PHYSICS

Motion 1

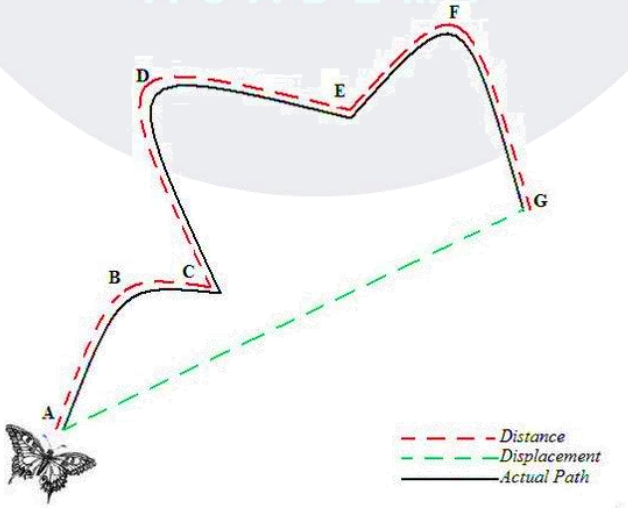
- To describe the position of an object we need a reference point or origin. An object may seem to be moving to one observer and stationary to another.
- **Example:** A passenger inside a bus sees the other passengers to be at rest, whereas an observer outside the bus sees the passengers to be in motion.
- In order to make observations easy, a convention or a common reference point or frame is needed. All objects must be in the same reference frame.

Rest and Motion

- If the position of an object does not change as time passes, then it is said to be at **rest**. If the position of an object changes as time passes, then it is said to be in **motion**.
- An object can be at rest with respect to one thing and in motion with respect to some other thing at the same time. So, the states of **rest and motion are relative** only.
- To locate the position of an object, we have to choose some suitable **reference point** called the **origin**.

Distance and Displacement

- The **distance** travelled by an object is the length of the actual path traversed by the object during motion. It is a **scalar** quantity.
- The **displacement** of an object in motion is the shortest distance between the initial position and the final position of the object. It is a **vector** quantity.



- The distance travelled by an object in motion can never be zero or negative.
- The displacement of an object can be positive, zero or negative. Never can the distance travelled be less than the displacement.
- Both distance and displacement have the same units.

Magnitude

- Magnitude is the size or extent of a physical quantity. In physics, we have scalar and vector quantities.
- Scalar quantities are only expressed as magnitude. E.g.: time, distance, mass, temperature, area, volume
- Vector quantities are expressed in magnitude as well as the direction of the object. E.g: Velocity, displacement, weight, momentum, force, acceleration, etc.

Time and speed

Time is the duration of an event that is expressed in seconds. Most physical phenomena occur with respect to time. It is a scalar quantity.

Speed is the rate of change of distance. If a body covers a certain distance in a certain amount of time, its speed is given by

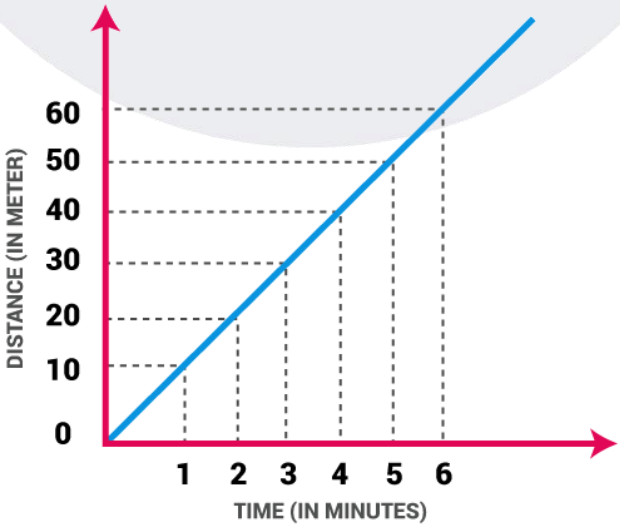
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Uniform and Non-uniform Motion

- An object is said to be in **uniform motion** if it travels equal distances in equal intervals of time, howsoever small the intervals may be.
- An object is said to have **non-uniform motion** if it travels unequal distances in equal intervals oftime.

Uniform Motion:

Definition: This type of motion is defined as the motion of an object in which the object travels in a straight line and its velocity remains constant along that line as it covers equal distances in equal intervals of time, irrespective of the duration of the time.



If a body is involved in rectilinear motion and the motion is consistent, then the acceleration of the body must be zero.

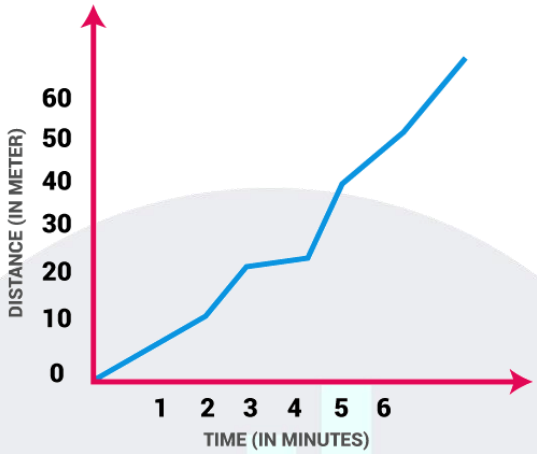
Example of Uniform Motion:

If the speed of a car is 10 m/s, it means that the car covers 10 meters in one second. The speed is constant in every second.

Movement of blades of a ceiling fan.

Non-Uniform Motion:

Definition: This type of motion is defined as the motion of an object in which the object travels with varied speed and it does not cover same distance in equal time intervals, irrespective of the time interval duration.



Speed

Speed of a body is defined as the distance travelled by the body in unit time. The SI unit of speed is **metre/second** (m/s

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

- If 's' is the distance travelled by a body in time 't', then its speed 'v' ' is given as v = s\t
- Speed of a body is a scalar quantity. It can be zero or positive but can never be negative.
- If a body covers equal distances in equal time intervals, howsoever small the intervals may be, then it is said to have uniform speed (or constant speed).
- If a body covers unequal distances in equal time intervals, however small the intervals may be, then it is said to have non-uniform speed (or variable speed).
- For bodies moving with non-uniform speed, we describe the rate of motion in terms of their average speed.

$$\text{Average Speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

Velocity

- **Velocity** of a body is defined as the distance travelled by the body in unit time in a given direction.
- The SI unit of velocity is the same as that of speed, i.e. metre/second (m/s).

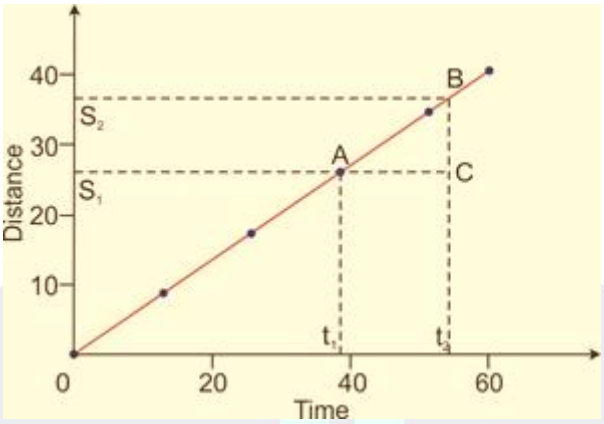
$$\text{Velocity} = \frac{\text{Distance travelled in a given direction}}{\text{Time taken}}$$

or,
$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$$

i.e.
$$\vec{v} = \frac{\vec{s}}{t}$$

where v is velocity and s is displacement of the body in time t.

- Velocity of a body is a **vector** quantity. It can be positive, negative or zero.
- A body is said to be moving with **uniform velocity** (or **constant velocity**) if it travels along a straight line, covering equal distances in equal intervals of time, howsoever small these intervals maybe.
- A body is said to be moving with **non-uniform velocity** (or **variable velocity**) if it covers unequal distances in a particular direction in equal intervals of time or if the direction of motion of the body changes.
- When the velocity of a body is changing at a uniform rate over a period of time, the **average velocity** for that time period is given by the arithmetic mean of the initial and final velocity of the body.



$$\text{Average velocity} = \frac{\text{Intial velocity} + \text{Final velocity}}{2}$$

or

$$\vec{V}av = \frac{u+v}{2}$$

where 'u' is initial velocity, 'v' is final velocity and $\vec{V}av$ is average velocity.

Acceleration

Acceleration of a body is defined as the rate of change of its velocity with time.

$$Acceleration = \frac{Change\ in\ velocity}{Time\ taken}$$

$$= \frac{Final\ velocity - Initial\ velocity}{Time\ taken}$$

where 'u' is initial velocity, 'v' is final velocity, 'a' is acceleration of the body and 't' is time taken for change in velocity.

- Acceleration is a **vector** quantity. It can be positive, negative or zero. The SI unit of acceleration is metre per second square (m/s^2).
- If the velocity of a body increases, then the acceleration is positive. If the velocity of a body decreases, then the acceleration is negative. **Negative acceleration** is called **retardation**.
- If acceleration occurs in the direction of velocity, then it is taken as positive and negative when it is opposite to the direction of velocity.
- A body is said to possess **uniform acceleration** if it travels in a straight line and its velocity increases or decreases by equal amounts in equal intervals oftime.
- A body is said to possess **non-uniform acceleration** if its velocity changes by unequal amounts in equal intervals of time.

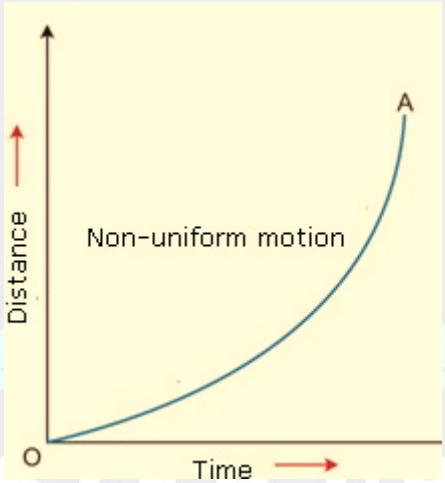
Distance–Time Graph

- Distance-Time graphs show the change in position of an object with respect to time.
- Linear variation = uniform motion and non-linear variations imply non- uniform motion
- The slope gives us speed
- The distance–time graph of a body moving with uniform speed is a straight line.
- Speed of a body can be obtained from the slope of the distance–time graph.
- Let s_1 and s_2 be the distance travelled by the object in time t_1 and t_2, respectively. Here ($s_2 - s_1$) gives the distance travelled by the body in time interval ($t_2 - t_1$).

Speed

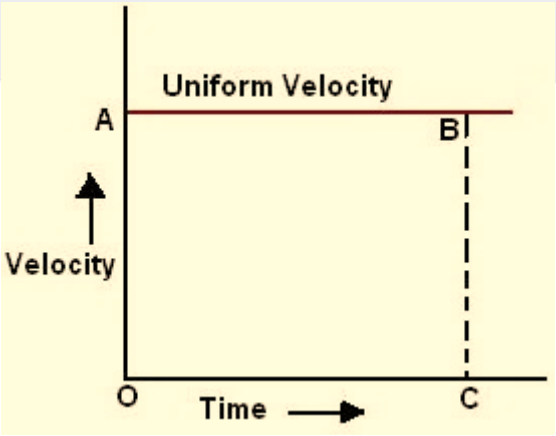
$$v = \frac{s_2 - s_1}{t_2 - t_1}$$

- The distance–time graph of a body moving with non-uniform speed is a curved line with a variable slope indicating variable speed.



Velocity–Time Graph

- The velocity–time graph of a body moving with uniform velocity is a straight line parallel to the time axis.



- The magnitude of displacement or distance travelled by the body is equal to the area enclosed by the velocity–time graph and time axis.

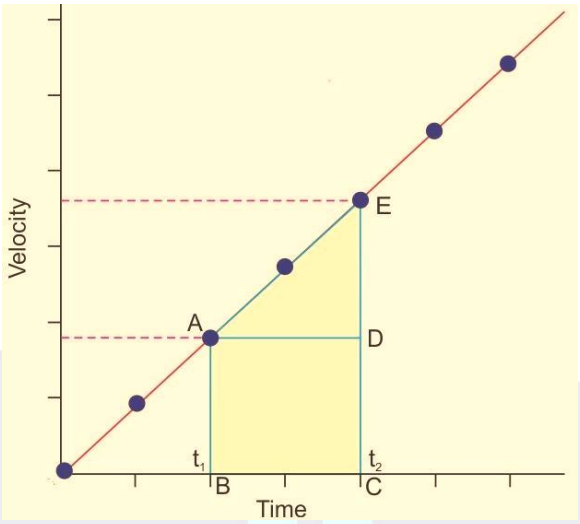
Distance travelled = Speed × Time taken

= OA × OC

= Area of rectangle OABC

- The velocity–time graph of a body moving with uniform acceleration is a straight line inclined to the time axis.
- The slope of the velocity–time graph represents the acceleration of the body.

$$= \frac{Change\ in\ speed}{Time\ taken} = \frac{ED}{AD}$$



$$Acceleration = \frac{Change\ in\ velocity}{Time\ taken} = \frac{ED}{AD}$$

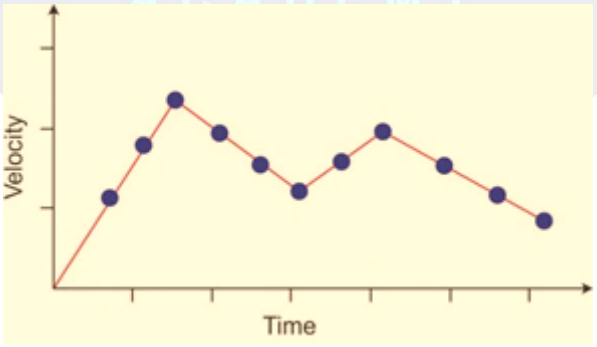
The area enclosed by the velocity–time graph and time axis gives the distance travelled by the body.

Distance travelled = Area of ABCDE

= Area of triangle ADE+ Area of rectangle ABCD

$$= \frac{1}{2} \times AD \times DE + AB \times BC$$

- The velocity–time graph of a body moving with non-uniform acceleration can have any shape, indicating variable speed.



Application Of Distance - Time Graph

What is a Distance-Time Graph

A distance-time graph shows how far an object has travelled in a given time. It is a simple line graph that denotes distance versus time findings on the graph.

Distance is plotted on the Y-axis.

Time is plotted on the X-axis.

Note: Curved lines on a distance-time graph indicate that the speed is changing.

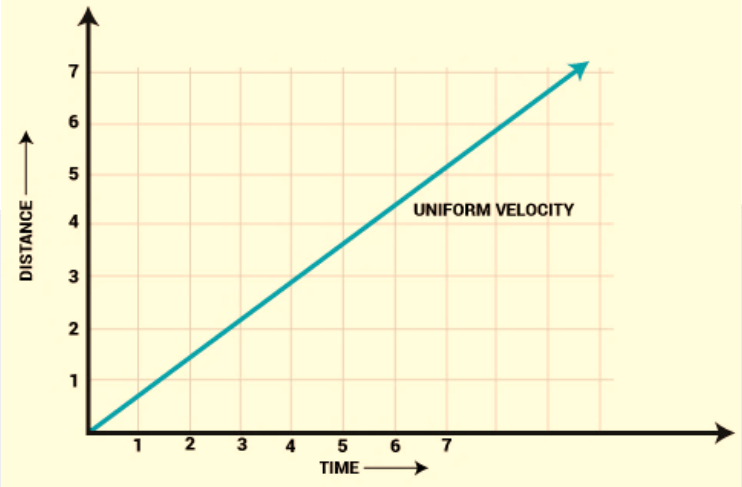
Importance of Distance-Time Graph

We deal with the distance-time graph while studying the motion of bodies. If we record distance and time for the motion of a body and plot the same data on a rectangular graph, we will obtain a distance-time graph corresponding to the motion of that body.

Example:

For better understanding, let us consider an example of uniform motion. A bus driver drives at a constant speed which is indicated by the speedometer and the driver measures the time taken by the bus for every kilometre. The driver notices that the bus travels 1 kilometre in every 2 minutes.

DISTANCE (IN KM)	1	2	3	4	5	6	7
TIME (IN MIN)	2	4	6	8	10	12	14

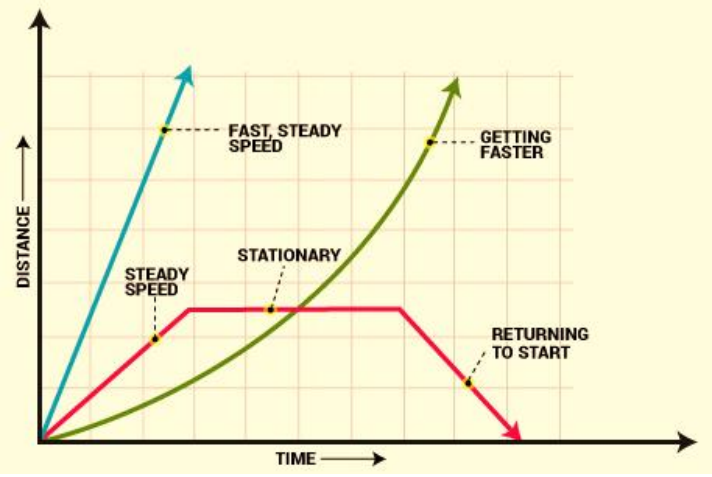


By this table, he had a clear idea about the speed which is: ½ × 60 = 30 km/hr.

The graph is a straight line and the motion of the bus is also uniform. Also, from the graph, we can find the speed of the bus at any instant of time. The initial and final position of the car can be found as the following:

Speed = (Final Position-Initial position)/Time

The slope of the line can be found by drawing a rectangle anywhere near the straight line which determines the speed of the bus. If an object is not moving, the distance-time graph results in a horizontal line which shows that the object is at rest.



The following things can be concluded now:

If the distance-time graph is a straight line then the motion is uniform.

If the distance-time graph of anybody is given, its speed can be calculated using the slope of the graph.

The slope of the straight-line graph is the same irrespective of the interval which is chosen. This implies that the speed of an object under uniform motion remains constant.

Equations of Motion

- The three equations of motion of a body moving along a straight line with uniform acceleration are

$v = u + at$

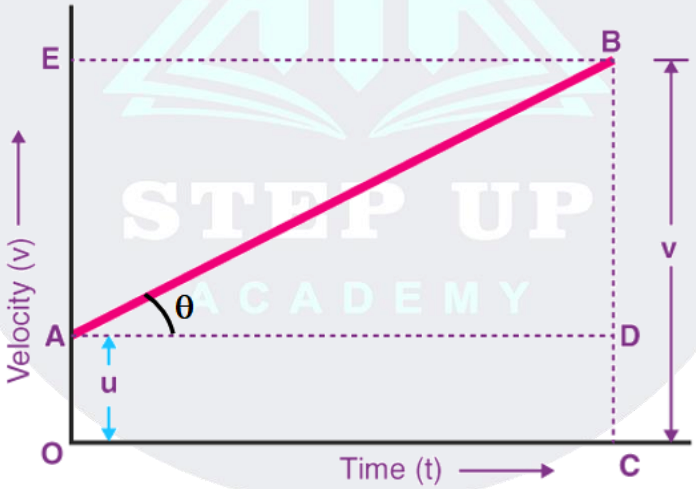
$s = ut + (1/2)\, at^2$

$v^2 - u^2 = 2as$

where 'u' is initial velocity of the body which moves with uniform acceleration 'a' for time t, 'v' is final velocity and 's' is distance travelled by the body in time t.

Equation of motion

In this article, we will learn how we can relate quantities like velocity, time, acceleration and displacement provided the acceleration remains constant. These relations are collectively known as the equation of motion. There are three equations of motion. There are three ways to derive the equation of motion and here we are going to derive with the help of graph.



First Equation of Motion

First equation of motion relates velocity, time and acceleration. Now in Δuxy,

$$\tan\theta = \frac{xy}{uy}$$

$$\tan\theta = \frac{v-u}{t}$$

We also know that tanθ is nothing but the slope and slope of v – t graph represents acceleration.

⇒ v = u + at ———– (1)

This is the first equation of motion where,

v = final velocity

u = initial velocity

a = acceleration

t = time taken

Second Equation of Motion

Now coming to the second equation of motion, it relates displacement, velocity, acceleration and time. The area under v – t graph represents the displacement of the body.

In this case,

Displacement = Area of the trapezium (ouxt)

$$S = \frac{1}{2}$$

x sum of parallel sides x height

$$S = \frac{1}{2}$$

$$x\ (v + u)\ x\ t \text{ ———- } (2)$$

We can substitute v in terms of others and get the final equation as:

$$S = ut + \frac{1}{2}\ at^2$$

Where symbols have their usual meaning.

