The population of lions remains unchanged.
   (d) The population of lions decreases and grass increases.
6. Which of the following is not a terrestrial ecosystem-
   (a) forest
   (b) desert
   (c) aquarium
   (d) grassland
7. In the garden ecosystem, which of the following are producers?
   (a) Insects
   (b) Snakes
   (c) Grasses
   (d) Rabbits
8. Which of the following is biodegradable?
   (a) Plastic mugs
   (b) Leather belts
   (c) Silver foil
   (d) Iron nails
9. Which of the following is an autotroph?
   (a) Lion
   (b) Insect
   (c) Tree
   (d) Mushroom
10. Which of the following is a logical sequence of food chain
    (a) producer → consumer → decomposer
    (b) producer → decomposer → consumer
    (c) consumer → producer → decomposer
    (d) decomposer → producer → consumer

Very Short Question:

1. What is environment?
2. Why is ozone layer getting depleted at higher levels of the atmosphere?
3. Name any two abiotic components of an environment.
4. What are two main components of our environment?
5. Which compounds are responsible for the depletion of ozone layer?
6. Why are green plants called producers?
7. The flow of energy in the food chain is unidirectional. Why?
8. Use of paper is more environment friendly than the use of polythene for packaging. Justify.
9. In a food chain comprising frogs, insects, birds and grass, which one of the organisms is likely to have maximum concentration of harmful non-biodegradable chemicals in the body.

10. State one advantage of using disposable paper cups over disposable plastic cups.

Short Questions:

1. Construct an aquatic chain showing four trophic levels.
2. Explain "biological magnification" with the help of an example.
3. A high concentration of harmful chemical is highly injurious, even fatal to higher trophic level organisms. Mention the basis of classifying substances as biodegradable and non-biodegradable. Give two examples of each.
4. What is ozone? How does it protect the organisms on the earth?
5. Observe the food chain:

   Plant (1000 kj) → Goat → Lion

   (a) If autotrophs occupying the first trophic level are called producers, what are herbivores called as?

   (b) How much energy does the lion get in the above food chain?
6. "The maximum concentration of harmful chemicals accumulates in human beings?" State the phenomenon involved and justify this statement.
7. In the food chain Grass → Deer → Lion operating in a forest, what will happen if all the

   (a) Lions are removed

   (b) Deer are removed.
8. Define

   (a) Biomass

   (b) Anaerobic degradation.

Long Questions:

1. (a) What is ozone? How is it formed in the atmosphere? Explain with equation.

   (b) How is ozone layer useful?

   (c) Name the substances responsible for the depletion of ozone layer.
2. (a) What are trophic levels in a food chain?

   (b) Explain the flow of energy through food chain.

   (c) Write a four trophic level food chain and represented in the form of an ecological pyramid.

Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Hospital wastes like used syringes, urine bags, etc. can be incinerated.

   Reason: Incineration burns the waste at very high temperature and converts it to ashes.
2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true, but R is false.

   d. A is false, but R is true.

   Assertion: Food waste can be converted to compost by burying in a pit dug into ground and used as manure.

   Reason: Non-biodegradable wastes like fruit and vegetable peels, tea leaves, broken glass jar are ideal for composting.

Case Study Questions:

1. Read the following and answer any four questions from: (i) to (v).

   In any given ecosystem, all living organisms are linked in a systematic chain with respect to their mode of manufacturing food/ feeding habits. This sequential interlinking of organisms involving transfer of food energy from producers through a series of organisms with repeated eating and being eaten is called the food chain. A food chain may have 3-4 trophic levels.

   i. Which of the following statements regarding food chain is incorrect?

a. It is a single straight pathway through which food energy travels in the ecosystem.
b. It adds adaptability and competitiveness to the organisms.
c. Presence of isolated food chains adds to instability of the ecosystem.
d. Food chain binds up inorganic nutrients of the ecosystem.

ii. Consider the following food chain.

Grass → A → Frog → Snake → Eagle.

Which of the following can be placed at A?

a. Grasshopper.
b. Rabbit.
c. Phytoplankton.
d. Rat.

iii. Select the correct food chain.

a. Aquatic plants → Tadpole → Water beetle → Pike → Perch.
b. Grass → Grasshopper → Snake → Frog → Eagle.
c. Grass → Rabbit → Wild cat → Tiger.
d. Zooplankton → Phytoplankton → Small fish → Fish.

iv. Food chains are sustained by producers and _____.

a. Herbivores.
b. Carnivores.
c. Omnivores.
d. Decomposers.

v. Select the incorrect statement.

a. Food chain may terminate at level of herbivore.
b. Food chain is always straight.
c. Food chain may have 3-5 trophic levels.
d. in a food chain, 80 to 90% of potential energy is lost as heat, at each transfer.