Third Equation of Motion

The third equation of motion relates to velocity, displacement, and acceleration. Using the same equation (2),

$$S = \frac{1}{2} x\ (v + u)\ x\ t$$

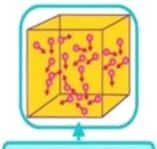
Using equation (1) if we replace t we get,

$$S = \frac{1}{2} \times (v + u) \times \frac{(v-u)}{a}\ S = \frac{v^2-u^2}{2a}\ u^2 = u^2 + 2as$$

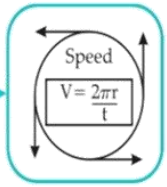
Uniform Circular Motion

- When a body moves along a circular path with a uniform speed, its motion is called uniform circular motion.
- Examples: Motion of the Moon around the Earth, a cyclist moving in a circular track at constant speed
- In uniform circular motion, although the speed remains constant, the direction of motion and velocity change continuously. Thus, uniform circular motion is an accelerated motion.
- The external force needed to make a body travel in a circular path is known as centripetal force.
- The circumference of a circle of radius 'r' is given by $2\pi r$. If a body takes 't' seconds to go once round the circular path of radius 'r', then its velocity 'v' is given by $\frac{2\pi r}{t}$

Class : 9th Science
Chapter- 8 : Motion

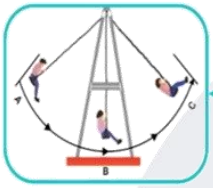


Random Motion



Uniform Circular Motion

Rotational Motion



Oscillatory Motion

Uniform Motion → Equal distance in equal intervals of time

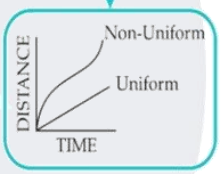
Rectilinear

Curvilinear

Circular

Translation Motion

Non-uniform Motion



Types of Motion

Equation of Motion

Rate of motion

Motion

$v^2 - u^2 = 2as$

$s = ut + \frac{1}{2}at^2$

$v = u + at$

$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$

$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time Taken}}$

Important Questions

Multiple Choice Questions:

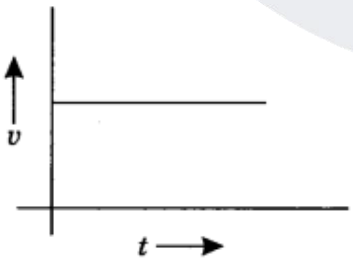
1. A particle is moving in a circular path of radius r. The displacement after half a circle would be:
   (a) Zero
   (b) πr
   (c) 2r
   (d) 2πr

2. A body is thrown vertically upward with velocity u, the greatest height h to which it will rise is,
   (a) u/g = h
   (b) $u^2/2g = h$
   (c) $u^2/g = h$
   (d) u/2g = h

3. The numerical ratio of displacement to distance for a moving object is
   (a) always less than 1
   (b) always equal to 1
   (c) always more than 1
   (d) equal or less than 1

4. If the displacement of an object is proportional to square of time, then the object moves with
   (a) uniform velocity
   (b) uniform acceleration
   (c) increasing acceleration
   (d) decreasing acceleration

5. From the given υ – t graph, it can be inferred that the object is

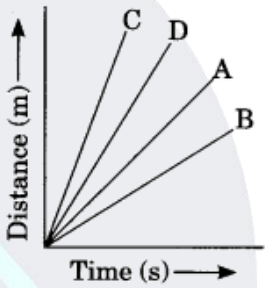


   (a) in uniform motion
   (b) at rest
   (c) in non-uniform motion
   (d) moving with uniform acceleration

6. Suppose a boy is enjoying a ride on a merry-go-round which is moving with a constant speed of 10 ms^{-1} It implies that the boy is
   (a) at rest
   (b) moving with no acceleration
   (c) in accelerated motion
   (d) moving with uniform velocity

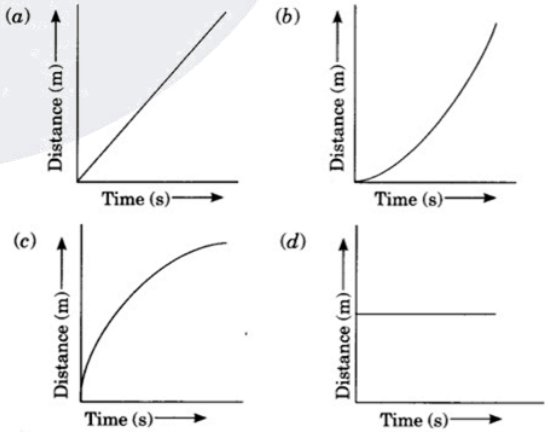
7. Area under a V–I graph represents a physical quantity which has the unit
   (a) m^2
   (b) m
   (c) m^3
   (d) ms^{-1}

8. Four cars A, B, C and D are moving on a levelled road. Their distance versus time graphs are shown in the adjacent figure. Choose the correct statement.



   (a) Car A is faster than car D.
   (b) Car B is the slowest.
   (c) Car D is faster than car C.
   (d) Car C is the slowest.

9. Which of the following figures correctly represents uniform motion of a moving object?

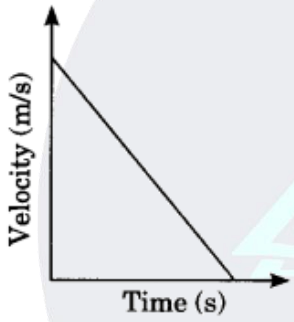


10. Slope of a velocity-time graph gives
    (a) the distance
    (b) the displacement
    (c) the acceleration
    (d) the speed

11. In which of the following cases of motions, the distance moved and the magnitude of displacement are equal?
    (a) If the car is moving on a straight road
    (b) If the car is moving in Circular path
    (c) The pendulum is moving to and from
    (d) The earth is revolving around the sun.

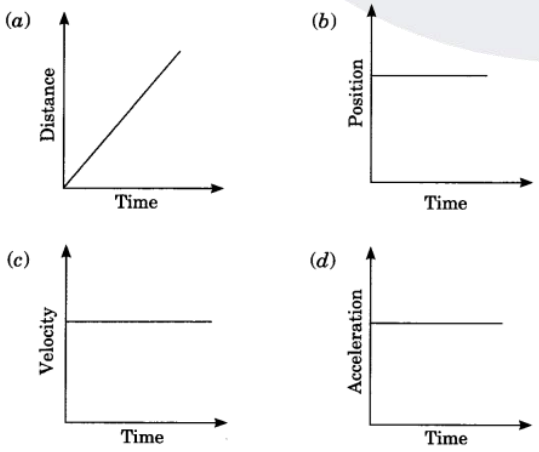
12. A boy goes from A to B with a velocity of 20 m/min and comes back from B to A with a velocity of 30 m/min. The average velocity of the boy during the whole journey is
    (a) 24 m/min
    (b) 25 m/s
    (c) Zero
    (d) 20 m/min

13. Velocity-time graph of an object is given below. The object has



    (a) Uniform velocity
    (b) Uniform speed
    (c) Uniform retardation
    (d) Variable acceleration

14. Which one of the following graphs shows the object to be stationary?



15. A body is projected vertically upward from the ground. Taking vertical upward direction as positive and point of projection as origin, the sign of displacement of the body from the origin when it is at height h during upward and downward journey will be:
    (a) Positive, positive
    (b) Positive, negative
    (c) Negative, negative
    (d) Negative, positive

Very Short Question:

1. An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.
2. What do you mean by a body in rest?
3. Are motion and rest absolute or relative? Explain with an example.
4. What is meant by scalars and vectors?
5. A farmer moves along the boundary of a square field of side 10 m in 40 s. What will be the magnitude of displacement of the farmer at the end of 2 minutes 20 seconds?
6. Which of the following is true for displacement?
    (a) It cannot be zero.
    (b) Its magnitude is greater than the distance travelled by the object.
7. What does the odometer of an automobile measure?
8. Distinguish between speed and velocity.
9. Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?
10. What does the path of an object look like when it is in uniform motion?

Short Questions:

1. Distinguish between distance and displacement.
2. Write down the SI unit of the following quantities:
    (a) Displacement
    (b) Speed
    (c) Velocity
    (d) Acceleration
3. Distinguish between uniform motion and non-uniform motion.

4. Distinguish speed at any instant and average speed.
5. Draw a velocity versus time graph of a stone thrown vertically upwards and then coming downwards after attaining the maximum height.
6. What is uniform circular motion? How is uniform circular motion regarded as an acceleration motion? Explain.
7. A person travels a distance of 4.0 m towards the east, then turns left and travels 3.0 m towards the north.
8. A person travels on a semi-circular track of radius 50 m during a morning walk. If he starts from one end of the track and reaches the other end, calculates the distance traveled and displacement of the person.

Long Questions:

1. Derive an expression for three equations of motion for uniform accelerated motion graphically.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: An object may acquire acceleration even if it is moving at a constant speed.

   Reason: With change in the direction of motion, an object can acquire acceleration.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Displacement of an object may be zero even if the distance covered by it is not zero.

   Reason: Displacement is the shortest distance between the initial and final position.

Case Study Based Question:

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

   One day Rahul decided to go his office by his car. He is enjoying the driving along with listening the old songs. His car is moving along a straight road at a steady speed. On a particular moment, he notices that the car travels 150 m in 5 seconds.

   (i) What is its average speed?
   (a) 20 m/s
   (b) 30 m/s
   (c) 10 m/s
   (d) 40 m/s

   (ii) How far does it travel in 1 second?
   (a) 20 m
   (b) 30 m
   (c) 10 m
   (d) 40 m

   (iii) How far does it travel in 6 seconds?
   (a) 120 m
   (b) 130 m
   (c) 180 m
   (d) 140 m

   (iv) How long does it take to travel 240 m?
   (a) 2s
   (b) 4s
   (c) 6s
   (d) 8s

(v) Which of the following statement is correct regarding velocity and speed of a moving body?

(a) velocity of a moving body is always higher than its speed

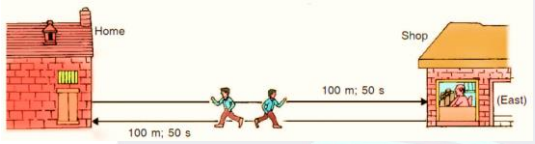
(b) speed of a moving body is always higher than its velocity

(c) speed of a moving body is its velocity in a given direction

(d) velocity of a moving body is its speed in a given direction

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

Suppose the boy first runs a distance of 100 metres in 50 seconds in going from his home to the shop in the East direction, and then runs a distance of 100 metres again in 50 seconds in the reverse direction from the shop to reach back home from where he started (see Figure 21).



(i) Find the speed of the boy.

(a) 1 m/s

(b) 2 m/s

(c) 3 m/s

(d) none of these

(ii) Find the Velocity of the boy.

(a) 1 m/s

(b) 2 m/s

(c) 3 m/s

(d) 0 m/s

(iii) A boy is sitting on a merry-go-round which is moving with a constant speed of 10m/s. This means that the boy is:

(a) at rest

(b) moving with no acceleration

(c) in accelerated motion

(d) moving with uniform velocity

(iv) In which of the following cases of motion, the distance moved and the magnitude of displacement are equal?

(a) if the car is moving on straight road

(b) if the car is moving on circular road

(c) if the pendulum is moving to and from

(d) if a planet is moving around the sun

(v) A particle is moving in a circular path of radius r. The displacement after half a circle would be:

(a) 0

(b) πr

(c) 2r

(d) 2πr

Answer Key

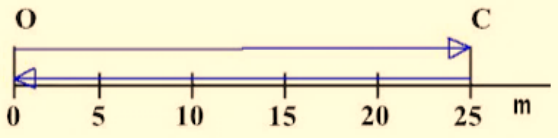
Multiple Choice Answers:

1. (c) 2r
2. (b) u^2l2g
3. (d) equal or less than 1
4. (b) uniform acceleration
5. (a) in uniform motion
6. (c) in accelerated motion
7. (b) m
8. (b) Car B is the slowest.
9. (a)
10. (c) the acceleration
11. (a) If the car is moving on a straight road
12. (a) 24 m/min
13. (c) Uniform retardation
14. (b)
15. (a) Positive, positive

Very Short Answers:

1. **Answer:** Yes an object can have zero displacement even though it has moved through a distance. It happens when the object moves

back to its original position i.e. final position coincides with the starting position.



Example: Suppose an object travels from O to C and then comes back to original position O.

Total distance traveled = actual path covered = OC + CO = 25 + 25 = 50m

Total displacement = shortest distance between final position and initial position = 0m

2. **Answer:** A body is said to be at rest, if it does not change its position with respect to a fixed point in its surroundings.

3. **Answer:** No these terms rest and motion are relative. For example, a person inside a car, carrying a ball in his hand will see the ball is at rest. While for another person, outside the car will see the ball is also moving.

4. **Answer:**

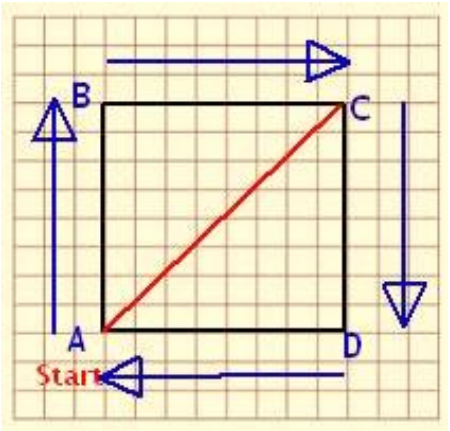
Scalar Quantities: Quantities that require magnitudes only to specify them are called scalar quantities or scalars. Mass, length, time, temperature, angle, area, speed, distance, volume and density are examples of scalar quantities.

Vector Quantities: Quantities that require both magnitudes and direction to specify them are called vector quantities or vectors. Displacement, velocity, force, momentum, weight etc. are the examples of vectors.

5. **Answer:** As shown in figure, let us assume, the farmer starts from A.

Given, length of each side = 10m

Distance covered in 1 lap = Perimeter of ABCD = 4 x 10 = 40m



Time taken by farmer to cover 1 lap = 40s

Speed of farmer = Distance ÷ Time Taken for one lap = 40/40s = 1m/s

Distance covered by farmer in 2min 20 secs = Speed x Time = 1 x 140s = 140m

Number of laps covered = 140 ÷ 40 = 3.5 laps.

⇒ After 140s, the farmer will be at position C (i.e. 3 and ½ laps).

Displacement = AC = (AB2 + BC2)½

(applying Pythagoras theorem)

= (100+100)½ = 10√2 = 10 x 1.414 = 14.14m

Note: Displacement is a vector quantity that measures the shortest distance (straight line) between the starting point and ending point, not taking the actual path traveled into account.

6. **Answer:**

(a) False. Displacement can be zero. (See Q1).

(b) False. Displacement is less than or equal to the distance travelled by the object.

7. **Answer:** Odometer is used to measure the distance covered by the automobile. It also tells the instant speed of the vehicle. It can be mechanical or electronic or electro-mechanical.

8. **Answer:**

Speed	Velocity
It is distance traveled by an object per unit time.	It is the displacement covered by an object per unit of time.
Speed = distance ÷ time	Velocity = displacement ÷ time
It is scalar quantity i.e. it has magnitude only.	It is vector quantity i.e. has both magnitude and direction.

9. **Answer:** When a body is in rectilinear motion i.e. moves in straight line, the magnitude of average velocity of an object is equal to its average speed.

10. **Answer:** When an object is in uniform motion, it means its speed is constant. Or it travels equal distance in equal intervals of time. The path may be a straight line or curved or zig-zag. Its direction may also vary but the magnitude is fixed.

Short Answers:

1. **Answer:**

Distance:

- It is the actual length of the path covered by a moving body.
- It is always positive or zero.
- It is a scalar quantity.

Displacement:

- It is the shortest distance measured between the initial and final positions.
- It may be positive, negative, or zero.
- it is a vector quantity.

2. **Answer:**

(a) m

(b) m/s

(c) m/s

(d) m/s^2

3. **Answer:**

Uniform motion: A body moving in a straight line has a uniform motion if it travels the equal distance in equal intervals of time

Non-uniform motion: A body has a non-uniform motion if it travels the unequal distance in equal intervals of time

4. **Answer:**

1. **Instantaneous speed:**

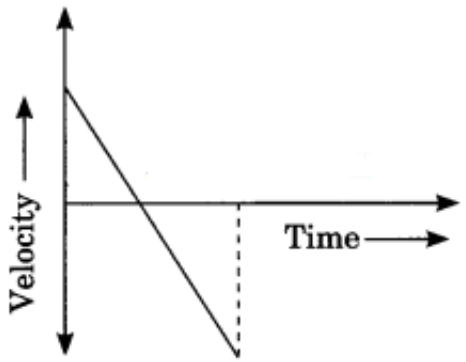
The speed at any particular instant is known as instantaneous speed.

2. **Average speed:**

Average speed is the ratio of total distance traveled by a body and time taken to travel that distance.

5. **Answer:**

velocity-time graph



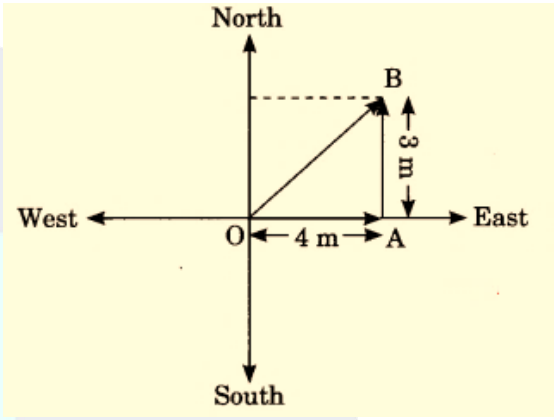
6. **Answer:** When an object is moving in a circular path with a constant speed, the motion of an object is said to be uniform circular motion. When a body has a uniform circular motion, its velocity changes due to the continuous change in the direction of its motion. Hence, the motion of the body is accelerated motion.

7. **Answer:**

1. Total distance = OA + AB

= 4m + 3m

Total distance = 7m



2. Total displacement = OB = $\sqrt{(OA)^2+(AB)^2}$

$=\sqrt{(4)^2+(3)^2}=\sqrt{25}=5$

Displacement = 5m

8. **Answer:**

Let the person start moving from A and reach B via O.

The distance travelled by the person

= Length of track = πr

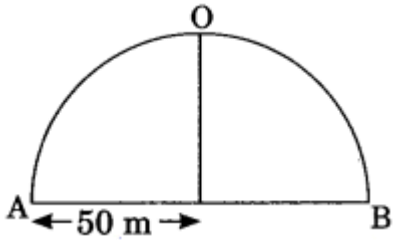
= 227 x 50 m = 157.14m

Distance = 157.14 m

The displacement is equal to the diameter of the semi-circular track joining A to B via O.

= 2r = 2 x 50 m = 100m

∴ Displacement = 100 m

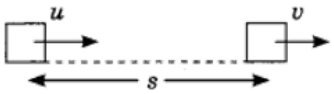


Long Answers:

1. Answer:

Equation of motion by graphical method

Let us consider a body is moving with acceleration where u is initial velocity and u is final velocity, s is the displacement of object and t is a time interval.



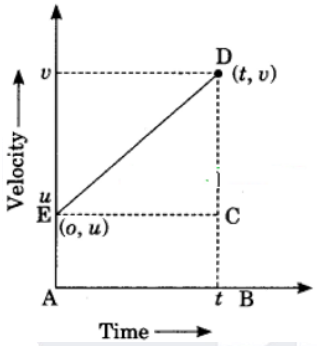
1. $\upsilon = u + at$

We know that slope of υ – t graph gives acceleration so slope

$$= a = \frac{\upsilon - u}{t - 0}$$

$$a = \frac{\upsilon - u}{t}$$

$$\therefore \upsilon = u + at$$



2. $s = ut + \frac{1}{2}at^2$

We know that area under u – t graph gives the displacement.

Area = s = area of triangle CDE + area of rectangle ABCE

$$s = ut + \frac{1}{2} \times t \times (\upsilon - u = at)$$

Putting the value of υ – u

$$s = ut + \frac{1}{2}at^2$$

3. $\upsilon^2 - u^2 = 2as$

We know that are under υ – t graph give displacement

Area = s = area of trapezium ABDE

$$s = \frac{1}{2} \times (\upsilon - u) \times t \text{ From I} \left(t = \frac{\upsilon - u}{a} \right)$$

Putting the value of t.

$\upsilon^2 - u^2 = 2as$

Assertion Reason Answer:

1. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

Case Study Answer:

1. Answer:

(i) (b) 30 m/s

Solution:

Average speed = total distance travelled/total time taken

= 150/5

= 30 m/s

(ii) (b) 30 m

Solution:

Time = 1 s

Distance = (average speed)(time)

= 30 m/s x 1s

= 30 m

(iii) (c) 180 m

Solution:

Time = 6 s

Distance = (average speed)(time)

= 30 m/s x 6s

= 180m

(iv) (d) 8s

Solution:

Distance = 240m

Time = Distance/average speed

= 240/30

= 8s

(v) (d) velocity of a moving body is its speed in a given direction.

2. Answer:

(i) (b) 2 m/s

Solution:

Total distance travelled is 100 m + 100 m = 200 m and

The total time taken is 50 s + 50 s = 100 s.

$$\text{Speed of boy} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$$= \frac{200\,m}{100\,s} = 2\,m/s$$

(ii) (d) 0 m/s

Solution:

The boy runs 100 m towards East and then 100 m towards West and reaches at the starting point, his home. So, the displacement will be 100 m – 100 m = 0 m.

The total time taken is 50 s + 50 s = 100 s.

$$\text{Velocity of boy} = \frac{\text{Displacement}}{\text{Time taken}}$$

$$= \frac{0\,m}{100\,s} = 0\,m/s$$

(iii) (c) in accelerated motion

(iv) (a) if the car is moving on straight road

(v) (c) 2r

Force and Laws of Motion 2

- While studying kinematics, we have already studied about the position, distance and displacement, and acceleration of a moving particle.
- Here in this chapter, we would take our understanding one step further to learn about origins of acceleration or force.
- Here we will specifically consider the cause behind the moving objects i.e. what causes the objects to move.
- Thus, we will learn the theory of motion based on the ideas of mass and force and the laws connecting these physical concepts to the kinematics quantities.
- Concept of force is central to all of physics whether it is classical physics, nuclear physics, quantum physics or any other form of physics
- So, what is force? When we push or pull anybody, we are said to exert force on the body
- Push or pull applied on a body does not exactly define the force in general. We can define force as an influence causing a body at rest or moving with constant velocity to undergo acceleration
- There are many ways in which one body can exert force on another body. Few examples are given below

  (a) Stretched springs exerts force on the bodies attached to its ends

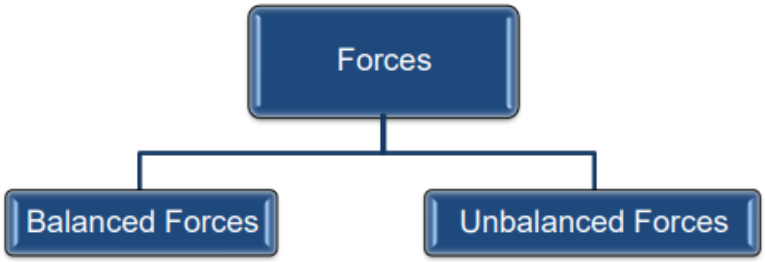
  (b) Compressed air in a container exerts force on the walls of the container

  (c) Force can be used to deform a flexible object
- Force of gravitational attraction exerted by earth is a kind of force that acts on every physical body on the earth and is called the weight of the body

Force

- Force is used in our everyday actions such as pushing, pulling, twisting, lifting, pressing and stretching.
- A force can produce the following **effects**:
  - ✓ **Move** a body at rest.
  - ✓ **Stop** a moving body.
  - ✓ **Change the speed** of a moving body.
  - ✓ **Change the direction** of a moving body.
  - ✓ **Change the shape and size** of a body.

Balanced and Unbalanced Forces



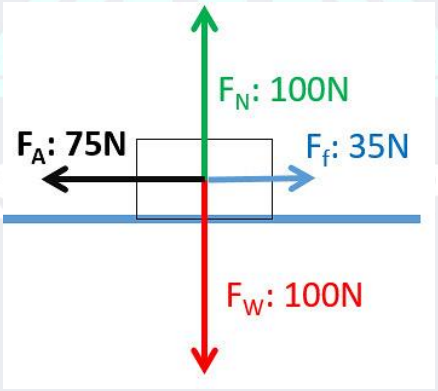
Balanced and Unbalanced Forces

When balanced forces are applied to an object, there will be no net effective force acting on the object. Balanced forces do not cause a change in motion.

Unbalanced forces acting on an object change its speed and/or direction of motion. It moves in the direction of the force with the highest magnitude.

Net force

When multiple forces act on a body, they can be resolved into one component known as the net force acting on the object. For Example:



Balanced Forces

- If the resultant of all forces acting on a body is zero then the forces are called balanced forces.

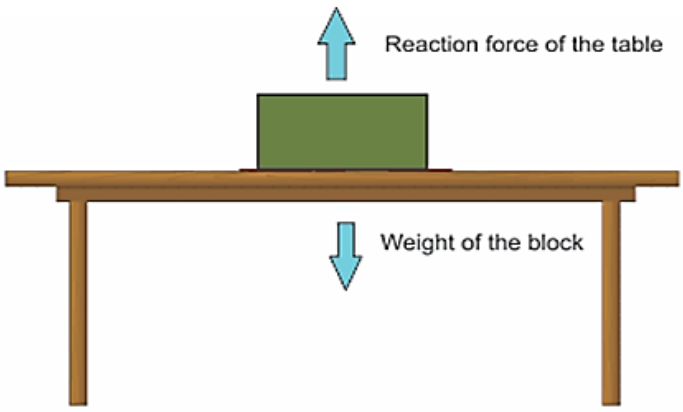


Figure 1. Balanced forces acting on the block

- To understand this concept consider an object rests on a surface such as a block on the table as shown below in the figure 1. Weight of the block is balanced by the reaction force from the table. The table pushes up against the block.

  So the weight of a block lying on a table is balanced by the reaction force from the table top
- If the forces on an object are balanced (or if there are no forces acting on it) than the object that is not moving stays still and the object that is moving continues to move at the same speed and in the same direction.
- Although balanced forces cannot produce motion in a stationary body or stop a moving body but they can however change the shape of the body.

Unbalanced Forces

- If the resultant forces acting on a body is not zero the forces are called unbalanced forces.
- To understand this consider the figure 2 which shows a block on a horizontal table and two strings X and Y are tied to the two opposite faces of the block.

Let us now pull the block using this string in two different directions such that two opposite forces of different magnitudes acts on the block.

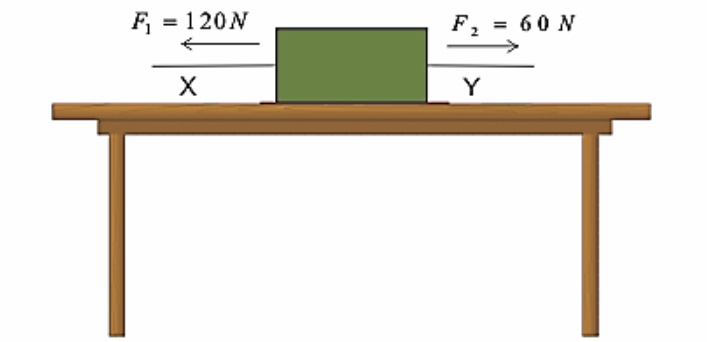
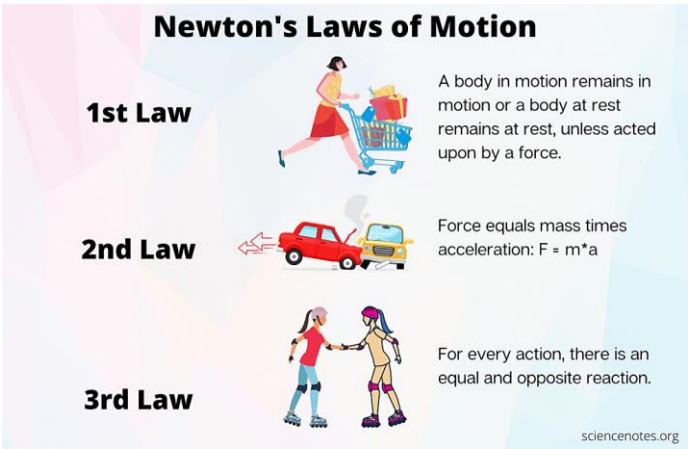


Figure 2. Unbalanced forces acting on the block

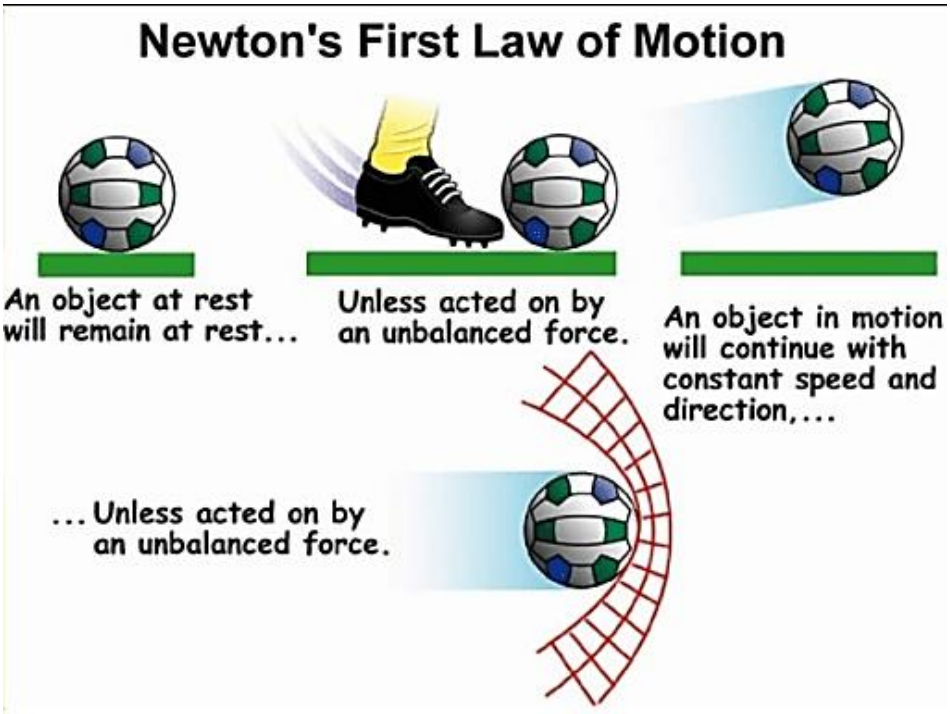
- Since two forces acting on the block are of different magnitude the block would begin to move in the direction of the greater force.
- Thus, the two forces acting on the block are not balanced and the unbalanced force acts in the direction the block moves.
- So unbalanced forces can move a stationary body and they can stop a moving body.
- The size of the overall force acting on an object is called the resultant force. If the forces are balanced, this is zero. In the example above, the resultant force is the difference between the two forces F_1 and F_2, which is 120 - 60 = 60 N.
- If all the forces acting on a body result in an unbalanced force, then the unbalanced force can accelerate the body. It means that a net force or resulting force acting on a body can either change the magnitude of its velocity or change the direction of its velocity.
- The force that opposes the relative motion between the surfaces of two objects in contact and acts along the surfaces in contact is called the force of friction or simply friction.

Laws of motion



- Newton gave three laws of motion that describe the motion of bodies. These laws are known as Newton's Laws of motion.
- They describe the relationship between the forces acting on a body and its motion due to those forces.
- The three laws of motion were first compiled by Sir Isaac Newton in his work Principia Mathematica, first published in 1687. Newton used these laws to explain and investigate the motion of many physical objects and systems.
- We shall now learn about Newton's First law of motion

Newton's First Law of Motion



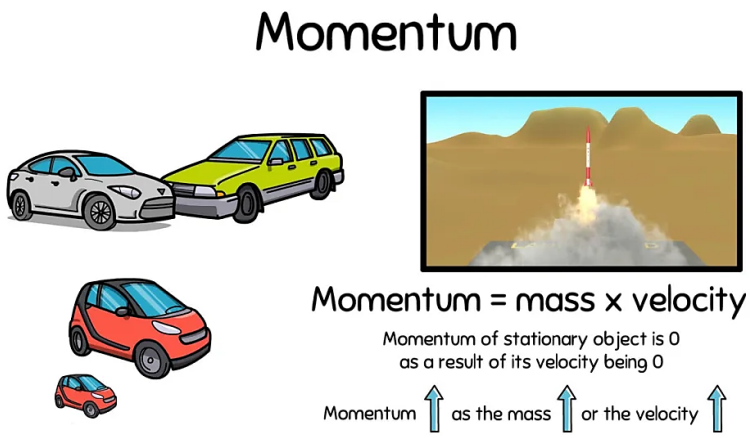
A body continues to be in a state of rest or in a state of uniform motion along a straight line unless acted upon by an external unbalanced force.

The first law of motion is stated as:

- An object remains in a state of rest or of uniform motion in a straight line unless compelled to change that state by an applied force.
- All objects resist a change in their state of motion. The tendency of undisturbed objects whether they are at rest or moving with uniform velocity is called inertia. Hence, the first law of motion is also known as the law of inertia.
- Greater the inertia of the body greater will be the force required to bring the change in the state of rest or uniform motion of the body.
- Mass is the measure of the inertia of the body so heavier objects have more inertia than lighter objects. For example, a ball of 2Kg has more inertia then a football and it takes more effort to kick a 2Kg ball then it takes to kick a football.
- Another example is even a small child can push a toy car. However, An adult also can't push a loaded vehicle forward.
- Newton's first law of motion gives us a definition of force. It says that

  Force is something that changes or tends to change the state of rest or uniform motion of a body

Momentum



- Before discussing about second law of motion we shall first learn about momentum of a moving object.
- From our daily life experiences like during the game of table tennis if the ball hits a player, it does not hurt him. On the other hand, when a fast-moving cricket ball hits a spectator, it may hurt him.
- This suggests that impact produced by moving objects depends on both their mass and velocity.
- So, there appears to exist some quantity of importance that combines the object's mass and its velocity called momentum and was introduced by Newton.
- Momentum can be defined as "mass in motion". All objects have mass; so if an object is moving, then it has momentum - it has its mass in motion.
- The momentum, p of an object is defined as the product of its mass, m and velocity, v. That is,

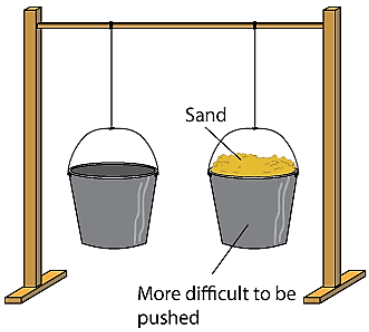
momentum p=mv (1)

- Momentum has both direction and magnitude, so it is a vector quantity. Its direction is the same as that of velocity, v.
- The SI unit of momentum is kilogram-meter per second (kg m s^{-1}).
- Since the application of an unbalanced force brings a change in the velocity of the object, it is therefore clear that a force also produces a change of momentum.
- We define the momentum at the start of the time interval is the initial momentum and at the end of the time interval is the final momentum.
- When the object moves then it gains momentum as the velocity increases. Hence greater the velocity greater is the momentum.

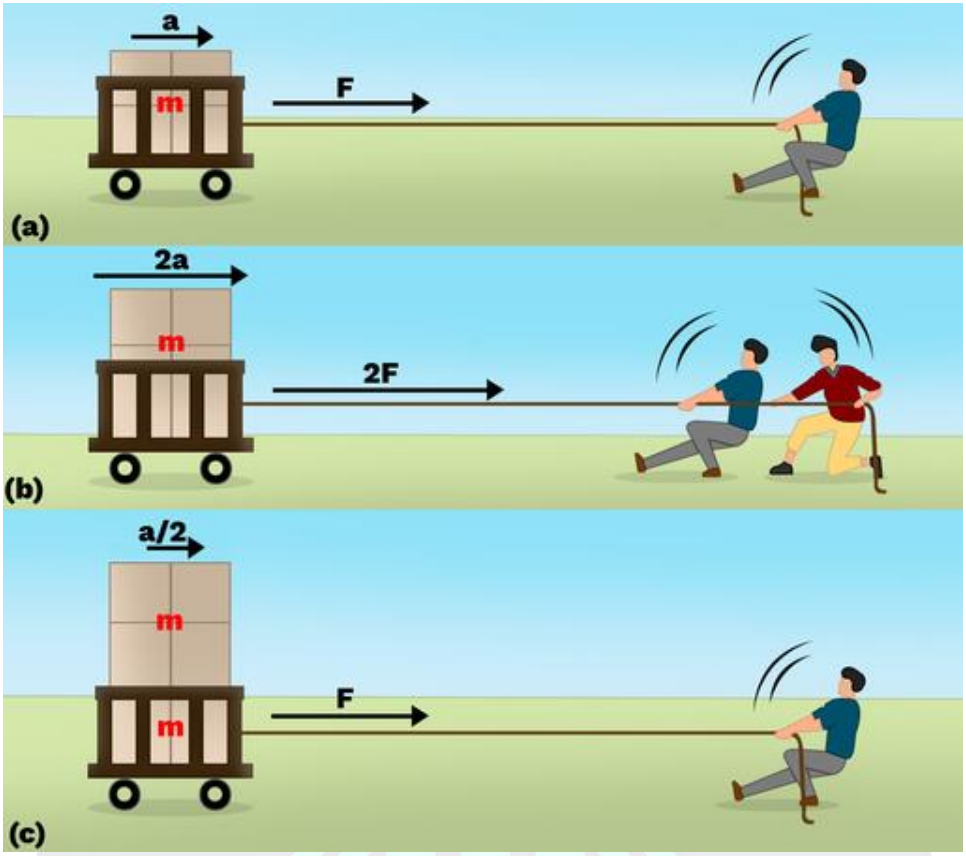
Inertia

Basically, all objects have a tendency to resist the change in the state of motion or rest. This tendency is called inertia. All bodies do not have the same inertia. Inertia depends on the mass of a body. Mass of an object is the measure of its inertia.

More the mass → more inertia and vice versa.



Newton's Second Law of Motion



The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

- If a body of mass 'm' moving with an initial velocity 'u' is accelerated to a velocity 'v' by the application of a constant force 'F' in time 't', then according to Newton's second law of motion

$$Force \propto \frac{Change\,of\ momentum}{Time\ taken}$$

If mu is the initial momentum and mv is the final momentum:

Change in momentum = mv

The force 'F' is applied for time 't' so that the final velocity of the body becomes 'v'.

or, $F \propto \frac{mv-mu}{t}$

$= \frac{m(v-u)}{t}$

$\left[we\ know\ that \left(\frac{v-u}{t}\right) = a\right]$

or, $F \propto m \times a$

$F = kma$

In SI units, k = 1

$\therefore F = ma$

- **Force** acting on a body is the **product of mass of the body and its acceleration**. i.e., **F = ma**

- The SI unit of force is kg m s^{-2}. This is also known as Newton and represented by the symbol N. A force of one Newton produces an acceleration of 1 ms^{-2} in a body of mass 1 kg.

1 Newton = 1 kg × 1 m/s^2

Concept of system

The part of the universe chosen for analysis is called a system.

Everything outside the system is called an environment.

For example, a car moving with constant velocity can be considered a system. All the forces within the car are internal forces and all forces acting on the car from the environment are external forces like friction.

Conservation of momentum

The total momentum of an isolated system is conserved.

Isolated system → net external force on the system is zero.

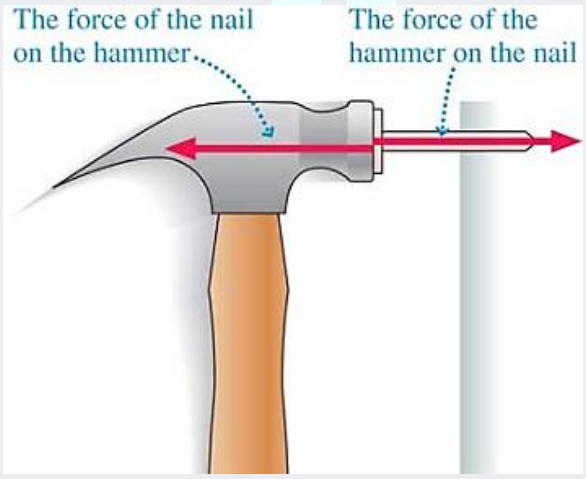
Example: Collision of 2 balls A and B.

From Newtons 3rd law F_{AB} = -F_{BA}

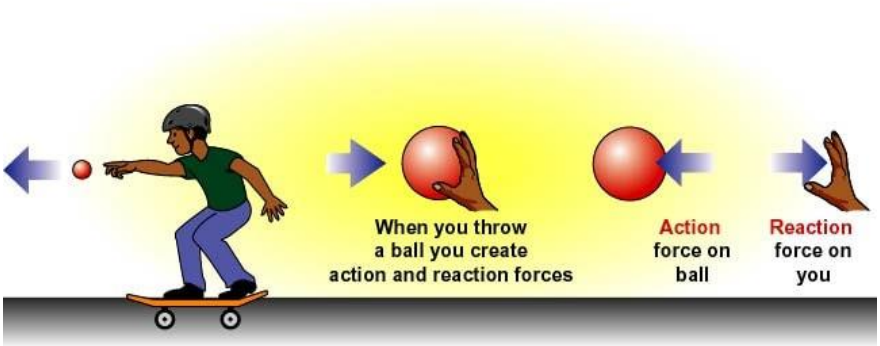
$$\Rightarrow \quad m_A \frac{V_a - U_a}{t} = m_B \frac{V_b - U_b}{t}$$

$$\Rightarrow \quad m_A U_A + m_B U_B = m_A V_A + m_B V_B$$

Newton's Third Law of Motion



Newton's Third Law of Motion



For every action force, there is a reaction force equal in strength and opposite in direction.

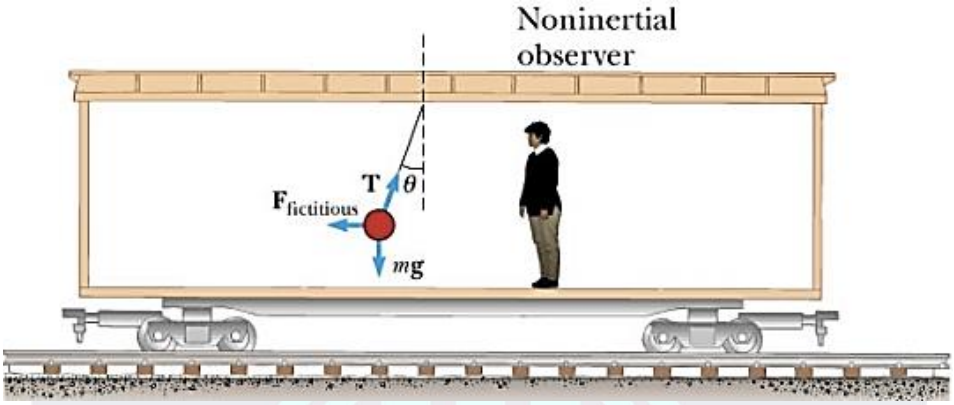
To every action, there is an equal and opposite reaction.

- The action and reaction forces act on two different bodies and never cancel each other.
- Although the action and reaction forces are always equal in magnitude, the forces may not produce acceleration of equal magnitude because they act on different bodies which may have different masses.

Inertial and Non-inertial frames

A non-inertial frame of reference is a frame of reference in which Newton's laws of motion do not hold. A non-inertial reference frame is a frame of reference that is undergoing acceleration with respect to an inertial frame. An accelerometer at rest in a non-inertial frame will, in general, detect a non-zero acceleration.

A frame of reference where Newton's Laws hold is known as an inertial frame of reference.

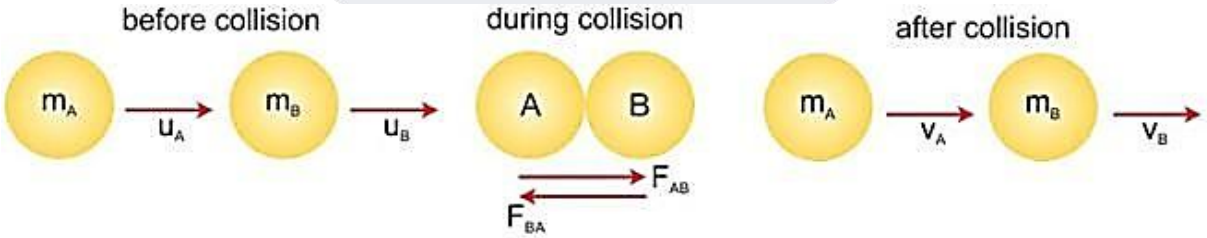


Law of Conservation of Momentum

According to the law of conservation of momentum, **the sum of momenta of two objects before collision is equal to the sum of momenta after collision**, provided there is no external unbalanced force acting on the objects.

Total momentum before collision = Total momentum after collision

i.e.