2. Read the following and answer any four questions from: (i) to (v).

An ecosystem may be defined as a structural and functional unit of the biosphere comprising living organisms and their non-living environment which interact by means of food chains and biogeochemical cycles resulting in energy-flow, biotic diversity and material cycling to form a stable, self-supporting system.

i. The two basic processes involved in an ecosystem are:

a. Cycling of materials and food chains.
b. Energy flow and self-sustainability.
c. Carbon cycle and biotic diversity.
d. Cycling of materials and flow of energy.

ii. Which among the following is not an artificial ecosystem?

a. Orchard.
b. Lake.
c. Aquarium.
d. Cropland.

iii. The role of fungi and bacteria in an ecosystem is to:

a. Increase the supply of nutrients.
b. Increase the supply of energy.
c. Release nutrients from dead organic matter.
d. Increase the amount of CO_2 in the atmosphere.

iv. What would one of the likely results if all decomposers in a particular ecosystem were wiped out?

a. The atmospheric reservoir of carbon dioxide would decline.
b. More food would be available for other consumers in the ecosystem.
c. The other organisms in the ecosystem would experience lower death rates.
d. There would be no significant impact, as dead organic matters would spontaneously decompose.

v. Which of the following holds true for an ecosystem?

a. Primary consumers are least dependent upon producers.
b. Primary consumers most of the time-out number producers.
c. Organic substances such as carbon, nitrogen and oxygen constitute the main abiotic components.
d. Permanent ecosystems are self-supporting natural ecosystems that maintain themselves for relatively long duration.

Answer Key

Multiple Choice Answers:

1. (a) 1%
2. (a) herbivores
3. (a) convert organic material to inorganic forms
4. (a) Humus
5. (d) The population of lions decreases and grass increases.
6. (c) aquarium
7. (c) Grasses
8. (b) Leather belts
9. (c) Tree
10. (a) producer → consumer → decomposer

Very Short Answers:

1. **Answer**: It is sum total of all external factors, substances, conditions and living beings that surround the organisms and influence the same without becoming their part.
2. **Answer**: Presence of ozone depleting chemicals like chlorofluorocarbons.
3. **Answer**:

   (a) Climatic factors (light, temperature, rainfall).

   (b) Edaphic factors (soil and its conditions).
4. **Answer**:

   (a) Biotic Components, e.g., producers, herbivores, carnivores, decomposers.

   (b) Abiotic Components e.g., climatic factors, edaphic factors, topographic factors, inorganic nutrients and organic substances.
5. **Answer**: Ozone depleting substances like chlorofluorocarbons, halons, methane, N2O, Chlorine, Carbon tetrachloride.
6. **Answer**: Green plants are also called producers because only they can synthesize organic food from inorganic raw materials with the help of solar energy in the process of photosynthesis. This food is not only used by green plants but also all other organisms called consumers.
7. **Answer**: There is dissipation of energy at every step of its transfer and transformation so that energy cannot flow back in the reverse direction. It flows from sun to plants, plants to animals, animals to animals, organic remains to decomposers and dissipation as heat at every stage.
8. **Answer**: Paper bags are biodegradable while polythene is nonbiodegradable.
9. **Answer**: Birds, as they form the topmost trophic level where the non-biodegradable chemicals will have maximum biomagnification.
10. **Answer**: Disposable paper cups are biodegradable while disposable plastic cups are non-biodegradable.

Short Answer:

1. **Answer**: Phytoplankton → Zooplankton → Small Carnivorous Fish
2. **Answer**: Biological magnification is increase in the concentration of a chemical per unit weight of the organisms with the successive rise in trophic level. In one study it was found that concentration of harmful chemical like DDT will increase 80,000 times the concentration present in water.

   Water → Plankton → Fish → Fish Eating Birds

   0.002 ppm 0.05 ppm 2.4 ppm 16.0 ppm
3. **Answer**: Substances are classified into biodegradable and non-biodegradable on the basis of their disposability or non-disposability by saprophytic organisms.

   Biodegradable. Used tea leaves, waste paper.

   Non-biodegradable. DDT, silver/ aluminium foil.
4. **Answer**: Ozone is triatomic form of oxygen, O3. It forms a protective ozone layer in the stratosphere. Ozone layer absorbs the very harmful component of ultraviolet radiations (100 – 320 nm) and thus protect the organisms on the earth.
5. **Answer**:

   (a) Primary consumers

   (b) 10 kj (10% law, 1000 → 100 → 10).
6. **Answer**: Human beings are omnivorous and lie at the tip of almost every food chain. They are also long lived. Harmful chemicals reach in higher concentration through biomagnification and continue to accumulate in their bodies. Therefore, non-biodegradable chemicals occur in maximum concentration in human beings.

7. **Answer**:

(a) Removal of Lions. It will cause spurt in population of deer so much so that whole of grass can disappear resulting in conversion of the area into desert and death of the deer as well.

(b) Removal of Deer Lions will die of starvation.

8. **Answer**:

(a) **Biomass.** It is the amount of living matter, measured as fresh or dry weight.

(b) **Anaerobic Degradation.** There is slowing down of rate of decomposition of organic remains which will pile up. Offensive odors may occur due to putrefaction of proteins while fermentation of carbohydrates gives rise to alcohols and organic acids that may kill the microbes. It is, however, useful in production of biogas.

Long Answer:

1. **Answer**:

(a) Ozone is triatomic form of oxygen, O_3. Ozone is formed in the upper atmosphere by the action of ultraviolet (UV) radiations over oxygen (O_2)

$$O_2 \xrightarrow{UV} [O] + [O]$$

$$O_2 + [O]\ O_3$$

(b) The important ozone depleting substances or ODS are chlorofluorocarbons (CFC), methane, N_2O, chlorine, halons and carbon tetrachloride.