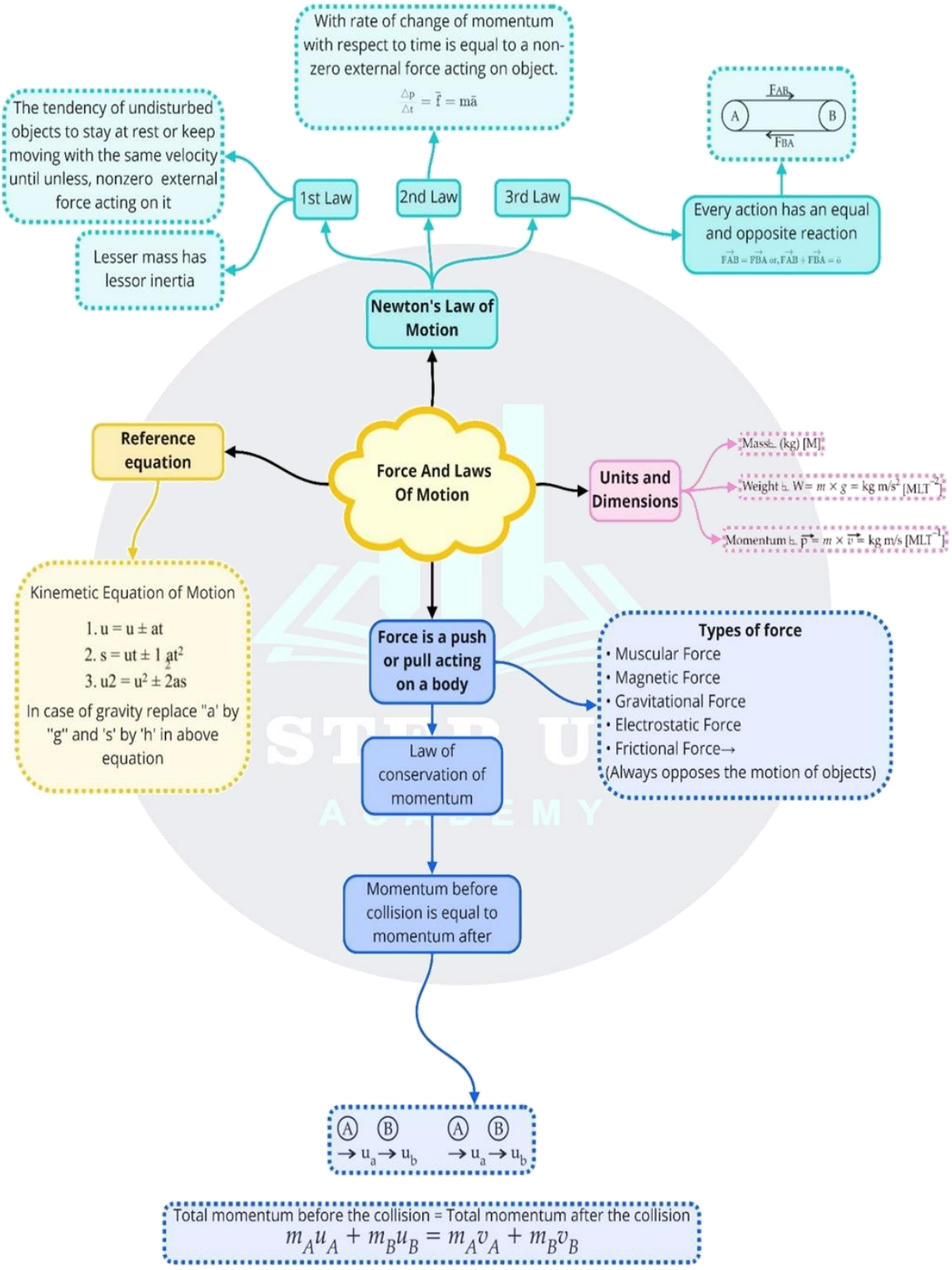
$m_A u_A + m_B u_B = m_A u_A + m_B v_B$

where m_A and m_B are masses of the bodies u_1 and u_2 are initial velocities of the bodies v_1 and v_2 are final velocities of the bodies

- All applications of Newton's third law of motion can be explained in terms of the law of conservation of momentum.
- When a bullet is fired from a gun, the gun moves backwards. The **recoil velocity** v_2 of the gun

  $v_2 = -\frac{m_1 v_1}{m_2}$ where v_1 is the velocity of the bullet of mass m_1 and m_2 is the mass of the gun.

Class : 9th Science
Chapter- 9 : Force And Laws Of Motion



Important Questions

Multiple Choice Questions:

1. Which of the following statements is not correct for an object moving along a straight path in an accelerated motion?
   (a) Its speed keeps changing
   (b) Its velocity always changes
   (c) It always goes away from the Earth
   (d) A force is always acting on it
2. According to the third law of motion, action and reaction
   (a) always act on the same body
   (b) always act on different bodies in opposite directions
   (c) have same magnitude and directions
   (d) act on either body at normal to each other
3. A goalkeeper in a game of football pulls his hands backwards after holding the ball shot at the goal. This enables the goalkeeper to
   (a) exert larger force on the ball
   (b) reduce the force exerted by the balls on the hands
   (c) increase the rate of change of momentum
   (d) decrease the rate of change of momentum
4. The inertia of an object tends to cause the object
   (a) to increase its speed
   (b) to decrease its speed
   (c) to resist any change in its state of motion
   (d) to decelerate due to friction
5. A passenger in a moving train tosses a coin which falls behind him. It means that motion of the train is
   (a) accelerated
   (b) uniform
   (c) retarded
   (d) along circular tracks
6. An object of mass 2 kg is sliding with a constant velocity of $4ms^{-1}$ on a frictionless horizontal table. The force required to keep the object moving with the same velocity is
   (a) 32 N
   (b) 0 N
   (c) 2 N
   (d) 8 N
7. Rocket works on the principle of conservation of
   (a) mass
   (b) energy
   (c) momentum
   (d) velocity
8. A water tanker filled up to 23 of its height is moving with a uniform speed. On a sudden application of brakes, the water in the tank would
   (a) move backward
   (b) move forward
   (c) be unaffected
   (d) rise upwards
9. If the mass of a body is doubled and its velocity becomes half, then the linear momentum of the body will
   (a) remain same
   (b) become double
   (c) become half
   (d) become four times.
10. When a number of forces acting simultaneously on a body bring about a change in its state of rest or of uniform motion in a straight line, then these forces acting on the body are said to be
    (a) balanced forces
    (b) equal forces
    (c) unbalanced forces
    (d) opposite forces
11. When a car at high speed makes a sharp turn, the driver in a car tends to get thrown to the side opposite to the turn. This is due to the
    (a) inertia of motion
    (b) inertia of time
    (c) inertia of rest
    (d) inertia of direction
12. A man is standing on a boat in still water. If he walks towards the shore, then the boat will
    (a) move away from the shore
    (b) move towards the shore
    (c) remain stationary
    (d) none of these

13. Which of the following is an incorrect statement?
    (a) Mass is measure of inertia of a body.
    (b) Newton's first law of motion is the law of inertia.
    (c) Unbalanced force produces constant velocity.
    (d) Newton's third law talks about the direction of the force.
14. A ball is thrown vertically upward in a train moving with uniform velocity. The ball will
    (a) fall behind the thrower
    (b) fall ahead of the thrower
    (c) return back to the thrower
    (d) fall on the left of the thrower
15. Which of the following is not an application of conservation of linear momentum?
    (a) While firing a bullet, the gun must be held tight to the shoulder
    (b) When a man jumps from a boat to the shore
    (c) A rocket explodes on midway from the ground
    (d) A body suspended from the hook of a spring balanced in a lift which is accelerated downward

Very Short Question:

1. Define force.
2. What is S.I. unit of force?
3. Define one Newton.
4. What is balanced force?
5. What is frictional force?
6. What is inertia?
7. State Newton's first law of motion.
8. State Newton's second law of motion.
9. What is momentum?
10. State Newton's III law of motion.

Short Questions:

1. State the difference in balanced and unbalanced force.
2. What change will force bring in a body?
3. When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side. Explain why?
4. Explain why it is dangerous to jump out of a moving bus.
5. Why do fielders pull their hand gradually with the moving ball while holding a catch?
6. In a high jump athletic event, why are athletes made to fall either on a cushioned bed or on a sand bed?
7. How does a karate player breaks a slab of ice with a single blow?
8. What is law of conservation of momentum?

Long Questions:

1. Explain Newton's second law of motion and with the-help of an example show how it is used in sports.
2. State all 3 Newton's law of motion. Explain inertia and momentum.
3. Define force. Give its unit and define it. What are different types of forces?

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
    b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
    c. Assertion is true but Reason is false.
    d. Both Assertion and Reason are false.

    Assertion: If the net external force on the body is zero, then its acceleration is zero.

    Reason: Acceleration does not depend on force.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
    b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
    c. Assertion is true but Reason is false.
    d. Both Assertion and Reason are false.

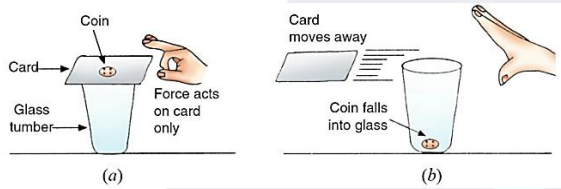
Assertion: A rocket works on the principle of conservation of linear momentum.

Reason: For two bodies system when there is a change in momentum of one body, the same change occurs in the momentum of the second body but in the opposite direction.

Case Study Question:

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

We take a glass tumbler and place a thick square card on its mouth as shown in Figure (a). A coin is then placed above this card in the middle. Let us flick the card hard with our fingers. On flicking, the card moves away but the coin drops into the glass tumbler [see Figure (b)].



(i) Give reason for the above observation.

(a) The coin possesses inertia of rest, it resists the change and hence falls in the glass.

(b) The coin possesses inertia of motion; it resists the change and hence falls in the glass.

(c) The coin possesses inertia of rest, it accepts the change and hence falls in the glass.

(d) The coin possesses inertia of rest, it accepts the change and hence falls in the glass.

(ii) Name the law involved in this case.

(a) Newton's second law of motion.

(b) Newton's first law of motion.

(c) Newton's third law of motion.

(d) Law of conservation of energy

(iii) If the above coin is replaced by a heavy five rupee coin, what will be your observation. Give reason.

(a) Heavy coin will possess more inertia so it will not fall in tumbler.

(b) Heavy coin will possess less inertia so it will fall in tumbler.

(c) Heavy coin will possess more inertia so it will fall in tumbler.

(d) Heavy coin will possess less inertia so it will not fall in tumbler.

(iv) Name the law which provides the definition of force.

(a) Law of conservation of mass

(b) Newton's third law.

(c) Newton's first law

(d) Newton's second law.

(v) State Newton's first law of motion.

(a) Energy can neither be created nor be destroyed, it can be converted from one form to another, total amount of energy always remains constant.

(b) A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless it is acted upon by an external unbalanced force.

(c) For every action in nature there is an equal and opposite reaction.

(d) The acceleration in an object is directly related to the net force and inversely related to its mass.

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

Akhtar, Kiran and Rahul were riding in a motorcar that was moving with a high velocity on an expressway when an insect hit the windshield and got stuck on the windscreen. Akhtar and Kiran started pondering over the situation. Kiran suggested that the insect suffered a greater change in momentum as compared to the change in momentum of the motorcar (because the change in the velocity of the insect was much more than that of the motorcar). Akhtar said that since the motorcar was moving with a larger velocity, it exerted a larger force on the insect. And as a result the insect died. Rahul while putting an entirely new explanation said that both the motorcar and the insect experienced the same force and a change in their momentum.

(i) Whose suggestion is correct?

(a) Akhtar's suggestion is incorrect as momentum is never conserved

(b) Kiran's suggestion is incorrect as momentum is always conserved

(c) Rahul's suggestion is incorrect as momentum is never conserved

(d) All of them have given correct suggestion.

(ii) Define momentum.

(a) Momentum is the product of mass and displacement.

(b) Momentum is the product of mass and distance.

(c) Momentum is the product of mass and velocity.

(d) Momentum is the product of mass and acceleration.

(iii) What is the SI unit of momentum?

(a) SI unit of momentum is kg

(b) SI unit of momentum is kg/s.

(c) SI u nit of momentum is kg. m/s.

(d) SI u nit of momentum is m/s.

(iv) Find the momentum of a man of mass 75 kg when he walks with a velocity of 2 m/s.

(a) P = 75 kgm/s

(b) P = 15 kgm

(c) P = 37.5 kgm/s

(d) P =150 kgm/s

(v) What is velocity?

(a) Distance travelled in given time.

(b) Rate of change of momentum.

(c) Rate of displacement.

(d) Shortest distance travelled.

Answer Key

Multiple Choice Answers:

1. (d) A force is always acting on it
2. (b) always act on different bodies in opposite directions
3. (d) decrease the rate of change of momentum
4. (c) to resist any change in its state of motion
5. (a) accelerated
6. (b) 0 N
7. (c) momentum
8. (b) move forward
9. (a) remain same
10. (d) opposite forces
11. (a) inertia of motion
12. (a) move away from the shore
13. (c) Unbalanced force produces constant velocity.
14. (c) return back to the thrower
15. (c) A rocket explodes on midway from the ground

Very Short Answers:

1. **Answer:** It is a push or pull on an object that produces acceleration in the body on which it acts.
2. **Answer:** S.I. unit of force is Newton.
3. **Answer:** A force of one Newton produces an acceleration of 1 m/s2 on an object of mass 1 kg.

$$\mathbf{1\ N = 1\ kg\ m/s^2}$$

4. **Answer:** When forces acting on a body from the opposite direction do not change the state of rest or of motion of an object, such forces are called balanced forces.
5. **Answer:** The force that always opposes the motion of object is called force of friction.
6. **Answer:** The natural tendency of an object to resist a change in their state of rest or of uniform motion is called inertia.
7. **Answer:** An object remains in a state of rest or of uniform motion in a straight line unless acted upon by an external unbalanced force.

8. **Answer:** The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.
9. **Answer:** The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. The S. I. unit is kg m/s. (p = mv)
10. **Answer:** To every action, there is an equal and opposite reaction and they act on two different bodies.

Short Answers:

1. **Answer:**

Balanced Force	Unbalanced Forces
The forces exerted on the object are equal in magnitude and opposite in direction	Forces applied on the object are unequal in magnitude
Net force is zero	Net force is not zero
Body will be at rest	Unbalanced forces makes the body move
It does not change the state of rest or of motion of an object.	It changes the state of rest or motion of an object

2. **Answer:** Force can bring following changes in the body:
   - It can change the speed of a body.
   - It can change the direction of motion of a body,
   - It can change the shape of the body.
3. **Answer:** It is due to law of inertia. When we are sitting in car moving in straight line, we tend to continue in our straight-line motion. But when an unbalanced force is applied by the engine to change the direction of motion of the motorcar. We slip to one side of the seat due to the inertia of our body.
4. **Answer:** While moving in a bus our body is in motion. On jumping out of a moving bus our feet touches the ground and come to rest. While the upper part of our body stays in motion and moves forward due to inertia of motion and hence we can fall in forward direction.

   Hence, to avoid this we need to run forward in the direction of bus.
5. **Answer:** While catching a. fast moving cricket ball, a fielder on the ground gradually pulls his hands backwards with the moving ball. This is done so that the fielder increases the time during which the high velocity of the moving ball decreases to zero. Thus, the acceleration of the ball is decreased and therefore the impact of catching the fast moving ball is reduced.
6. **Answer:** In a high jump athletic event, athletes are made to fall either on a cushioned bed or on a sand bed so as to increase the time of the athlete's fall to stop after making the jump. This decreases the rate of change of momentum and hence the force.
7. **Answer:** A karate player applied the blow with large velocity in a very short interval of time on the ice slab which therefore exerts large amount of force on it and suddenly breaks the ice slab.
8. **Answer:** Momentum of two bodies before collision is equal to the momentum after collision.

   In an isolated system, the total momentum remain conserved.

Long Answers:

1. **Answer:** Newton's second law of motion: The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.

   Let us assume:

   Object of mass m, is moving along a straight line with an initial velocity 'u', It is uniformly accelerated to velocity v in time 't by the application of force,

   F throughout the time 't'.

   Initial momentum of the object = $\rho_1 = mu$

   Final momentum of the object = $\rho_2 = mu$

   The change in momentum $\propto \rho_2 - \rho_1$

   $\propto mv - mu$

   $= m\,(v - u)$

   The rate of change of momentum $\propto \frac{m(v-u)}{t}$

   $\therefore$ Applied Force $F \propto \frac{m(v-u)}{t}$

   $F = \frac{km(v-u)}{t}$

   $\therefore$ F = kma

$\therefore \quad a = \frac{v-u}{t}$

k = constant of proportionality

$F = kg\ m/s^2$ = Newton

Use of second law of motion in sports:

In cricket field, the fielder gradually pulls his hands backward while catching a ball. The fielder catches the ball and gives swing to his hand to increase the time during which the high velocity of the moving ball decreases to zero.

The acceleration of the ball is decreased and therefore the impact of catching the fast moving ball4s reduced.

If not done so, then the fast moving ball will exert large force and may hurt the fielder.

2. **Answer:** Newton's I law of motion: An object remains in a state of rest or of uniform motion in a straight line unless acted upon by an external unbalanced force.

Newton's II law of motion: The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the-force.

Newton's III law of motion: To every action, there is an equal and opposite reaction and they act on two different bodies.

Inertia: The natural tendency of an object to resist a change in their state of rest or of uniform motion is called inertia.

Momentum: The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. Its S.I. unit is kgm/s. p = m x v

3. **Answer:** Force: It is a push or pull on an object that produces acceleration in the body on which it acts.

A force can do 3 things on a body

(a) It can change the speed of a body.

(b) It can change the direction of motion of a body.

(c) It can change the shape of the body.

The S.I. unit of force is Newton.

Newton: A force of one Newton produces an acceleration of 1 m/s2 on an object of mass 1 kg.

$1N = 1kg\ m/s^2$

Types of forces:

- **Balanced force:** When the forces acting on a body from the opposite direction do not change the state of rest or of motion of an object, such forces are called balanced forces.
- **Unbalanced force:** When two opposite forces acting on a body move a body in the direction of the greater force or change the state of rest, such forces are called as unbalanced force.
- **Frictional force:** The force that always opposes the motion of object is called force of friction.

Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

Case Study Answer:

1. **Answer:**

(i) (a) The coin possesses inertia of rest; it resists the change and hence falls in the glass.

(ii) (b) Newton's first law of motion.

(iii) (c) Heavy coin will possess more inertia so it will fall in tumbler.

(iv) (c) Newton's first law

(v) (b) A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless it is acted upon by an external unbalanced force.

2. **Answer:**

(i) (b) Kiran's suggestion is incorrect as momentum is always conserved

(ii) (c) Momentum is the product of mass and velocity.

(iii) (c) SI u nit of momentum is kg. m/s.

(iv) (d) P =150 kgm/s

Solution:

Momentum, $P = m \times v$

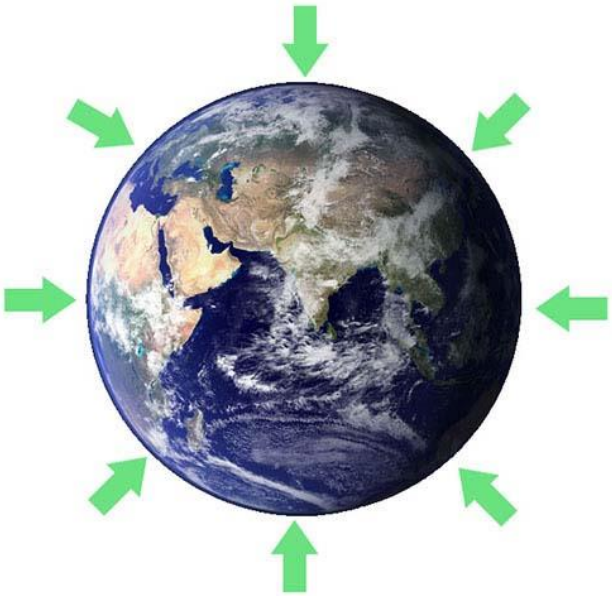
= 75 x 2

= 150 kg.m/s

(v) (c) Rate of displacement

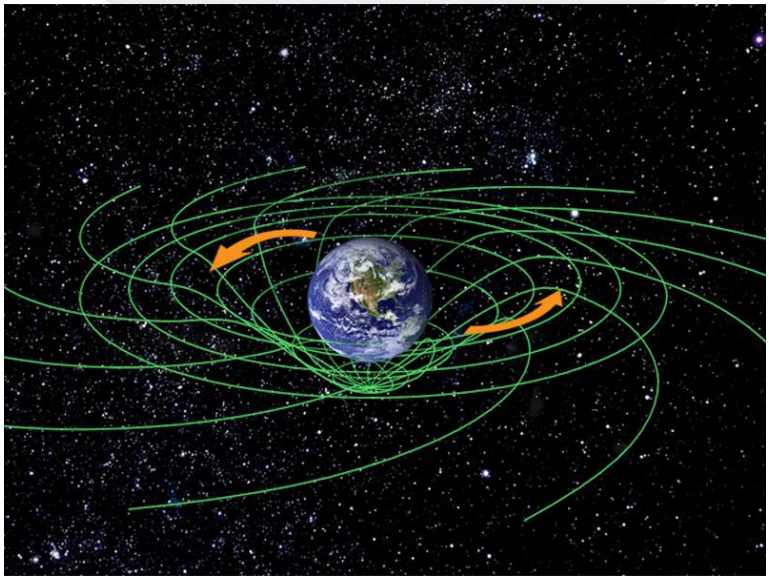
Gravitation 3

- According to Newton, every object in this Universe attracts every other object with a certain force. This force with which two objects attract each other is called **gravitational force**.
- If the masses of two bodies are small, then the gravitational force between them is very small.
- The gravitational force holds the Solar System together.
- In our dairy life we have noticed things falling freely downwards towards earth when thrown upwards or dropped from some height.
- Fact that all bodies irrespective of their masses are accelerated towards the earth with a constant acceleration was first recognized by Galileo (1564-1642).
- The motion of celestial bodies such as moon, earth, planets etc. and attraction of moon towards earth and earth towards sun is an interesting subject of study since long time.
- Toss a stone from a great height. What are your observations?
- The stone, which was at first at rest, begins to move towards the ground and reaches its maximum speed right before it meets it.
- The stone is not travelling at a constant rate. Its speed fluctuates at all times, indicating that the stone is accelerating.
- A force is necessary to cause an acceleration in a body, according to Newton's second law of motion.
- The stone was not pushed or pulled in any way. What was the source of the force?
- Sir Isaac Newton came up with the solution to this dilemma after seeing an apple fall from a tree.
- His thesis was that the apple is attracted to the Earth, and the Earth is attracted to the apple The Earth's force on the apple is enormous, and as a result, the apple arrives on Earth.
- The apple, on the other hand, is unable to draw the Earth since the force it exerts on it is insignificant.
- As a result, we can deduce that the acceleration caused by Earth's immense force of attraction is the cause of the stone's acceleration.
- It is evident from the preceding example that this force of attraction ties our complicated universe together, keeps the moon revolving around the Earth, keeps all of the planets in their orbits around the Sun, and helps us walk correctly on the Earth's surface.
- The force of gravitation, or gravitation, is a form of attraction that exists between any two objects in the universe.
- The force of gravity or gravity is the attraction or gravitational force between Earth (or any planet) and any other material objects in the cosmos.



More About Gravitation

- You must have observed that whenever you throw any object upwards it reaches a certain height and then falls downward towards the Earth. So, these objects are acting under the gravitational pull of the Earth or gravitational forces which are forces of attraction.
- Gravitational force or gravity of earth is responsible for pulling you and keeping you on earth.
- Now each and every object in this universe that has mass exerts a gravitational force on every other mass and the size of that pull depends on how large or small are the masses of two objects under consideration.
- So for smaller masses like two human beings the gravitational force of attraction is very small and is negligible because two peoples are not very massive
- Now when you consider massive objects like planets, Sun, Earth, Moon or other celestial bodies, the gravitational pull becomes very strong.
- So here you must note that gravitational force depends on how massive objects under consideration are.
- Gravity is very important on earth. It is the gravitational pull of earth that keeps our planet orbiting round Sun.
- The motion of moon is also affected by both Sun and Earth.



Why don't Moon Fall down

The moon revolves around the Earth due to centripetal force, which is the force of gravity of the Earth. If the force of attraction between the Earth and moon ceases, then the moon will continue to travel in a straight-line path tangential to its orbit around the Earth.

Centripetal force

When a body undergoes circular motion, it experiences a force that acts towards the center of the circle. This center-seeking force is called a centripetal force.

- You must wonder If gravitational force is a force of attraction, then why does moon not fall into earth?
- To understand this consider a person whirling a stone tied to a thread along a circular path as shown below in the figure.

When an object is under free fall, acceleration due to gravity is constant at g = $9.8ms^{-2}$

Value of g does not depend on mass i.e any object big or small experiences the same acceleration due to gravity under free fall. All three equations of motion are valid for freely falling objects as it is under uniform motion.

The sign of convention → towards earth g is +ve / away from earth g is -ve.

Weight and Mass

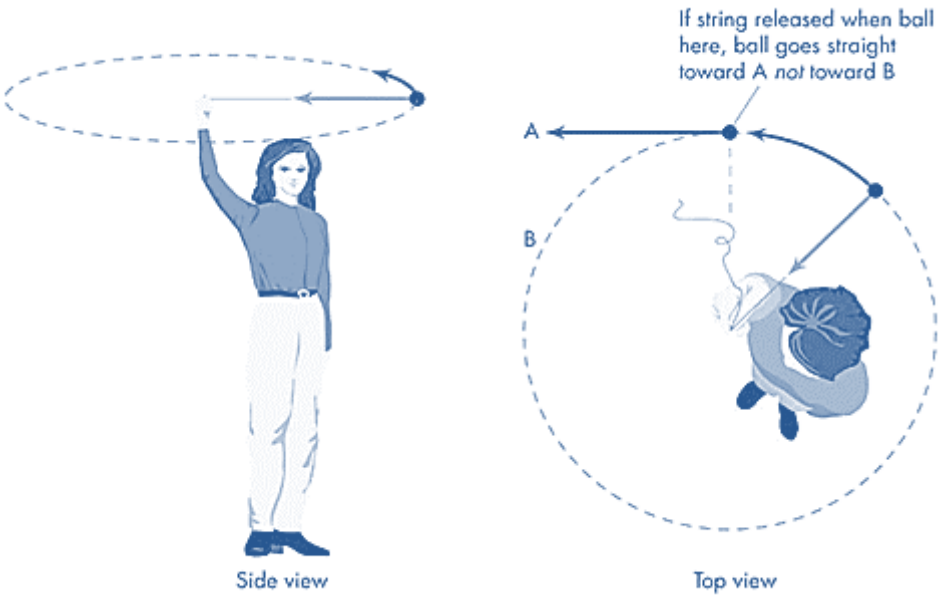
Mass of an object is the measure of its inertia and is constant throughout the universe. Weight of an object keeps changing as the value of g changes. Weight is nothing but a force of attraction of the Earth on an object = mg.

Weight of an object on the Moon is $\frac{1}{6}$

times the weight on Earth.

Thrust and Pressure

Force acting on an object perpendicular to the surface is called thrust. Effect of thrust depends on the area of contact. The pressure is thrust per unit area. SI unit is the pascal (Pa). Force acting on a smaller area applies more pressure than the same force acting on a larger area.



- If he releases the stone then it flies along the tangent, at that point on the circular path.
- Before the release of thread, it is centripetal force responsible for the motion of stone in the circular path where the stone moves with a certain speed and changes direction at every point.

- During this motion the change in direction involves change in velocity which produces acceleration. This force, which is called centripetal force, causes this acceleration, and keeps the body moving along the circular path is acting towards the center.
- Now when the thread is released the stone does not experience this force and flies off along a straight line that is tangent to the circular path.
- The motion of the moon around the earth is due to the centripetal force. The centripetal force is provided by the force of attraction of the earth. If there were no such force, the moon would pursue a uniform straight-line motion.

Pressure in fluids

The pressure exerted by a fluid in a container is transmitted undiminished in all directions on the walls of the container.

Archimedes' Principle – Why objects float or sink

The upward force exerted by a fluid on an object is known as upthrust or buoyant force.

The magnitude of buoyancy depends on the density of the fluid. If the density of an object is less than the fluid, it will float. If the density of the object is greater than the fluid, it will sink.

According to the Archimedes' principle, when a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

Relative Density

Relative density = Density of a substance/ Density of water

Elementary Idea Of Relative Density

In this article, we will understand what is relative density, calculations related to the relative density, and density of various substances. Let us start with the definition of density.

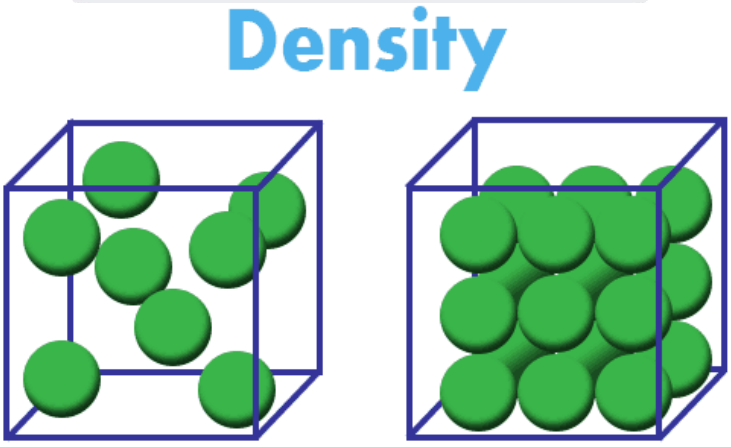
What is Density?

Density is the amount of mass in a unit volume of matter, every substance has a different density, to understand the idea of density let's conduct an experiment, we will need a tall glass cup, honey, water, coconut oil, and food coloring,

Step1: Pour a one-quarter cup of honey,

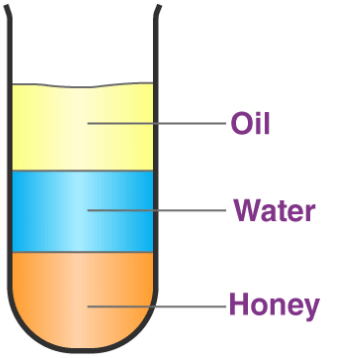
Step2: Pour a one-quarter cup of colored water gently on top of the honey.

Step3: pour a one-quarter cup of coconut oil on top of the colored water.



Notice how the different liquids from different layers, why is it so? The different substance has a different density, which means for the same volume different substances weigh differently, as they weigh differently heavier substances tend to settle at the bottom, like honey and lighter material like oil tend to float at the top which means.

What is Relative Density?



The difference between the specific gravity and density is that at room temperature and pressure is 1gram per 1 cubic cm is the density of water this density is treated as a standard and the density of any other material (usual liquids) is calculated relative to this is called relative density or specific gravity.

Hence, specific gravity is the ratio of the mass of a substance to that of a reference substance, let's consider the density of honey is approx. 1.42 grams/cm3, so its specific gravity would be 1.42/1 = 1.42. Notice that specific gravity is a ratio, therefore specific gravity does not have a unit, and hence specific gravity is a dimensionless physical quantity.

The specific gravity of a substance will let us know if it will float or sink, it gives us the idea about relative mass or relative density. If the specific gravity of a substance is below 1 then it will float and if it is greater than 1 it will sink.

Let's extend our experiment further for more liquids, this time, we will use several liquids with different specific gravities, use the table given below for reference.

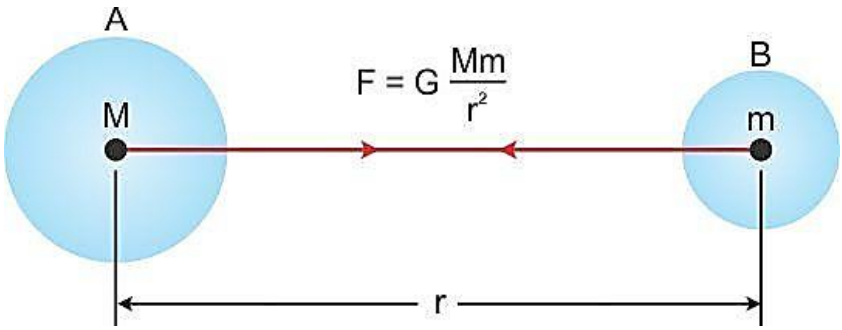
Material	Density(gram/cm^3)
Rubbing Alcohol	0.79
Lamp Oil	0.8
Baby Oil	0.83
Water	1.0
Milk	1.03
Liquid Soap	1.06
Corn Syrup	1.33
Maple Syrup	1.37
Honey	1.42

Universal Law of Gravitation

- This law was given by **Sir Isaac Newton**.

> Every object in the Universe attracts every other object with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them.

- Consider two objects A and B of mass 'M' and 'm' separated by a distance 'r'.



- According to Newton's law of gravitation, the force of attraction (F) between the two objects is given as

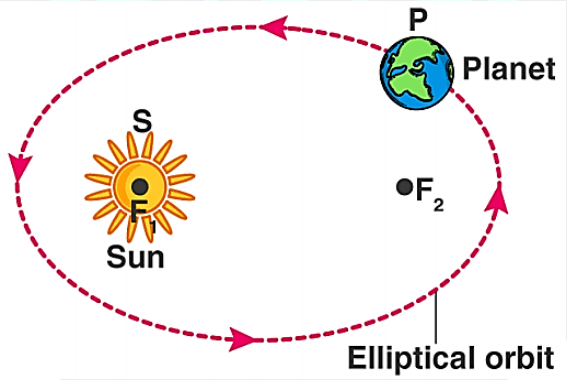
$$F = \frac{GMm}{r^2}$$

where **G** is the proportionality constant known as the **universal gravitation constant.**

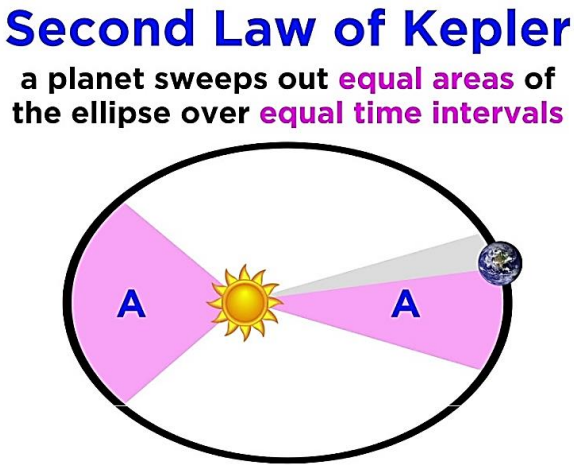
- Universal gravitation constant 'G' is numerically equal to the gravitational force of attraction between the two bodies, each of unit mass kept at unit distance from each other.
- The value of G is $6.67 \times 10^{-11}\ Nm^2/kg^2$.
- The universal law of gravitation successfully explained several phenomena such as the motion of the Moon around the Earth, the motion of the planets around the Sun and the force which binds us to the Earth.

Kepler's Laws of Planetary Motion

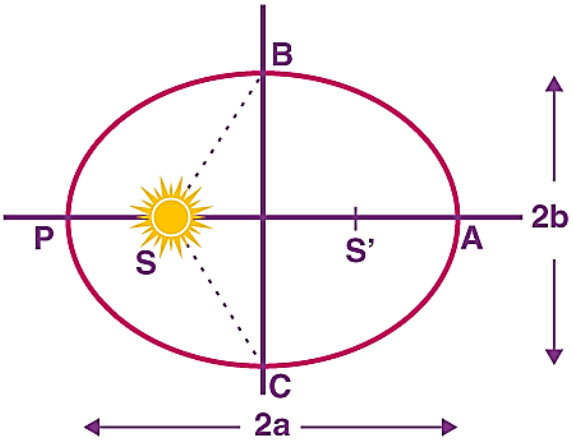
Kepler's First Law	• The planets move around the Sun in elliptical orbits, with the Sun at one of the two foci of the elliptical orbit.
Kepler's Second Law	• In an elliptical orbit of the planet, the line joining the centre of the planet to the centre of the Sun sweeps out equal areas in equal intervals of time.
Kepler's Third Law	• The cube of the mean distance 'r' of a planet from the Sun is directly proportional to the square of its orbital period 'T'. • i.e. $r^3 \alpha T^2$



Kepler's First Law



Kepler's Second Law



Kepler's Third Law

Free Fall

- Whenever objects fall towards the Earth under the influence of gravitational force alone, the objects are said to be in a state of free fall.
- The uniform acceleration produced in a freely falling body because of the gravitational force of the Earth is known as **acceleration due to gravity**. It is denoted by **g**, and its value on the surface of the Earth is 9.8 m/s^2.
- During free fall, there is no change in the direction of motion of the object, but the magnitude of the velocity of the falling object changes.
- The relation connecting the acceleration due to gravity **g** and universal gravitational constant **G** is

$$g = \frac{GM}{R^2}$$

where M is the mass of the Earth and R is the radius of the Earth.

- The value of 'g' is maximum at the **poles** (where R is minimum) and minimum at the **equator** (where R is maximum).
- The value of 'g' is maximum on the surface of the Earth; it decreases as we move above or go beneath the surface of the Earth.

Motion of Objects under the Influence of Gravitational Force of the Earth

- The equations of motion for freely falling bodies are

$$v = u + gt$$

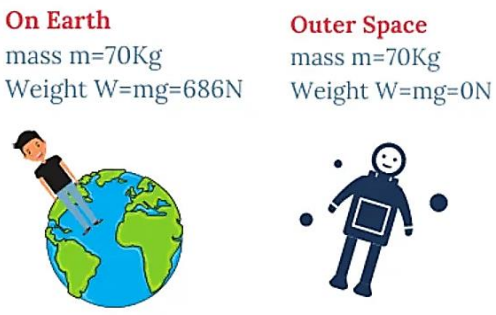
$$h = ut + (1/2)\, gt^2$$

$$v^2 - u^2 = 2gh$$

where '**u**' is the **initial velocity**, '**v**' is the **final velocity** after 't' sec and '**h**' is the **height** covered in 't' sec.

- Here, g should be positive if the acceleration due to gravity is in the direction of motion, and it should be negative if it is in the direction opposite to the motion.

Mass and Weight



g is acceleration due to gravity.
g(earth)= 9.8 m/s^2 and g=0 in outer space

- Mass of an object is the measure of its inertia.
- The force with which an object is attracted towards the Earth is the **weight** (W) of the object. It is equal to the product of mass (m) and acceleration due to gravity (g).

$$W = mg$$

- SI unit of weight is Newton, same as that of force.
- The weight of an object on the Moon is one-sixth its weight on the Earth.

Differences between Mass and Weight

Mass	Weight
1. Mass of a body is the quantity of matter contained in it.	1. Weight of a body is the force with which the body is attracted towards the centre of the Earth.
2. Mass of a body is a constant quantity.	2. Weight of a body varies from place to place.
3. It is a scalar quantity.	3. It is a vector quantity.
4. SI unit of mass is kilogram (kg).	4. SI unit of weight is newton (N).

Thrust and Pressure

- Thrust is the force acting perpendicularly on an object.
- Pressure is the force acting perpendicularly on a unit area of the object.

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}}$$

- SI unit of thrust is newton (N) and that of pressure is pascal (Pa), where 1 Pa = 1 N/m^2

Density

- Density (d) of a substance is defined as mass (M) per unit volume (V).

$$d = \frac{M}{V}$$

- The relative density of a substance is the ratio of its density to the density of water at 4°C.

$$\text{Relative density} = \frac{\text{Density of a substance}}{\text{Density of water 4°C}}$$

- Relative density has no units as it is the ratio of similar quantities.

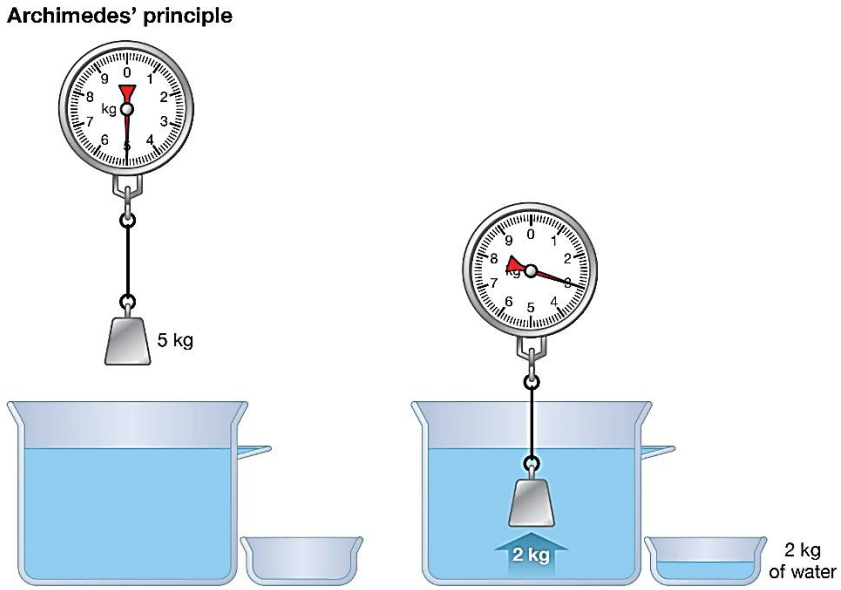
Pressure in Fluids

- A fluid exerts pressure in all directions, even upwards.
- According to **Pascal's law**, pressure exerted in any confined mass of fluid is transmitted uniformly in all directions.

Buoyancy

- When an object is partially or wholly immersed in a fluid, an upward force acts on it, which is called upthrust or **buoyant force**.
- The magnitude of buoyant force depends on
- The volume of the object immersed in the liquid.
- The density of the liquid.
- Let W be the weight of a body and F_B be the buoyant force acting on it.
- If $W > F_B$, then the body sinks.
- If $W < F_B$, then the body floats.
- An object with density less than the liquid floats on the liquid. If the object is denser than the liquid, then it sinks in the liquid.