2. **Answer**:

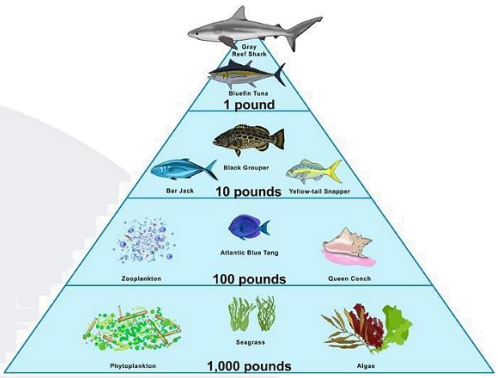
(a) Trophic Levels. They are steps or divisions of food chain which are characterised by particular methods of obtaining food, e.g., producers (T_1), herbivores (T_2), primary carnivores (T_3), etc.

(b) Flow of Energy Through Food Chain. Energy enters a food chain through producers. Producers or green plants trap solar energy and convert it into chemical energy of food during photosynthesis. From producers energy passes into herbivores. A lot of energy dissipates during transfer and utilization of food energy by herbivores (10% law). From herbivores the food energy passes into primary carnivores, again with a lot of dissipation. Only about 10% of herbivore energy is passed into body mass of primary carnivores. From primary carnivores, nearly 10% energy passes into secondary carnivores and so on. It is ultimately lost as heat.

$$\text{Sun} \xrightarrow{100\%} \text{Producers} \xrightarrow{100\%} \text{Herbivores} \xrightarrow{100\%} \text{Primary} \xrightarrow{100\%} \text{carnivores} \xrightarrow{100\%} \text{Secondary carnivores}$$

(c) Aquatic Four Trophic Level Food Chain.

Phytoplankton → Zooplankton → Small Carnivorous Fish → barge Carnivorous Fish.



Assertion Reason Answer:

1. (a) Both A and R are true, and R is correct explanation of the assertion.

Explanation:

Hospital waste contains a lot of germs, so it should not be disposed openly. Burning the waste kills the germs and disposes the waste in proper way.

2. (c) A is true, but R is false.

Explanation:

Biodegradable domestic waste such as leftover food, fruit, and vegetables peels, leaves of potted plants can be converted into compost.

Case Study Answer:

1. i. (b) It adds adaptability and competitiveness to the organisms.

Explanation:

Since a food chain is a sequential flow of food energy, it does not add to the adaptability and competitiveness of the organism.

ii. (a) Grasshopper.

Explanation:

In the given food chain, A is a primary consumer that feeds on grass and being

eaten by frog. Therefore, among the given organisms, A should be grasshopper.

iii. (c) Grass → Rabbit → Wild cat → Tiger.

iv. (d) Decomposers.

v. (a) Food chain may terminate at level of herbivore.

Explanation:

In a food chain, there is repeated eating in which each group eats the smaller one and is eaten by the larger one.

2. i. (d) Cycling of materials and flow of energy.

ii. (b) Lake.

Explanation:

Artificial ecosystems are maintained by man and hence are also termed as man-made, or man engineered ecosystems. In these ecosystems, man maintains/ disturbs the natural balance by the addition of energy and planned manipulations. Common examples of artificial ecosystems are croplands, orchards, gardens, aquarium, etc.

iii. (c) Release nutrients from dead organic matter.

Explanation:

Fungi and bacteria are decomposers which serve to convert carbon locked up in dead organic matter into carbon dioxide, which can then be utilized by plants during photosynthesis. A, B and O are incorrect since decomposers do not increase the amount of nutrients, energy, and carbon dioxide in the ecosystem. They merely allow cycling of nutrients, including carbon, to occur.

iv. (a) The atmospheric reservoir of carbon dioxide would decline.

v. (d) Permanent ecosystems are self-supporting natural ecosystems that maintain themselves for relatively long duration.

Explanation:

Primary or first-order consumers include the animals which eat plants or plant products. They are called herbivores. As the herbivores feed on plants/ plant products and convert them into animal matter, they are often called key industry animals. Inorganic substances, e.g., carbon, nitrogen, oxygen, calcium, phosphorus, etc. and their compounds (water, carbon dioxide, etc.) constitute the main abiotic components. These occur either in the form of compounds dissolved in water, in the soil or in free state in the air.

Management of Natural Resources 6

- Any matter or energy, derived from the environment, which can be used by all living organisms, including man, for their welfare constitute our **natural resources**.
- Forests and wildlife, water, coal and petroleum are some of our important natural resources.
- A system of controlling the use of natural resources in such a way so as to avoid their wastage and allow their use in the most judicial way is called **management of natural resources**.
- We need to manage our resources to ensure that they are used judiciously, to prevent their exploitation for short-term gains, and to make equitable distribution of natural resources and deal with environmental problems.
- **Sustainable development** is development which meets the needs of the present generation as well as preserves the resources for future generations.