Archimedes' Principle

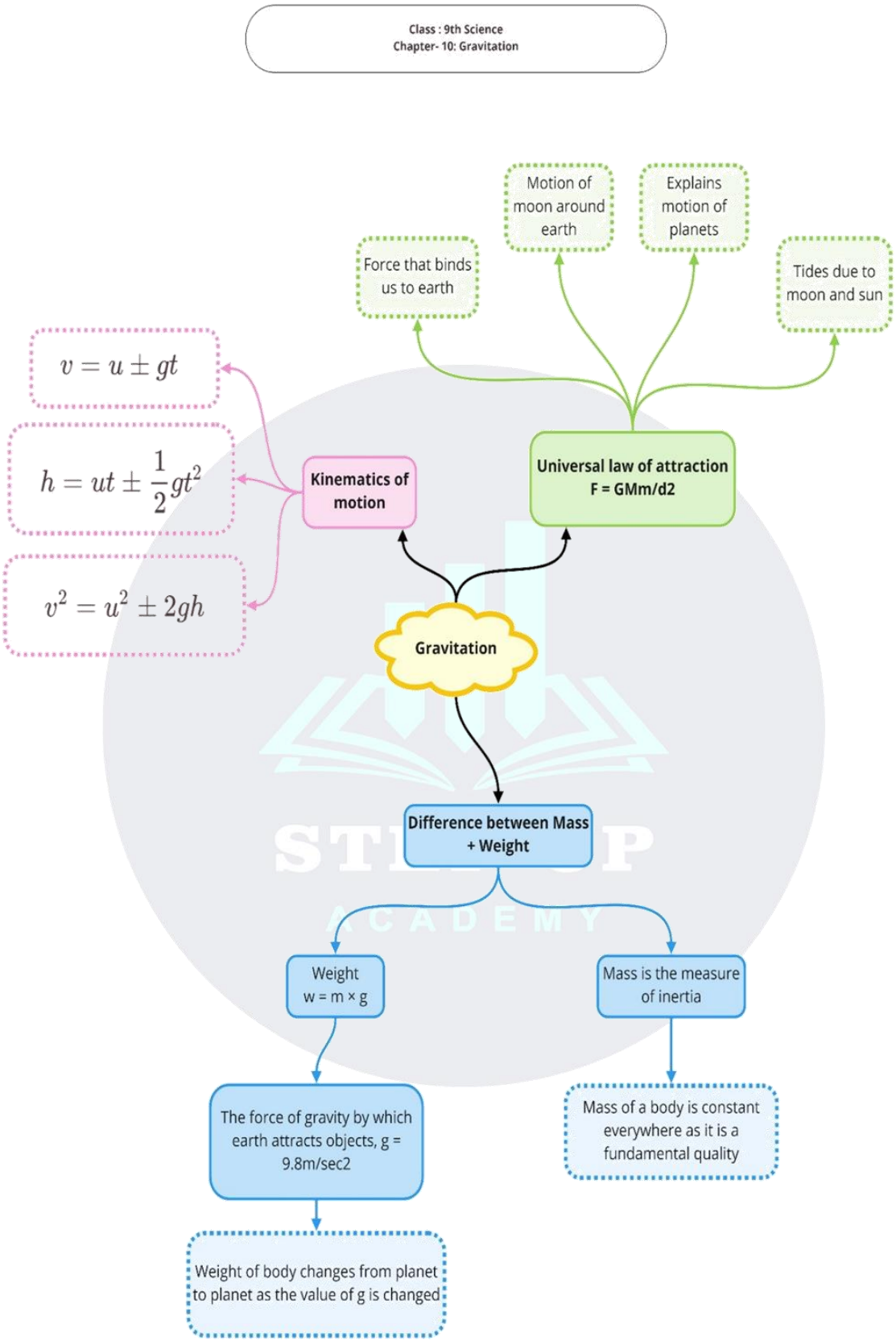


When an object is immersed wholly or partially in a fluid, it experiences an upward force which is equal to the weight of the fluid displaced by it.

- The buoyant force acting on an object = Weight of fluid displaced by that object

Applications of Archimedes' Principle

- In designing ships and submarines
- In determining the purity of milk with a lactometer
- In determining the density of liquids with a hydrometer


Class : 9th Science
Chapter- 10: Gravitation
Motion of moon around earth
Explains motion of planets
Force that binds us to earth
Tides due to moon and sun
$v = u \pm gt$
$h = ut \pm \frac{1}{2}gt^2$
$v^2 = u^2 \pm 2gh$
Kinematics of motion
Universal law of attraction F = GMm/d2
Gravitation
Difference between Mass + Weight
Weight w = m × g
Mass is the measure of inertia
The force of gravity by which earth attracts objects, g = 9.8m/sec2
Mass of a body is constant everywhere as it is a fundamental quality
Weight of body changes from planet to planet as the value of g is changed

Important Question

Multiple Choice Questions:

1. Two objects of different masses falling freely near the surface of the moon would
   (a) have same velocities at any instant
   (b) have different acceleration
   (c) experience forces of same magnitude
   (d) undergo a change in their inertia
2. The value of acceleration due to gravity
   (a) is same on equator and poles
   (b) is least on poles
   (c) is least on equator
   (d) increases from pole to equator
3. The gravitational force between two objects is F. If masses of both objects are halved without changing the distance between them, then the gravitational force would become
   (a) F/4
   (b) F/2
   (c) F
   (d) 2F
4. A boy is whirling a stone tied to a string in a horizontal circular path. If the string breaks, the stone
   (a) will continue to move in the circular path
   (b) will move along a straight line towards the centre of the circular path
   (c) will move along a straight line tangential to the circular path
   (d) will move along a straight line perpendicular to the circular path away from the boy
5. An object is put one by one in three liquids having different densities. The object floats with $\frac{1}{9}$, $\frac{2}{11}$ and $\frac{3}{7}$ parts of their volumes outside the liquid surface in liquids of densities d_1, d_2 and d_3 respectively. Which of the following statement is correct?
   (a) $d_1 > d_2 > d_3$
   (b) $d_1 > d_2 < d_3$
   (c) $d_1 < d_2 > d_3$
   (d) $d_1 < d_2 < d_3$
6. In the relation $F = GM\,mld^2$, the quantity G
   (a) depends on the value of g at the place of observation
   (b) is used only when the Earth is one of the two masses
   (c) is greatest at the surface of the Earth
   (d) is universal constant of nature
7. Law of gravitation gives the gravitational force between
   (a) the Earth and a point mass only
   (b) the Earth and Sun only
   (c) any two bodies having some mass
   (d) two charged bodies only
8. The value of quantity G in the law of gravitation
   (a) depends on mass of Earth only
   (b) depends on radius of Earth only
   (c) depends on both mass and radius of Earth
   (d) is independent of mass and radius of the Earth
9. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be
   (a) $\frac{1}{4}$ times
   (b) 4 times
   (c) $\frac{1}{2}$ times
   (d) unchanged
10. The atmosphere is held to the Earth by
    (a) gravity
    (b) wind
    (c) clouds
    (d) Earth's magnetic field

Very Short Question:

1. What is the S.I. unit of thrust?
2. What is the S.I. unit of pressure?
3. Define thrust.
4. Define pressure.
5. Why is it easier to swim in sea water than in river water?

6. Why a truck or a motorbike has much wider tires?
7. Why are knives sharp?
8. Why is the wall of dam reservoir thicker at the bottom?
9. Why do nails have pointed tips?
10. While swimming why do we feel light?

Short Questions:

1. State the difference in balanced and unbalanced force.
2. What change will force bring in a body?
3. When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side. Explain why?
4. Explain why it is dangerous to jump out of a moving bus.
5. Why do fielders pull their hand gradually with the moving ball while holding a catch?
6. In a high jump athletic event, why are athletes made to fall either on a cushioned bed or on a sand bed?
7. How does a karate player breaks a slab of ice with a single blow?
8. What is law of conservation of momentum?

Long Questions:

1. With the help of an activity prove that the force acting on a smaller area exerts a larger pressure?

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Universal gravitational constant G is a scalar quantity.

   Reason: The value of G is same through out the universe.

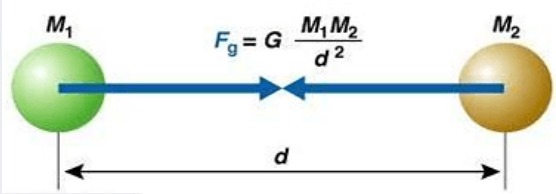
2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: When distance between two bodies is doubled and also mass of each body is doubled, then the gravitational force between them remains the same.

   Reason: According to Newton's law of gravitation, product of force is directly proportional to the product mass of bodies and inversely proportional to square of the distance between them.

Case Study Questions:

1. Every object in the universe attracts every other object with a force which is proportional to the product of their masses (m1*m2) and inversely proportional to the square of the distance (d^2) between them. The force is along the line joining the centers of two objects.



Mathematically,

$$F = G\frac{M_1 \times M_2}{d_2}$$

Where,

M_1 = mass of one object.

M_2 = mass of another object.

d = distance between two objects.

G = universal gravitational constant.

The value of G was found out by Henry Cavendish (1731-1810) by using a sensitive balance.

The accepted value of G is 6.673×10^{-11} N-m^2/kg^2. Answer the following questions from above case.

(i) Gravitational force does not depend on

(a) Masses of objects

(b) Separation between objects

(c) Charges on objects

(d) None of these

(ii) Force of gravitation varies with masses of object as:

(a) Product of masses

(b) Sum of masses

(c) Difference of masses

(d) None of these

(iii) When mass of one body is doubled then force of gravitation will become:

(a) Force will remain same

(b) Force will become double

(c) Force will become halved

(d) None of these

(iv) What is universal gravitational constant? What is its SI unit?

(v) Two objects of masses 10kg and 20kg separated by distance 10m. What is gravitational force between them?

2. We know that the earth attracts every object with a certain force and this force depends on the mass (m) of the object and the acceleration due to the gravity (g). The weight of an object is the force with which it is attracted towards the earth.

Mathematically

$$W = m \times g$$

Where, W= weight of object

m= mass of object

g = acceleration due to the gravitational force

As the weight of an object is the force with which it is attracted towards the earth, the SI unit of weight is the same as that of force, that is, Newton (N). The weight is a force acting vertically downwards; it has both magnitude and direction. We have learnt that the value of g is constant at a given place. Therefore at a given place, the weight of an object is directly proportional to the mass, say m, of the object, that is, W αm. It is due to this reason that at a given place, we can use the weight of an object as a measure of its mass. Answer the following questions.

(i) Unit of acceleration due to the gravity (g) is:

(a) m/s

(b) m/s^2

(c) Newton(N)

(d) None of these

(ii) Direction of weight of any object is:

(a) Always towards centre of earth

(b) Always away from centre of earth

(c) Weight don't have direction

(d) None of these

(iii) Which of the following has same unit:

(a) Mass and weight

(b) Weight and force

(c) Velocity and acceleration

(d) None of these

(iv) Whether weight is scalar quantity or vector quantity? Justify your answer.

(v) Differentiate between mass and weight.

Answer Key

Multiple Choice Answers:

1. (a) have same velocities at any instant
2. (c) is least on equator
3. (a) F/4
4. (c) will move along a straight line tangential to the circular path
5. (d) $d_1 < d_2 < d_3$
6. (d) is universal constant of nature
7. (c) any two bodies having some mass
8. (d) is independent of mass and radius of the Earth
9. (b) 4 times
10. (a) gravity

Very Short Answers:

1. **Answer:** Newton.
2. **Answer:** The S.I. unit of pressure = N/m^2 = Pascal.
3. **Answer:** The net force exerted by a body in a particular direction is called thrust.
4. **Answer:** The force exerted per unit area is called pressure.
5. **Answer:** The density of sea water is more due to dissolved salts in it as compared to the density of river water. Hence the buoyant force exerted on the swimmer by the sea water is more which helps in floating and makes swimming easier.
6. **Answer:** The pressure exerted by it can be distributed to more area, and avoid the wear and tear of tires.
7. **Answer:** To increase the pressure, area is reduced,

As pressure $\propto$ 1/Area hence the pressure or force exerted on a body increases.

8. **Answer:** The pressure of water in dams at the bottom is more, to withstand this pressure the dams have wider walls.
9. **Answer:** The force exerted when acts on a smaller area, it exerts larger pressure. So the nails have pointed tips.
10. **Answer:** The swimmer is exerted by an upward force by water, this phenomenon is called buoyancy and it makes the swimmer feel light.

Short Answers:

1. **Answer:** The iron rod sinks due to high density and less buoyant force exerted by the water on it, but in case of ship the surface area is increased, the upthrust experienced by the body is more. So it floats on water
2. **Answer:** Camels feet are broad and the larger area of the feet reduces the force/ pressure exerted by the body on the sand. But when we have to walk on the same sand, we sink because the pressure exerted by our body is not distributed but is directional.
3. **Answer:** Lactometer is a device used to find the purity of a given sample of milk. Hydrometer is a device used to find the density of liquids.
4. **Answer:** It means that the density of silver is 10.8 times more than that of water. T
5. **Answer:**

Relative density of gold = 19.3

$$\text{Relative density of gold} = \frac{\text{Density of gold}}{\text{Density of water}}$$

$\therefore$ Density of gold = Relative density of gold $\times$ Density of water

$= 19.3 \times 10^3$ kg/m^3

$= 19300$ kg/m^3

6. **Answer:** Archimedes' principle- When a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

It is used in designing of ships and submarines.

floats on water but another sink in oil. Why?

7. **Answer:** The cork floats on water because the density of cork is less than the density of water, and another cork sinks in the oil because the density of cork is more than the oil.
8. **Answer:** Fluids are the substances which can flow e.g., gases and liquids are fluids. Archimedes' principle is based on the upward force exerted by fluids on any object immersed in the fluid.

Hence it is applicable only for fluids.

Applications of Archimedes' principle:

- It is used in designing of ship and submarine.
- It is used in designing lactometer, used to determine the purity of milk,
- To make hydrometers, used to determine the density of liquids.

Long Answers:

1. **Answer:** Consider a block of wood kept on a table top. The mass of the wooden block is 5 kg. Its dimension is 40 cm $\times$ 20 cm $\times$ 10 cm.

Now, we have to find the pressure exerted by the wooden block on the table top by keeping it vertically and horizontally.

The mass of wooden block = 5 kg

Weight of the wooden block applies a thrust on the table top

$\therefore$ Thrust = $F = m \times g$

$= 5 \text{ kg} \times 9.8 \text{ m/s}^2 = 49$ N

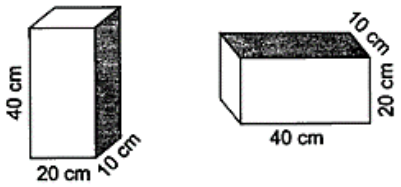
(case a)—When the wooden box is kept vertically with sides 20 cm $\times$ 10 cm

Area of a side = length × breadth

= 20 cm × 10 cm

= 200 cm2 = 0.02 m2

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = \frac{49\,\text{N}}{0.02\,\text{m}^2} = 2450\,\text{N/m}^2$$



(case b)—When the block is kept horizontally with side 40 cm × 20 cm

Area of a side = length × breadth

= 40 cm × 20 cm

= 800 cm2 = 0.08 m2

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = \frac{49\,\text{N}}{0.08\,\text{m}^2} = 612.5\,\text{N/m}^2$$

∴ The pressure exerted by the box in case (a) is more as compared to the pressure exerted in case (b).

The area is reduced and the pressure exerted is more.

This shows that pressure ∝ 1/area.

Pressure will be larger if the area is reduced.

Application:

- Nails have pointed tips.
- Knives have sharp edges.
- Needles have pointed tips.

Assertion Reason Answer:

1. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

Case Study Answers:

1. (i) (c) Charges on objects

   (ii) (a) Product of masses

   (iii) (b) Force will become double

   (iv) The force of attraction between any two unit masses separated by a unit distance is called universal gravitational constant denoted by G measured in Nm^2/kg^2.

   (v) Mathematically,

$$F = G\frac{M_1 \times M_2}{d_2}$$

Here, M_1 = 10 kg

M_2 = 20 kg

D = 10 m

Then, force is given by

$F = 6.67 \times 10^{-11} \times 20 \times 10/100$

$F = 13.34 \times 10^{-11}$ N

2. (i) b

   (ii) a

   (iii) b

   (iv) Weight is vector quantity as it has magnitude as well as direction which is always towards centre of a earth.

   (v) Difference between mass and weight is given below

No.	Mass	Weight
1	Mass is amount of matter in a body.	Weight is the measure of force acting on a mass due to acceleration due to gravity.
2	it is a scalar quantity	it is a vector quantity
3	SI unit of mass is Kilogram (Kg).	SI unit of weight is Newton (N).
4.	Mass can never be zero	Weight can be zero where gravity is zero.

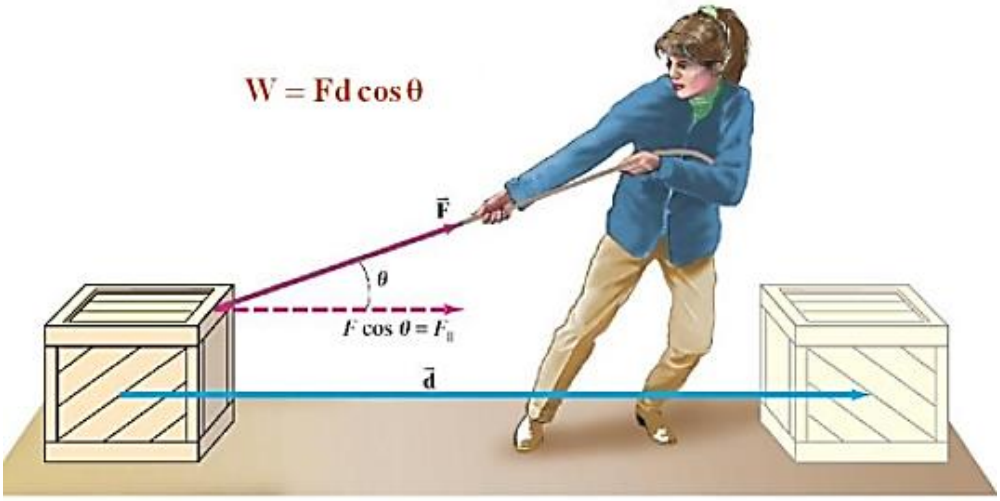
Work and Energy 4

- In our everyday life we use terms like work and energy.
- Term work is generally used in context to any kind of activity requiring physical or mental effort.
- When we push or pull a heavy load or lift it above the floor then we are doing work, but a man carrying heavy load and standing still is not doing any work according to scientific definition of work.
- Another term we often use is energy. Energy is usually associated with work done in the sense that a person feeling very energetic is capable of doing lot of work.
- This way energy is defined to be as capacity of doing work.
- There are many forms of energy like chemical energy, mechanical energy, electrical energy, heat energy etc. These forms of energies can be used in number of ways.
- One form of energy can be converted into another form of energy.
- In this chapter we will study about work, relation between work and energy, conservation of energy etc.

Work Done

Work done on an object is defined as the product of the magnitude of the force acting on the body and the displacement in the direction of the force. W = F.s

If a force acting on a body causes no displacement, the work done is 0. For example, pushing a wall.



Work: Factors On Which It Depends

We use terms such as overworked and hard workers to describe the effort put by a person. But what is the meaning of work and how do we quantify it? In this article, we will learn the definition of work in terms of physics and the factors on which work depends.

Defining Work

The scientific definition of work is different in many ways from its everyday meaning. The definition of work in physics reveals its relationship to energy – whenever work is done, energy is transferred.

For a work to be done, in a scientific sense, a force must be exerted and there must be displacement in the direction of the force. With this said, we can say that

Work is the product of the component of the force in the direction of the displacement and the magnitude of this displacement.

Mathematically, the above statement is expressed as follows:

$$W = (F \cos \theta)\, d = F.\, d$$

Where,

W is the work done by the force.

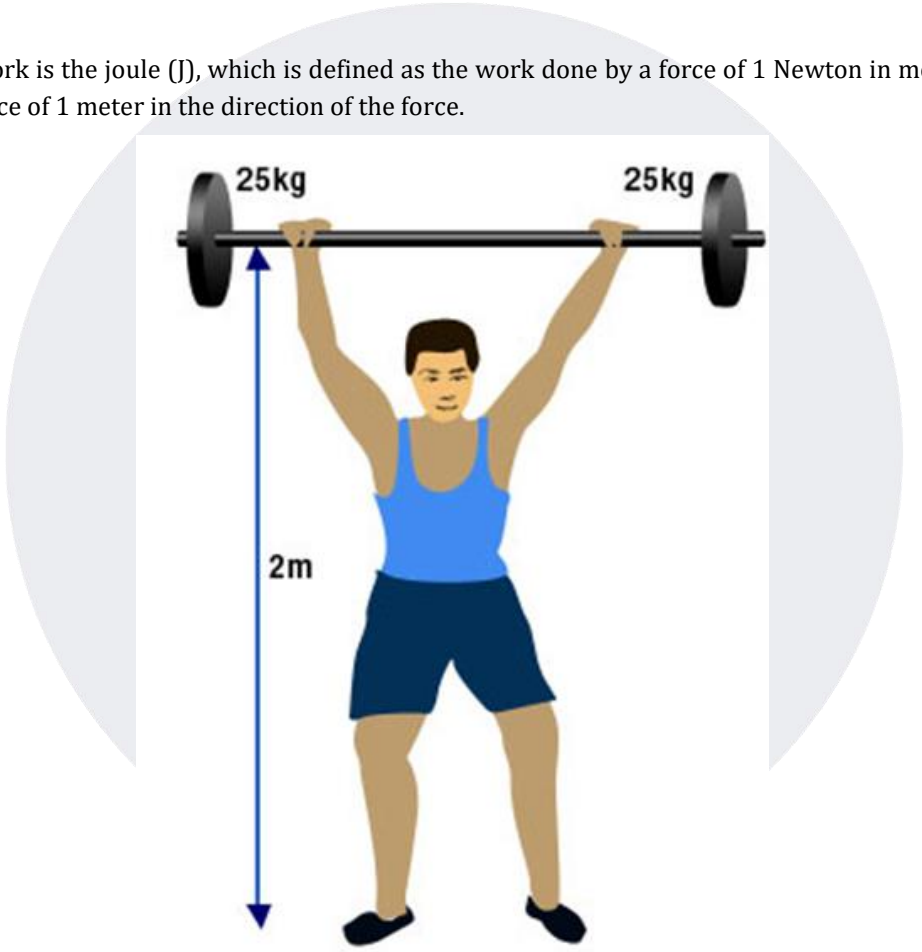
F is the force, d is the displacement caused by the force

θ is the angle between the force vector and the displacement vector

The dimension of work is the same as that of energy and is given as, $[ML^2T^{-2}]$.

Unit of Work

The SI unit of work is the joule (J), which is defined as the work done by a force of 1 Newton in moving an object through a distance of 1 meter in the direction of the force.



The work done upon the weight against gravity can be calculated as follows:

$$\text{Work Done} = (\text{Mass} \times \text{acceleration due to gravity}) \times \text{Displacement}$$

$$= (25 \times 9.8) \times 2 \text{ J}$$

Factors Affecting Work

Let us now consider the factors on which work done on an object by a force depends.