Pollution in Ganga

- The river Ganga is used as a sewage dump for more than 100 cities stretching across Uttar Pradesh, Bihar and West Bengal.
- Dumping of untreated sewage, excreta and chemicals from industries increases the toxicity of the water.
- This makes it inhabitable for the flora and fauna in the river system.
- In 1985 the GAP (Ganga Action Plan) project was initialised to curb the poor quality of the water of river Ganges.

The 5 R's to save the environment can be performed by each individual in our society:

Refuse: This means to say No to things people offer you that you don't need. Refuse to buy products that can harm you and the environment, say No to single-use plastic carry bags.

Reduce: This means that you use less. You save electricity by switching off unnecessary lights and fans. You save water by repairing leaky taps. Do not waste food. Can you think of other things that you can reduce the usage of?

Reuse: This is actually even better than recycling because the process of recycling uses some energy. In the 'reuse' strategy, you simply use things again and again. Instead of throwing away used envelopes, you can reverse it and use it again. The plastic bottles in which you buy various food-items like jam or pickle can be used for storing things in the kitchen.

Repurpose: This means when a product can no more be used for the original purpose, think carefully and use it for some other useful purpose. For example, cracked crockery, or cups with broken handles can be used to grow small plants and as feeding vessels for birds.

Recycle: This means that you collect plastic, paper, glass and metal items and recycle these materials to make required things instead of synthesising or extracting fresh plastic, paper, glass or metal. In order to recycle, we first need to segregate our wastes so that the material that can be recycled is not dumped along with other wastes

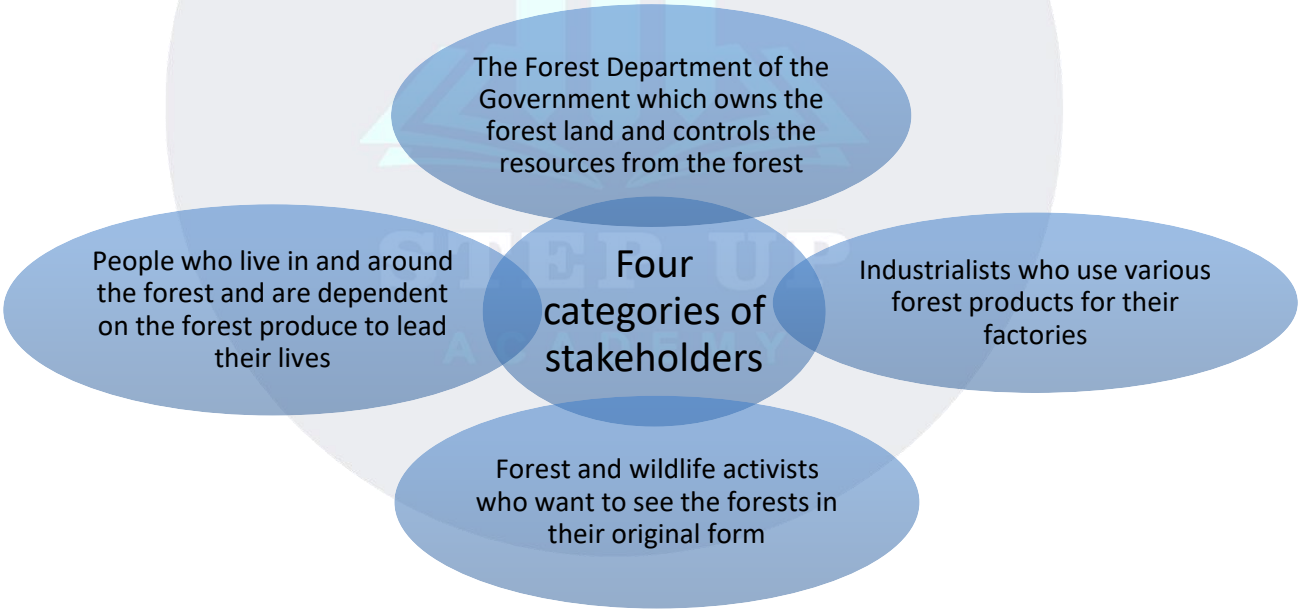
Why Do We Need to Manage Our Resources

- Because the resources available to us are limited and take millions of years to form.
- With the human population increasing at a tremendous rate the demand for resources is also increasing which increases the use of resources.
- Exploiting or reckless use of natural resources causes damage to the environment.
- The management of natural resources should be in a sustainable manner so that these will last for generations to come.
- And should be available to everyone i.e., should be equally distributed to everyone.

Forests and Wildlife

- **Forests** refer to a large piece of land covered with trees, shrubs and herbs growing naturally and sustaining a variety of life forms.
- Uncultivated plants and non-domesticated animals which live in their natural habitat collectively constitute the **wildlife** of an area.
- Naturally occurring plants and animals constitute the **flora** and **fauna** of the forest.
- The main aim of management of forests and wildlife is to conserve the vast inherited biodiversity, because loss of biodiversity leads to loss of ecological stability of the forest ecosystem.

Stakeholders in the Management of Forests



Sustainable Management of Forests

People's participation in the management of forests can help in increasing the forest produce as well as in their conservation.

INSTANCES OF PEOPLE'S PARTICIPATION IN THE MANAGEMENT OF FORESTS
The Case of Khejri trees
• In 1731, Amrita Devi Bishnoi led a group of 363 people who sacrificed their lives for the protection of Khejri trees in Khejrali village near Jodhpur in Rajasthan.

The Chipko Andolan
• The Chipko Andolan also called the 'Hug the trees movement' was organised under the leadership of Sunderlal Bahuguna to stop the destruction of forests. • The movement began in 1970s in a remote village called Reni in Garhwal in the Himalayas.
Revival of Sal forests
• A forest officer, A. K. Banerjee got the villagers involved in protecting 1.272 hectares of badly degraded Sal forests of West Bengal. • In return, the villagers were given employment in silviculture and harvesting operations. • They were also given 25% if the final harvest and were allowed to collect fuel wood and fodder on the payment of a nominal fee.

Conservation of Wildlife

Large-scale poaching of wild animals disturbs the food chains in which these animals occur. This results in undesirable consequences for the entire ecosystem.

Measures to be Taken for the Conservation of Wildlife

- Breeding of wild animals in captivity and then releasing them into their original natural habitat.
- Enacting and enforcing strict laws, action plans and projects started by non-government organisations.
- Ban on hunting and killing of endangered animals.
- Establishment of national parks, wildlife sanctuaries and biosphere reserves.
- Educating the public about the importance of wildlife conservation by observing 'Wildlife Week'.

Water

- Water is an important constituent of the body. Nearly 75% of our body weight is due to the presence of water.
- Rains, rivers, lakes, ponds, wells, tube wells, dams, oceans and glaciers are the important sources of water.

Dams

What are dams?	• The large reservoir of a dam stores a huge amount of water which is allowed to flow downstream at the desired rate. • The Dharoi dam on the river Sabarmati, the Ukai dam on the River Tapi and the Machhu dam on the river Machhu are some famous dams.
Uses of dams	• They regulate the flow of water. • They also ensure the storage of water for irrigation and for generating electricity.

Problems faced in the construction of dams	• Social problems arise because construction of dams causes the displacement of a large number of tribals and peasants who are then rendered homeless. • Construction of dams leads to several environmental problems such as deforestation and loss of biodiversity leading to ecological imbalance. • Economic problems arise because the construction of dams involves spending of large amounts of public money without generating proportionate funds.

Rainwater Harvesting

What is rainwater harvesting?

- Rainwater which falls on roofs and terraces of buildings can be collected through pipes and stored in underground tanks or can be allowed to percolate into the soil and used to recharge the groundwater table. This is called water harvesting or rainwater harvesting.

Advantages of rainwater harvesting

- The main aim of rainwater harvesting is to check the runoff water.
- It also prevents flooding of living areas and streets in cities.
- It can also reduce topsoil loss or soil erosion and improve plant growth.

Method of rainwater harvesting

- In rainwater harvesting, tanks are fitted with motors for lifting water for use.
- Water from the open space around buildings can also be recharged into the ground by simple, effective methods.

Traditional methods of rainwater harvesting

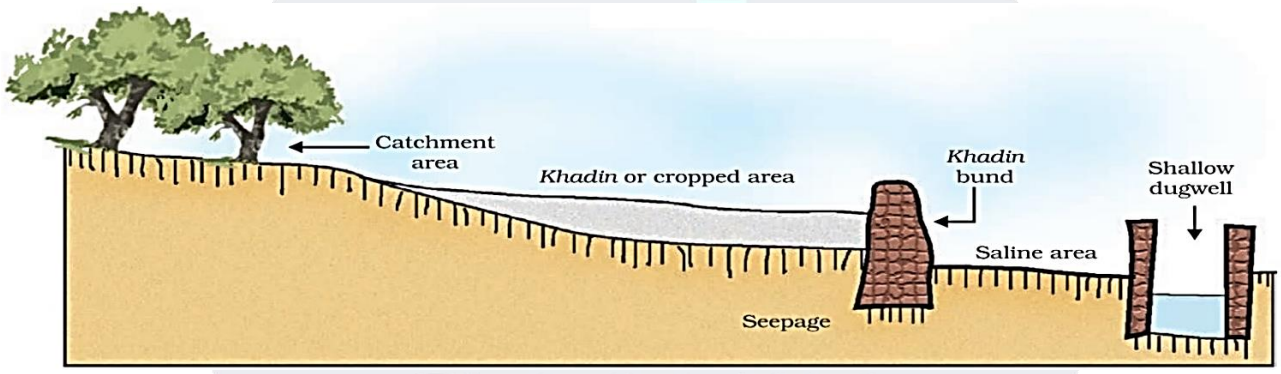
- In traditional methods of rainwater harvesting, water is not only stored but also used to recharge the groundwater.

Region	Traditional water harvesting structures
Rajasthan	Tanks, Khadins, Nadis
Maharashtra	Tals, Bandharas
Bihar	Ahars, Pynes
Uttar Pradesh and Madhya Pradesh	Bundhis
Himachal Pradesh	Kuhls
Kerala	Surangams
Kandi belt of Jammu region	Ponds
Karnataka	Kattas

Bawris

- Bawris or step-wells are wells or ponds constructed in the ground. The water in bawris can be reached by descending a set of steps.
- With acute shortage of water, people began to revive these traditional bawris. As a result, despite scanty rains, these places are managing their water needs well.