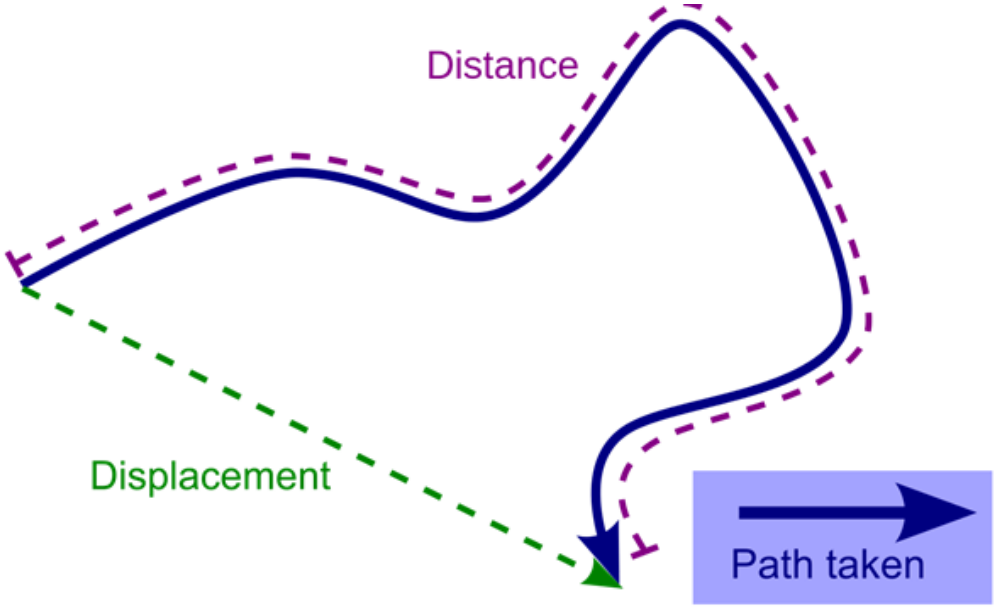
Force:

Force is defined as a push or a pull that can cause any object with a mass to change its velocity and acceleration. Force is a vector quantity and has both a magnitude and a direction. If the force acting on an object is zero irrespective of the state of the object (dynamic or static) that work done by the force is zero.

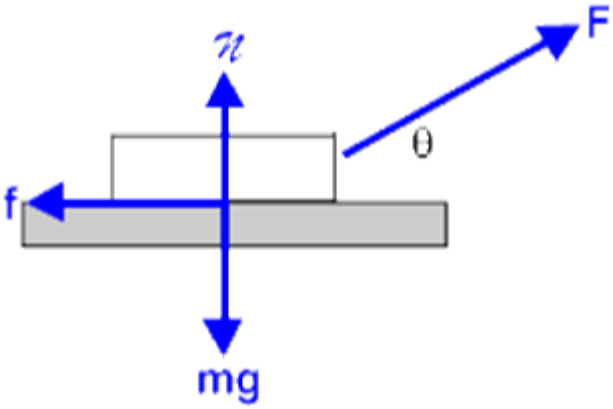
Displacement:

Displacement is a vector quantity that gives the shortest distance between the initial position and the final position of any object. If the resulting displacement in the direction of force, due to force acting on any object is zero, the net work done by that force on that object is zero. For e.g., if we push a rigid wall with all our might and still fail to displace it, then we can say no work has been performed by us on the wall.

The Angle between the Force Vector and the Displacement Vector



The work done by a force on an object can be positive, negative, or zero, depending upon the direction of displacement of the object with respect to the force. For an object moving in the opposite direction to the direction of force, such as friction acting on an object moving in the forward direction, the work is done due to the force of friction is negative.



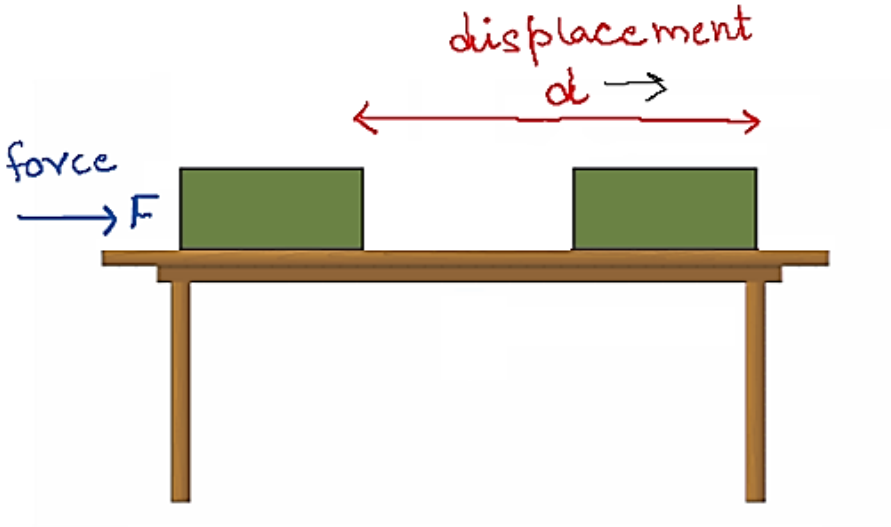
Similarly, an object experiences a zero force when the angle of displacement is perpendicular to the direction of the force. Consider an example of a coolie lifting a mass on his head moving at an angle of 90° with respect to the force of gravity. Here, the work done by gravity on the object is zero.

Work

- **Work** is done when a **force** produces **motion** in a body.
- Work done in moving a body is equal to the product of force exerted on the body and the distance moved by the body in the direction of force.

$$\text{Work} = \text{Force} \times \text{Distance}$$

$$W = F \times S$$



Force **F** points in the same direction as displacement ***d***

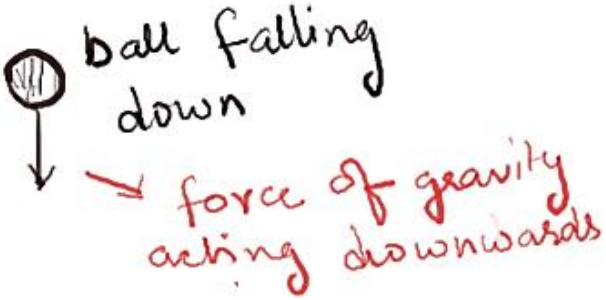
- Work is a **scalar** quantity. It has only magnitude and no direction.
- Its SI unit is **joule** (J).
- **One joule of work** is said to be done on an object when a force of 1 N displaces the object by 1 m along the line of action of force.
- Work done by a force can be positive, negative or zero.
- It is **positive** when a force acts in the direction of motion of the body.
- It is **negative** when a force acts opposite to the direction of motion of the body.
- It is **zero** when a force acts at right angles to the direction of motion of the body.

Positive Work

If a force displaces the object in its direction, then the work done is positive

So, W= Fd

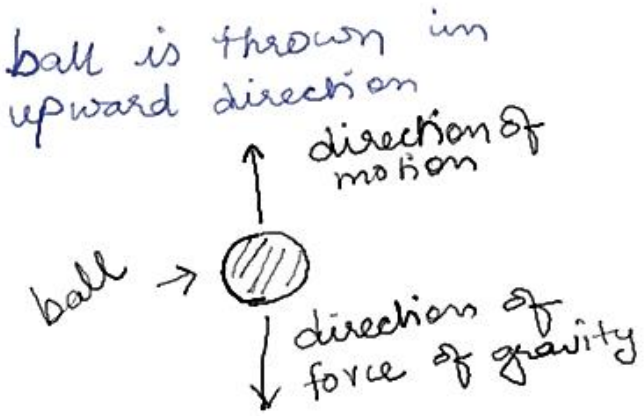
The example of this kind of work done is motion of ball falling towards ground where displacement of ball is in the direction of force of gravity.

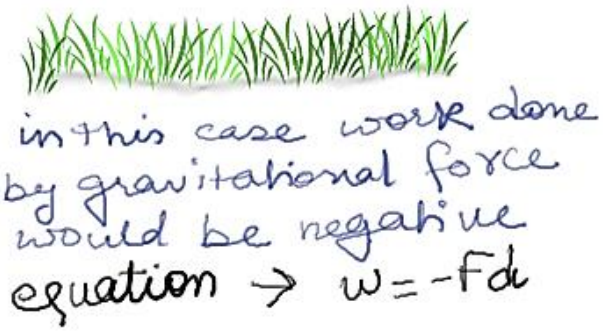


in this case work done would be positive
equation → W = Fd

Negative work

If the force and the displacement are in opposite directions, then the work is said to be negative. For example if a ball is thrown in upwards direction, its displacement would be in upwards direction but the force due to earth's gravity is in the downward direction.



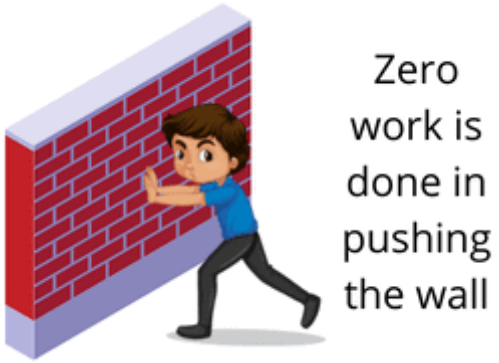


So here in this case gravity is doing negative work when you throw the ball upwards. Hence the work done by gravitational force is negative. Mathematically when displacement is opposite to the force work done is given by

Negative work just means that the force and the displacement act in opposite directions.

Case of zero work done

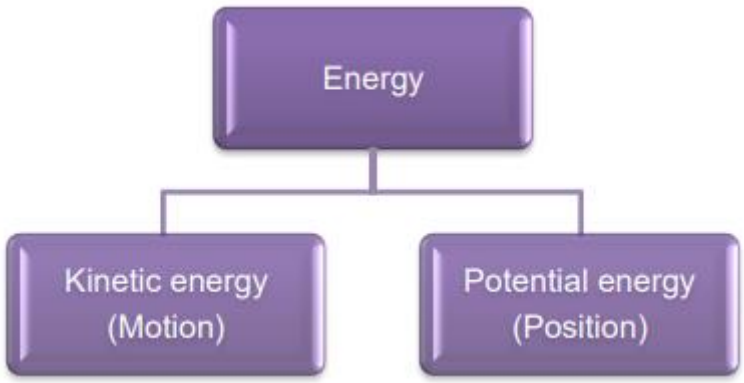
If the directions of force and the displacement are perpendicular to each other, the work done by the force on the object is zero.



For example, when we push hard against a wall, the force we are exerting on the wall does no work, because in this case the displacement of the wall is d = 0. However, in this process, our muscles are using our internal energy and as a result we get tired.

Energy

- We define energy as the ability to do work.
- The amount of energy possessed by a body is the amount of work it can do when that energy is released.
- Energy is a scalar quantity.
- Its SI unit is joule (J). 1 kJ = 1000 J
- The main forms of energy are kinetic energy, potential energy, chemical energy, heat energy, light energy, sound energy, electrical energy and nuclear energy.

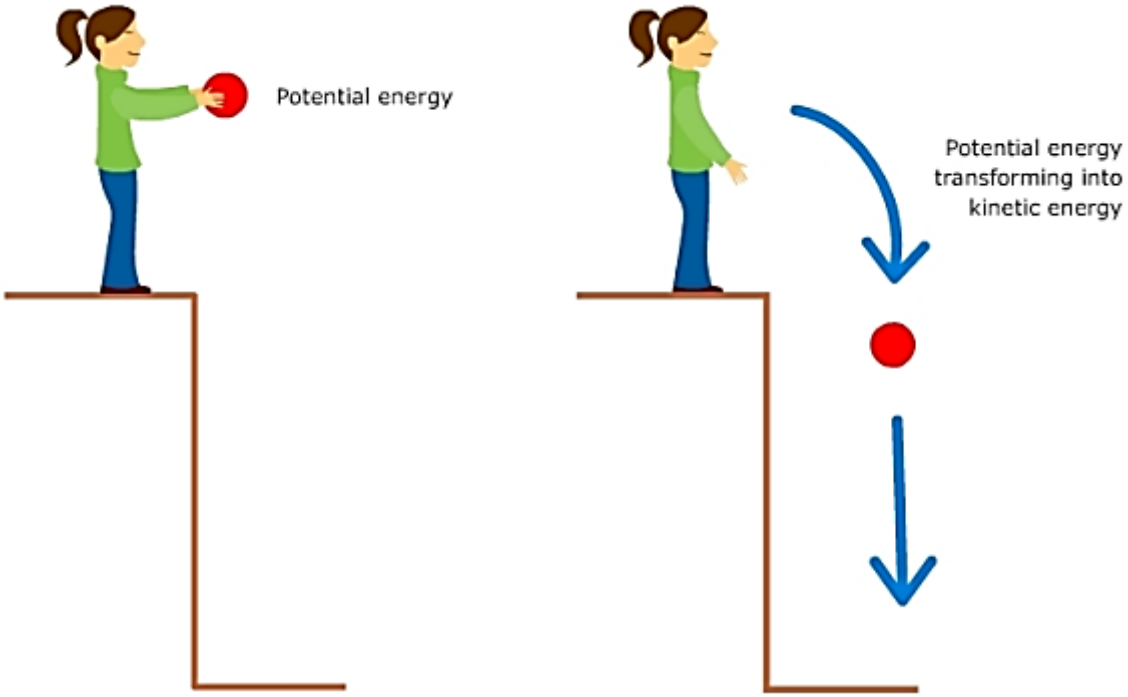


Kinetic Energy

- The energy possessed by a body on account of its motion is known as kinetic energy.
- Kinetic energy possessed by a body of mass 'm' moving with a velocity 'v' is given by the formula:

$$\text{Kinetic Energy} = \frac{1}{2}mv^2$$

- Kinetic energy of a body is directly proportional to
- the mass of the body
- the square of the velocity of the body



Potential Energy

- The energy possessed by a body because of its **position** or **configuration** is known as **potential energy**.
- The work done in raising an object from the ground to a point against gravity is called gravitational potential energy.
- Potential energy of a body of mass 'm' raised to a height 'h' above the surface of the Earth is given by the formula:

  Potential Energy = m g h

  where 'g' is the acceleration due to gravity.

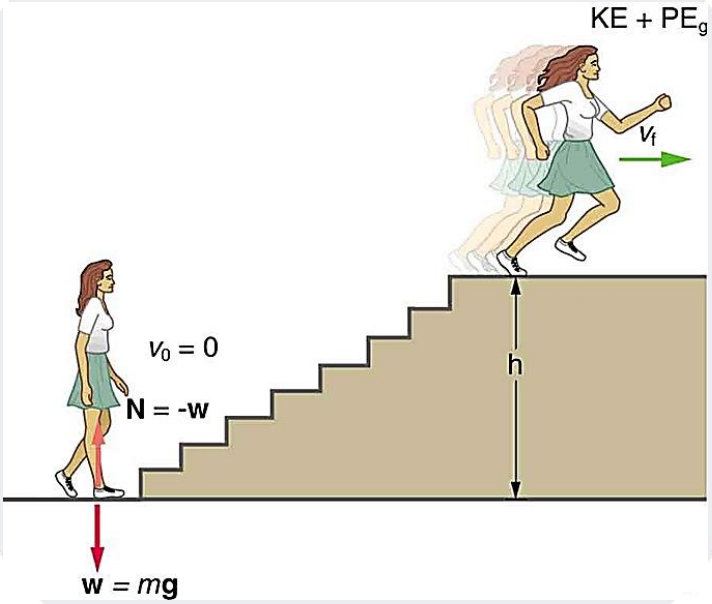
Law of conservation of energy:

Sum of kinetic energy and potential energy of an object is its total mechanical energy.

> Energy can neither be created nor destroyed; it can only be converted from one form to the other.

Power

Power is defined as the rate of doing work or the rate of transfer of energy.



$$Power = \frac{Work\ done}{Time\ taken}$$

or

$$Power = \frac{Energy\ consumed}{Time\ taken}$$

- Power is a scalar quantity. Its SI unit is watt (W).
- It is said to be one watt when the rate of consumption of energy is 1 Js^{-1}.
- Larger units of power are kilowatt (kW), megawatt (MW) and horsepower (hp). 1 kW = 1000 W
- 1 MW = 10^6 W
- 1 hp = 746 W

Commercial Unit of Energy

- The commercial unit of energy is kilowatt hour (kWh).
- One kilowatt hour is the amount of electrical energy consumed when an electrical appliance with a power rating of 1 kilowatt is used for 1 hour.

- 1 kWh is equal to 3.6×10^6 J of energy.
- 1 kilowatt hour of electrical energy is commonly known as 1 unit.

Work-energy theorem

The work-energy theorem states that the net work done by a moving body can be calculated by finding the change in KE.

$$\Rightarrow W_{net} = KE_{final} - KE_{initial}$$

$$\Rightarrow W_{net} = \frac{1}{2}$$

$m[v^2 - u^2]$

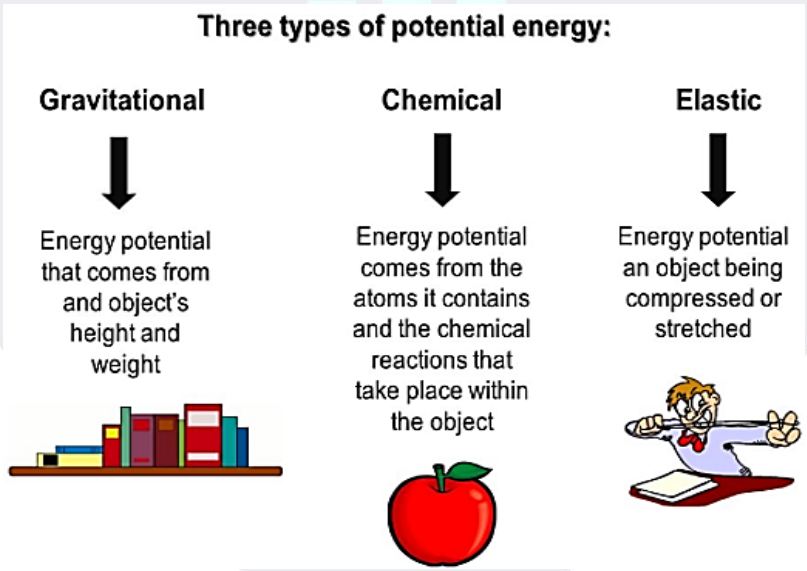
Factors affecting kinetic energy

- ✓ Mass
- ✓ Velocity
- ✓ Momentum

Potential Energy

Energy can get stored in an object when work is done on it.

For example, stretching a rubber string. The energy that is possessed by a body by virtue of its configuration or change in position is known as Potential Energy.



The potential energy of an object at a height.

When an object is raised to a certain height, work is done against gravity to change its position. This energy is stored as Potential Energy.

$\Rightarrow W = F.s$

$\Rightarrow F = ma$

In the case of increasing the height, F = mg

Therefore, W (P.E) = mgh

$\Rightarrow \Delta PE = mg\ (h_{final} - h_{initial})$

Law of Conservation of Energy

Law of conservation of energy states that energy can neither be created nor destroyed, but can be transferred from one form to another. The total energy before and after the transformation remains constant.

Total energy = KE + PE

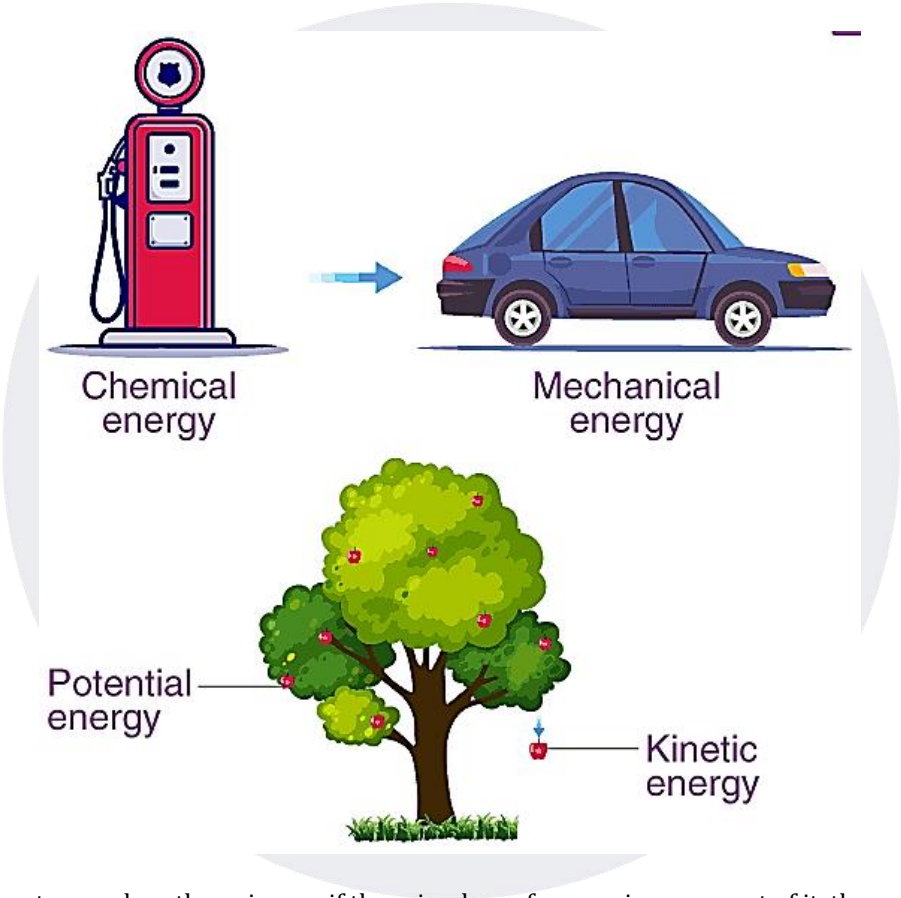
For example: consider a ball falling freely from a height. At height h, it has only PE = mgh.

By the time it is about to hit the ground, it has a velocity and therefore has KE = $\frac{1}{2}$ mv^2. Therefore, energy gets transferred from PE to KE, while the total energy remains the same.

Energy is required for the evolution of life forms on earth. In physics, it is defined as the capacity to do work. We know that energy exists in different forms in nature. You have learned about various forms of energy – heat, electrical, chemical, nuclear, etc. In this article, we will learn about the laws and principles that govern energy. This law is known as the law of conservation of energy.

The law of conservation of energy states that energy can neither be created nor be destroyed. Although, it may be transformed from one form to another. If you take all forms of energy into account, the total energy of an isolated system always remains constant. All the forms of energy follow the law of conservation of energy. In brief, the law of conservation of energy states that

In a closed system, i.e., a system that is isolated from its surroundings, the total energy of the system is conserved.