Khadin
• Khadin consists of a 100–300-m long embankment called bund made of Earth. • Rainwater from the catchment area flows down the slope and collects in front of the bund forming a reservoir. • Sluiceways or pathways through the bund allow excess water to flow through and collectin shallow wells dug behind the bund. • The water which collects in both the reservoir and the wells seeps into the land and recharges the groundwater. Later, crops can be grown on the water-saturated soil.
Water harvesting structures on the level terrain
• The water harvesting structures on the level terrain are mostly crescent-shaped, earthen embankments or straight, low concrete and rubble check dams. • The main purpose of these water harvesting structures is to recharge the groundwater beneath the surface so as to provide moisture for vegetation. • The water does not evaporate, does not form breeding grounds for mosquitoes and is also protected from human and animal waste.



Taditional water harvesting system — an ideal setting of the Khadin System

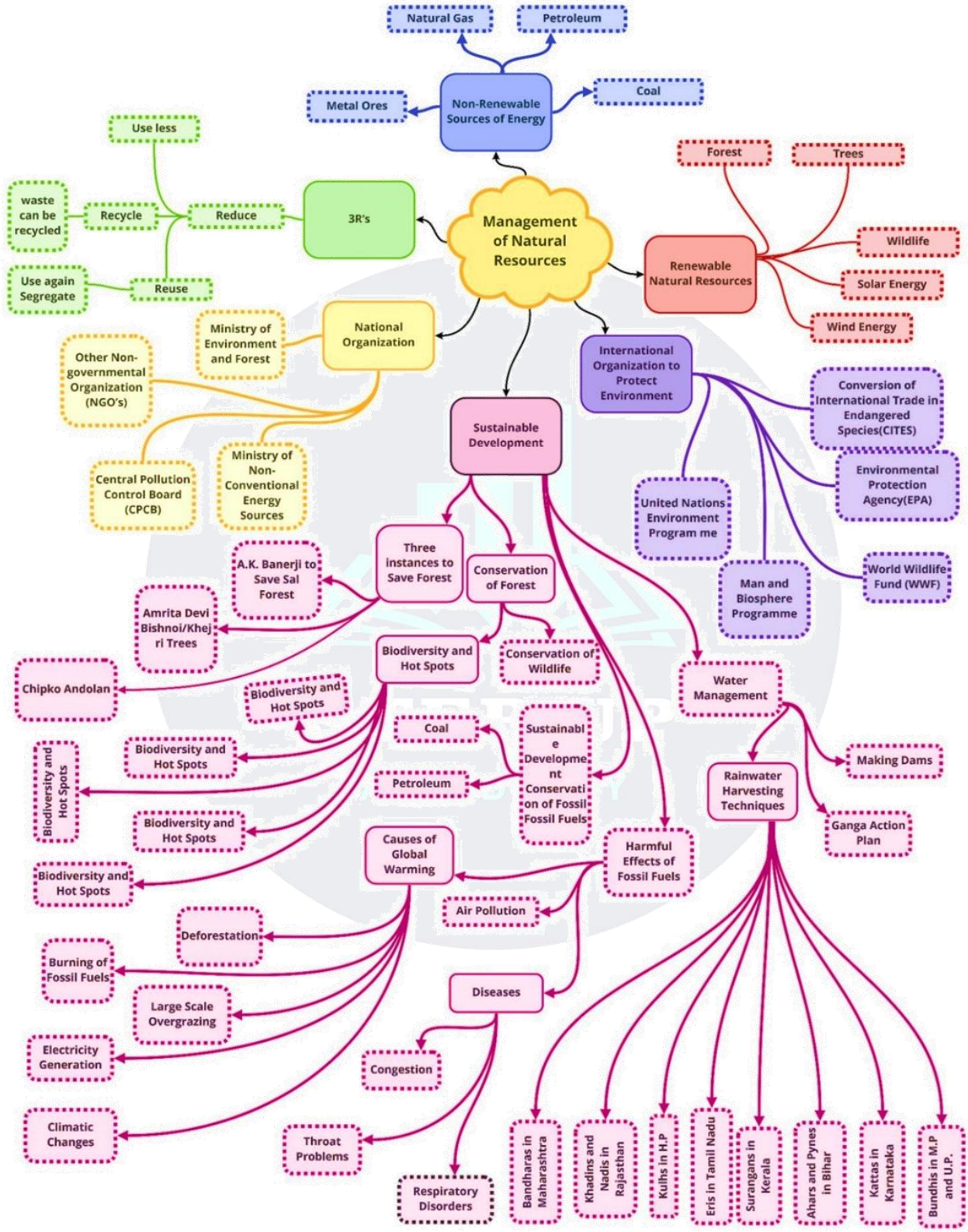
Coal and Petroleum

- Fossil fuels such as coal and petroleum are **non-renewable resources** of energy and exist on the Earth in a limited amount.
- On burning in air, coal produces mainly **carbon dioxide** as well as **oxides of nitrogen and sulphur** as products. Increased quantities of carbon dioxide in the atmosphere can cause climatic changes and lead to global warming.
- Burning of coal in the absence of air produces **carbon monoxide** gas. High concentrations of carbon monoxide and oxides of nitrogen and sulphur are poisonous and pollute the environment.
- **Acid rain** is caused because of sulphur particles present in coal.
- Burning of coal also generates waste products which contain **arsenic**, **mercury**, **uranium**, **thorium** and other heavy metals which are harmful to human health and the environment.
- Burning of coal produces dust nuisance and contaminates land and water.

Alternatives to Reduce the Consumption of Coal and Petroleum

- Switch off electrical appliances when not required.
- Use energy-efficient electrical appliances like CFL.
- Use pressure cookers or solar cookers for cooking food.
- Use of biogas as a domestic fuel should be encouraged.
- Bicycles should be used instead of cars and scooters to travel short distances.

Class : 10th Biology
Chapter-16 : Management of Natural Resources



Important Questions

Multiple Choice Questions:

1. Surangams are the age-old concept of water harvesting in
   (a) Karnataka
   (b) Kerela
   (c) Tamil Nadu
   (d) Andhra Pradesh
2. The quality of environment can be improved by-
   (a) deforestation
   (b) over use of natural environment
   (c) erosion
   (d) conservation
3. Which one of the following is an example of nonrenewable resource?
   (a) Water
   (b) Vegetation
   (c) Wind
   (d) Coal and minerals
4. Which of the following community in Rajasthan has a religious tenet of conservation of forest and wildlife?
   (a) Munda
   (b) Jaiswal
   (c) Bishnoi
   (d) Jain
5. Which of the following is not an use of forest?
   (a) Controls floods.
   (b) Used to make paper.
   (c) Causes soil erosion.
   (d) Resin, gum and drugs are obtained.
6. Which environmental problem is associated with the construction of high rise dams?
   (a) A large number of human settlements are submerged in the water.
   (b) It contributes to deforestation and loss of biodiversity.
   (c) It involves the spending of huge amounts of money.
   (d) All of the above
7. What do you mean by GAP
   (a) Government Action Plan
   (b) Ganga Action Plan
   (c) Government Agency for Pollution Control
   (d) Government Animal Protection Plant
8. Ganga Action plan was started in:
   (a) 1975
   (b) 1985
   (c) 1995
   (d) 2005
9. Which of the following canals brought about greenery in Rajasthan ?
   (a) Rajiv Gandhi Canal
   (b) Indira Gandhi Canal
   (c) Jawaharlal Canal
   (d) Mahatma Gandhi Canal
10. Which of the following is the age-old concept of water harvesting system in Madhya Pradesh?
    (a) Bundhis
    (b) Ponds
    (c) Bandharas
    (d) Nadis

Very Short Question:

1. How is the increase in demand for energy affecting air environment already?
2. Which one of the following is a renewable resource: Natural gas, petroleum, Ground water, coal?
3. Fire wood is our conventional fuel. List any four reasons for replacing it by alternate sources of energy.
4. Which one of the following gases is the major constituent of biogas: CO_2, H_2, CH_4, CO_2?
5. State an instance where human intervention saved the forest from destruction.
6. What is meant by renewable natural resources?
7. Why are coal and petroleum considered to be non-renewable sources of energy?
8. A person lives near a forest. Make a list of four items which he can get from the forest to meet his daily needs.

9. State any one reason for conservation of forests and wildlife.
10. Give two examples to emphasise the concept of REUSE.

Short Questions:

1. Write two advantages of classifying energy sources as renewable and non-renewable.
2. What are fossil fuels? Give two examples of fossil fuels.
3. Why should we conserve forests? Suggest any two ways to conserve forests.
4. List four changes you would incorporate in your lifestyle in a move towards sustainable use of available resources.

   OR

   Every one of us can do something to reduce our consumption of various natural resources. List four such activities based on 3-R approach.
5. State two reasons each of conserving
   (a) Forest
   (b) Wildlife.
6. What are natural resources? State two factors that work against an equitable distribution of these resources.
7. What is water harvesting? Mention any two water harvesting structures.
8. Why must we conserve our forests? List any two causes for deforestation taking place.

Long Questions:

1. The nature and wildlife enthusiasts who do not depend upon forests have considerable say in their management. Initially the conservationists raised their voice for particular animals like tigers, elephants, rhinoceros. They have now recognized the need to preserve biodiversity?
   (a) Explain reason for this change of approach of wildlife enthusiasts.
   (b) State two values that inspire them for this approach.
2. Yamuna River passing through 22Km in Delhi was once described as the life line of the city but today it has become one of the most polluted rivers in the country. According to CPCB, the water quality of Yamuna River falls under the category "E" which makes it fit for only for recreation and industrial cooling. It is completely unfit for underwater life.
   (a) Give two possible causes of water pollution in Yamuna River.
   (b) Suggest any one method by which pollution could be reduced in Yamuna river.
   (c) Mention the values portrayed by you here?

Answer Key

Multiple Choice Answers:

1. (b) Kerela
2. (d) conservation
3. (d) Coal and minerals
4. (c) Bishnoi
5. (c) Causes soil erosion.
6. (d) All of the above
7. (b) Ganga Action Plan
8. (b) 1985
9. (b) Indira Gandhi Canal
10. (a) Bundhis

Very Short Answers:

1. **Answer**: Increased consumption of fossil fuels (coal, petroleum, natural gas) is releasing a lot of polluting gases (CO_2, CO, SO_2, NOx) some of which are causing green house effect and producing acid rain.
2. **Answer**: Ground water.
3. **Answer**:
   It results in deforestation,
   Energy value is small.
   It is bulky,
   It causes more pollution.
4. **Answer**: CH_4 (methane).
5. **Answer**: Silent Valley (Kerala). A dam was proposed to be built up here but opposition from environmentalists and others forced to government to convert it into biosphere reserve.
   Garwal Himalayas (Uttarakhand). 'Chipko

andolan prevented the destruction of forests and saved the environment from deterioration.

Kelase Forests (Karnataka). The felling of trees in the forests was opposed by 'apiko chaluvati' led by Pandurang Hegde

6. **Answer**: Renewable natural resources are those resources of nature which are replenished regularly and are therefore, likely to remain available indefinitely if they are not used beyond their renewability, e.g., forests.
7. **Answer**: Coal and petroleum are considered non-renewable sources of energy as they are not being formed continuously in nature and are, therefore, not replenished. Continuous use will result in their depletion one day.
8. **Answer**:

   Firewood.

   Bamboo and thatch.

   Food articles (edible fruits and nuts).

   Grazing animals and fodder.
9. **Answer**: Forests protect soil, retain and regulate flow of rainwater while wildlife maintains an ecological balance of the area.
10. **Answer**: Reuse saves a lot of resources, e.g., reuse of carry bags, re-use of plastic bottles and jars.

Short Answer:

1. **Answer**:

   A judicious use of non-renewable energy resource so as to prevent its depletion.

   Increasing use of renewable energy source but not beyond its renewability. Stress should be laid on exploitation of inexhaustible sources of energy like solar energy.
2. **Answer**: Fossil fuels are energy yielding combustible substances that have been formed million of years ago by compression and anaerobic heating of organic matter.

   Examples. Coal, Petroleum.
3. **Answer**: We should conserve forests because they not only provide a number of economically important products but also provide shelter to wild animals, protect soil, regulate water flow and climate.

   Forests are conserved through

   - Regular sustained yield block cutting and
   - Separation of commercial forestry (production plantation) from natural forestry.
4. **Answer**:

   - Electricity: Reduce consumption of electricity by switching off unwanted fans and bulbs, changing incandescent bulbs to compact fluorescent lamps.
   - Water: Prevent overflow of water by closing the taps when water is not required. Leaky taps are got repaired immediately.
   - Refills: Use of refills instead of purchasing new packs, e.g., pens.
   - Cloth Bags: Using cloth bags instead of polythene, plastic or paper bags.
5. **Answer**:

   Conservation of Forests:

   - Forest provide a number of economically important products
   - They protect the soil, retain and regulate flow of rain water.

   Conservation of Wildlife:

   - Wildlife is important in maintaining ecological balance of the area,
   - It is gene bank for improvement of domesticated plants and animals.
6. **Answer**:

   Definition: Natural resources are living and non-living components of nature which can be used by humans to meet their requirements.

   Factors Against Equitable Distribution,

   - Unequal availability of resources, abundant at one place and deficient at another place,
   - Excessive use of resources by rich people and struggle for the resource in the area of deficiency by common man.
7. **Answer**:

   Definition. Water harvesting is capturing, collection and storage of rain water and surface run off for filling water bodies and recharging ground water.

   Harvesting Structures

   - Khadin
   - Kattas.

8. **Answer**:

(a) Why Conserve Forests: We should conserve forests because they not only provide a number of economically important products but also provide shelter to wild animals, protect soil, regulate water flow and climate.

(b) Causes of Deforestation:

- Clearing forests for agriculture, roads, canals, human habitation.
- Overgrazing and excessive felling of trees.

Long Answer:

1. **Answer**:

(a) Nature and wildlife enthusiasts are highly educated, well connected and influential persons who are concerned about degradation of environment and depletion of natural resources including forests and wildlife. They were initially concerned about the dwindling population of big animals like tigers, elephants and rhinoceros. The enthusiasts soon realized that ecological balance can be maintained only by preserving the biodiversity of nautre. They have, therefore, started emphasising on creation of protected areas where exploitation is minimal and preservation is maximum.

(b) Love of Nature. Nature in its entirely is a pleasure to watch. It has inspired all our poets, writers and artists besides providing recreation to all others.

- Welfare of Tribals. Tribals have been living in and around forests for centuries. They not only meet their requirements from forests but are also traditionally conservationists with a lot of traditional knowledge of wildlife uses. By conserving biodiversity the welfare of the tribals will also be taken care of.

2. **Answer**:

(a) Causes of Water Pollution:

- Passage of untreated and half treated sewage into river.
- Passage of untreated industrial effluents into it.
- Dumping of garbage, waste water and other materials by people living in slums on the bank of river.

(b) Prevention of Pollution:

- Only properly treated and tested water should be allowed to be passed into river.
- Industrial effluents should not be allowed to flow into river. Every industrial unit must have its own effluent treatment.
- Slums should be shifted away from the banks and parks developed there to prevent future encroachments.

(c) Values:

- Critical thinking
- Problem solving
- Control of pollution
- Love for nature.