So in an isolated system such as the universe, if there is a loss of energy in some part of it, there must be a gain of an equal amount of energy in some other part of the universe. Although this principle cannot be proved, there is no known example of a violation of the principle of conservation of energy.

The amount of energy in any system is determined by the following equation:

$$U_T = U_i + W + Q$$

U_T is the total energy of a system

U_i is the initial energy of a system

Q is the heat added or removed from the system

W is the work done by or on the system

The change in the internal energy of the system is determined using the equation

$$\Delta U = W + Q$$

Law of Conservation of Energy Derivation

Considering the potential energy at the surface of the earth to be zero. Let us see an example of a fruit falling from a tree.

Consider a point A, which is at height 'H' from the ground on the tree, the velocity of the fruit is zero hence potential energy is maximum there.

E = mgH ———- (1)

When the fruit is falling, its potential energy is decreasing and kinetic energy is increasing.

At point B, which is near the bottom of the tree, the fruit is falling freely under gravity and is at a height X from the ground, and it has speed as it reaches point B. So, at this point, it will have both kinetic and potential energy.

E = K.E + P.E

P.E = mgX ——— (2)

According to third equation of motion

$v^2 = 2g(H-X)$

$\Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}m.2g(H-X)$

$\Rightarrow K.E = \frac{1}{2}m.2g(H-X)$

$\Rightarrow K.E = mg(H-X)$

K.E = mg (H-X)———- (3)

Using (1), (2) and (3)

E = mg (H – X) + mgX

E = mg (H – X + X)

E = mgH

Similarly, if we see the energy at point C, which is at the bottom of the tree, it will come out to be mgH. We can see as the fruit is falling to the bottom and here, potential energy is getting converted into kinetic energy. So there must be a point where kinetic energy becomes equal to potential energy. Suppose we need to find that height 'x' from the ground. We know at that point,

K.E = P.E

P.E = K.E = $\frac{E}{2}$ ———- (4)

E2 is the new energy

Where, E = mgH2

H2 is the new height.

As the body is at height X from the ground,

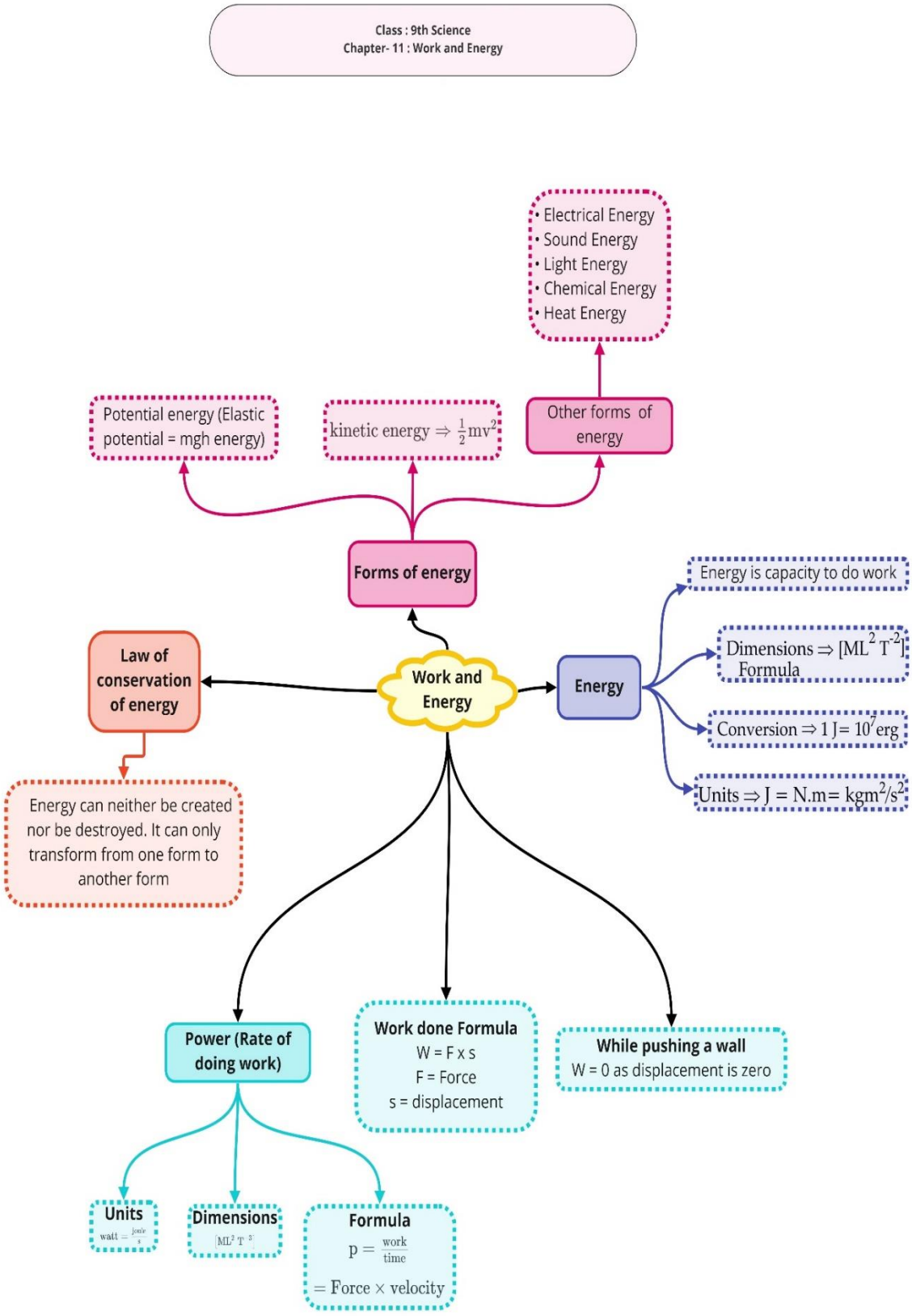
P.E = mgX ——— (5)

Using (4) and (5) we get,

$mgX = \frac{mgH}{2}$

$\Rightarrow X = \frac{H}{2}$

H2 is referred to the new height


Class : 9th Science
Chapter- 11 : Work and Energy
• Electrical Energy
• Sound Energy
• Light Energy
• Chemical Energy
• Heat Energy
Potential energy (Elastic potential = mgh energy)
kinetic energy ⇒ $\frac{1}{2}mv^2$
Other forms of energy
Forms of energy
Energy is capacity to do work
Dimensions ⇒ $[ML^2T^{-2}]$ Formula
Conversion ⇒ 1 J = 10^7 erg
Units ⇒ J = N.m = kgm^2/s^2
Law of conservation of energy
Work and Energy
Energy
Energy can neither be created nor be destroyed. It can only transform from one form to another form
Power (Rate of doing work)
Work done Formula
W = F x s
F = Force
s = displacement
While pushing a wall
W = 0 as displacement is zero
Units
watt = joule/s
Dimensions
$[ML^2T^{-3}]$
Formula
$p = \frac{work}{time}$
= Force × velocity

Important Question

Multiple Choice Questions:

1. When a body falls freely towards the earth, then its total energy
   (a) increases
   (b) decreases
   (c) remains constant
   (d) first increases and then decreases
2. A car is accelerated on a levelled road and attains a velocity 4 times of its initial velocity. In this process the potential energy of the car
   (a) does not change
   (b) becomes twice to that of initial
   (c) becomes 4 times that of initial
   (d) becomes 16 times that of initial
3. In case of negative work the angle between the force and displacement is:
   (a) 0°
   (b) 45°
   (c) 90°
   (d) 180°
4. An iron sphere of mass 10 kg has the same diameter as an aluminium sphere of mass is 3.5 kg. Both spheres are dropped simultaneously from a tower. When they are lo m above the ground, they have the same.
   (a) acceleration
   (b) momenta
   (c) potential energy
   (d) kinetic energy
5. A girl is carrying a school bag of 3 kg mass on her back and moves 200 m on a levelled road. The work done against the gravitational force will be ($g = 10\ ms^2$)
   (a) 6×10^3 J
   (b) 6 J
   (c) 0.6 J
   (d) zero
6. Which one of the following is not the unit of energy?
   (a) joule
   (b) newton meter
   (c) kilowatt
   (d) kilowatt hour
7. The work done on an object does not depend upon the
   (a) displacement
   (b) force applied
   (c) angle between force and displacement
   (d) initial velocity of the object
8. Water stored in a dam possesses
   (a) no energy
   (b) electrical energy
   (c) kinetic energy
   (d) potential energy
9. A body is falling from a height h. After it has fallen a height $\frac{h}{2}$, it will possess
   (a) only potential energy
   (b) only kinetic energy
   (c) half potential and half kinetic energy
   (d) more kinetic and less potential energy
10. The number of joules contained in 1 kWh is
    (a) 36×10^5 J
    (b) 3.6×10^7 J
    (c) 36×10^8 J
    (d) 3.7×10^7 J

Very Short Question:

1. Define the following terms.
   (a) Work was done
   (b) Energy
   (c) Mechanical energy
   (d) Kinetic energy
   (e) Potential energy
   (f) Power
   (g) Commercial unit of energy.
2. Write down the type of energy stored in
   (a) spring of a watch
   (b) flowing water
   (c) rolling stone
   (d) raised hammer
   (e) running athlete
3. What will be the kinetic energy of a body when its mass is made four-time and the velocity is doubled?

4. If we lift a body of 7 kg vertically upwards to a height of 10 m, calculate the work done in lifting the body.
5. State the transformation of energy that takes place when

   Green plants prepare their food.

   Head of a nail hammered hard and it becomes hot.
6. How much work is done by a man who tries to push the wall of a house but fails to do so?
7. Establish a relationship between SI unit and commercial unit of energy.
8. Write down the energy transformation taking place
   (a) In electric bulb
   (b) In torch
   (c) In the thermal power station
   (d) In solar cell
   (e) Electric heater
9. A body of mass m is moving in a circular path of radius r. How much work is done on the body?
10. A horse of mass 200 kg and a dog of mass 20 kg are running at the same speed. Which of the two possesses more kinetic energy? How?

Short Questions:

1. State law of conservation of energy and law of conservation of mechanical energy.
2. Define (a) 1 joule (b) 1 watt.
3. Write down SI unit of the following quantities.
   (a) work
   (b) kinetic energy
   (c) potential energy
   (d) power
4. What is the sequence of energy change that takes place in the production of electricity from adam?
5. A light and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has larger kinetic energy?
6. Why a man does not do work when he moves on a level road while carrying a box on his head?
7. If an electric iron of 1200 W is used for 30 minutes every day, find electric energy consumed in the month of April.
8. What is work done by a force of gravity in the following cases?
   (a) Satellite moving around the Earth in a circular orbit of radius 35000 km.
   (b) A stone of mass 250 g is thrown up through a height of 2.5 m.

Long Questions:

1. State the conditions for positive, negative, and zero work. Give at least one example of each.
2. Give a reason for the following:
   (a) A bullet is released on firing the pistol.
   (b) An arrow moves forward when released from the stretched bow.
   (c) Winding the spring of a toy car makes it to run on the ground.
   (d) Falling water from a dam generates electricity.
   (e) Winding the spring of our watch, the hands of the watch movement.
3. State the law of conservation of energy. Show that the energy of a freely falling body is conserved.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Assertion is false but Reason is true.

   Assertion: Work done by or against gravitational force in moving a body from one point to another is independent of the actual path followed between the two points.

   Reason: Gravitational forces are conservative forces.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.

b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

c. Assertion is true but Reason is false.

d. Assertion is false but Reason is true.

Assertion: The work done during a round trip is not zero.

Reason: No force is required to move a body in its round trip.

Case Study Questions:

1. Work done by force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force. Work has only magnitude and no direction. Work done is negative when the force acts opposite to the direction of displacement. Work done is positive when the force is in the direction of displacement. The unit of work is newton-metre (N m)or joule (J).

(i) Work done is:

(a) Scalar quantity

(b) Vector quantity

(c) Tensor quantity

(d) None of these

(ii) When force acts against the direction of displacement then work done will be:

(a) positive

(b) negative

(c) both a and b can possible

(d) None of these

(iii) SI unit of work is:

(a) Joule(J)

(b) Newton meter(N-m)

(c) both a and b

(d) None of these

(iv) You are lifting stone from floor. Work is done by the force exerted by you on the stone. The object moves upwards. The force you exerted is in the direction of displacement. However, there is the force of gravity acting on the object. Which one of these forces is doing positive work?

Which one is doing negative work?

(v) Define 1J of work.

2. A moving object can do work. An object moving faster can do more work than an identical object moving relatively slow. A moving bullet, blowing wind, a rotating wheel, a speeding stone can do work. How does a bullet pierce the target? How does the wind move the blades of a windmill? Objects in motion possess energy. We call this energy kinetic energy.

Thus, the kinetic energy possessed by an object of mass, m and moving with a uniform velocity, v is:

$$KE = ½ *mv^2$$

The energy possessed by an object is thus measured in terms of its capacity of doing work. The unit of energy is, therefore, the same as that of work, that is, joule (J).

(i) Energy possessed by body which is in motion is called:

(a) Potential energy

(b) Kinetic energy

(c) Nuclear energy

(d) None of these

(ii) Which of the following has same unit?

(a) Potential energy and Force

(b) Kinetic energy and work

(c) Both a and b

(d) None of these

(iii) Kinetic energy depends:

(a) Inversely on velocity of body

(b) Directly on square of velocity of body

(c) Directly on velocity of body

(d) None of these

(iv) Define kinetic energy of body. Give its SI unit

(v) Is kinetic energy scalar or vector? Justify your answer

Answer Key

Multiple Choice Answers:

1. (c) remains constant
2. (a) does not change
3. (d) 180°
4. (a) acceleration
5. (d) zero
6. (c) kilowatt
7. (d) initial velocity of the object
8. (d) potential energy
9. (c) half potential and half kinetic energy
10. (a) 36×10^5 J

Very Short Answers:

1. Answer:

(a) **Work done:** Work done by a force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force.

(b) **Energy:** Energy of a body is defined as the capacity or ability of the body to do work.

(c) **Mechanical energy:** Mechanical energy includes kinetic energy and potential energy.

(d) **Kinetic energy:** The energy possessed by a body by virtue of its motion.

(e) **Potential energy:** The energy possessed by a body due to its position or configuration.

(f) **Power:** Power is defined as the rate of doing work or the rate of transfer of energy.

(g) **Commercial unit of energy:** The energy used in households, industries, and commercial establishment are usually expressed in kilowatt-hour.

1 kWh 1 unit = 3.6 x 10^6J

2. Answer:

(a) potential energy

(b) kinetic energy

(c) kinetic energy

(d) potential energy

(e) kinetic energy.

3. Answer:

Initial kinetic energy,

$$E_{K_i} = \frac{1}{2} mv^2$$

Final kinetic energy,

$$E_{K_f} = \frac{1}{2} (4m) \times (2v)^2$$

$$= 16 \times \frac{1}{2} mv^2$$

$$E_{K_f} = 16\, E_{K_i}$$

4. Answer:

Given, m = 7 kg

s = 10m

Work done, W = F × s

E = mg × s

W = 7 × 10 × 10 J

w = 7000 J

5. Answer:

- Solar energy of sun into chemical energy.
- The kinetic energy of the hammer into heat energy.

6. Answer:

W = Fs = 0

As there is no displacement.

7. Answer:

SI unit of energy is joule and the commercial unit of energy is the joule.

1kWh = 1000 W × 3600 s = 3.6 × 10^6J

8. Answer:

(a) Electricity into light energy

(b) The chemical energy of the cell into light and heat energy

(c) The chemical energy of fuel into electricity

(d) Solar energy into electricity

(e) Electricity into heat energy.

9. **Answer:** Zero. This is because the centripetal force acting on the body is perpendicular to the displacement of the body.

10. **Answer:** The kinetic energy of the horse is more as kinetic energy is directly proportional to mass.

Short Answers:

1. **Answer: Law of conservation of energy:** Energy can neither be created nor be destroyed, it can only be transformed from one form to another.

   Conservation of mechanical energy: If there is no energy, then the mechanical energy of a system is always constant.

2. **Answer:**

   (a) 1 joule is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.

   (b) 1 watt is the power of an agent, which does work at the rate of 1 joule per second.

3. **Answer:**

   (a) joule (J)

   (b) joule (J)

   (c) joule (J)

   (d) watt (W).

4. **Answer:** The potential energy of stored water is converted into the rotational kinetic energy of turbine blades. The rotational kinetic energy of turbine blades is finally converted into electric energy by the generator.

5. **Answer:** The relation between kinetic energy and momentum

   Given,

   $$E_K = \frac{p^2}{2m}$$

   Given, $p_1 = p_2$

   Take $m_1 > m_2$,

   and $$\boxed{E_{K_2} = \frac{p_2^2}{2m^2}}$$

   $\therefore$ $$\frac{E_{K_1}}{E_{K_2}} = \frac{m^2}{m^1}$$

   $E_{K_2} > E_{K_1}$ as $m_1 > m_2$

6. **Answer:** When a man carries a load on his head, the angle between displacement (s) and force (F) is 900. Therefore, work done is zero.

7. **Answer:**

   Given,

   Power, P = 1200 W

   time, t = 30 minutes

   Power, $p = \frac{W}{t} = \frac{E}{T}$

   $E = P \times t$

   Energy consumed, $E = 1200 \times 30 \times 60$

   $= 2.16 \times 10^6 J = 2.16 MJ$

8. **Answer:**

   (a) Zero

   (b) Given,

   mass (m) = 250 g = 0.25 kg

   height (h) = 2.5 m

   Workdone, W = Fs = mgh

   $= 0.25 \times 10 \times 2.5$

   = 6.25 J

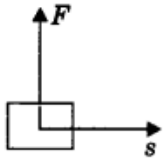
   W = 625 J

Long Answers:

1. **Answer:**

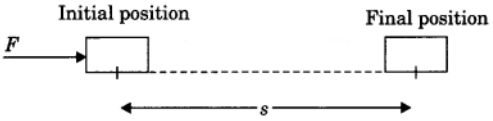
   1. **Zero work:** If the angle between force and displacement is 90°, then work done is said to be zero work.

      Example: When a man carries a load on his head and moves on a level road. Work done by the man on the load is zero.

   2. **Positive work:** Work done is said to be positive if the force applied on an object and displacement are in the same direction.

      W = Fs

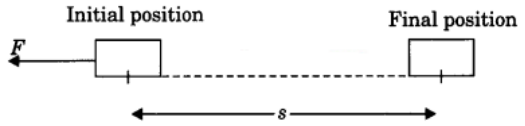
      Work, Power And Energy Class 9 Extra Questions and Answers Science Chapter 11 img 11

      Example: Work done by the force of gravity on a falling body is positive.

   3. **Negative work:** Work done is said to be negative if the applied force on an object and displacement is in opposite direction.

      W = -Fs

      Her displacement is taken to be negative (-s).



Example: Work done by friction force applied is negative on a moving body.

2. **Answer:**

(a) The chemical energy of gun powder is converted into kinetic energy of the bullet.

(b) The elastic potential energy in a stretched bow is converted into kinetic energy of the arrow.

(c) The potential energy of a spring is converted into kinetic energy of the toy.

(d) The kinetic energy of water is converted into electric energy.

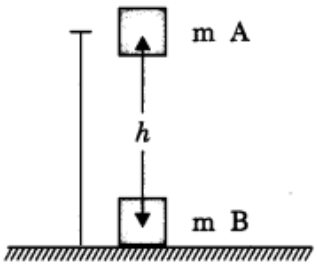
(e) The potential energy of spring due to its windings is converted into mechanical energy of the watch.

3. **Answer:**

Energy can neither be created nor be destroyed, it can only be transformed ' m A from one form to another. The total energy before and after the transformation always remains constant.

Let us consider an object of mass 'm' dropped from a height h.

Total energy at point A



$$E_{T_A} = E_K + E_P$$

or, $$E_{T_A} = 0 + mgh$$

$\therefore$ $$E_{T_A} = mgh$$

Total energy at point B,

$$E_{T_B} = E_T + E_P$$

For finding out velocity at point B

apply $$\upsilon^2 - u^2 = 2as$$

$$\upsilon_B^2 = 2gh = 2gh$$

Hence, $$E_{T_B} = \frac{1}{2}mV_B^2 + mg$$

$$E_{T_B} = \frac{1}{2}m(2gh) = mgh$$

here, $$E_{T_A} = E_{T_B}$$

Hence if there is no energy loss, total energy is conserved.

Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (d) Assertion is false but Reason is true.

Case Study Answers:

1. (i) (a) Scalar quantity

(ii) (b) negative

(iii) (c) both a and b

(iv) Here work done by you is positive work as work is being done in the direction of displacement unlike in case of gravitational force which acts in downward direction against the direction of displacement which is in upward direction.

(v) When 1 Newton of force acts on body and body displaces from its position by 1 meter then the work done is said to be 1 joule (J).

2. (i) (b) Kinetic energy

(ii) (b) Kinetic energy and work

(iii) (b) Directly on square of velocity of body

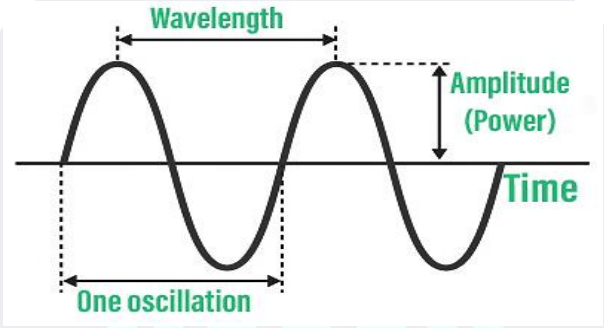
(iv) Energy possessed by object due to its motion is called as kinetic energy. Its SI unit is N-m or Joule(J).

(v) Kinetic energy is scalar quantity as it is a work done and work done is scalar quantity hence kinetic energy is also scalar quantity and doesn't have any direction.

Sound 5

- Sound is a form of **mechanical energy** which produces the sensation of **hearing**.
- It is produced due to **vibrations** of different objects. It travels in the form of waves.
- Sound is a form of energy which produces a sensation of hearing in our ears.

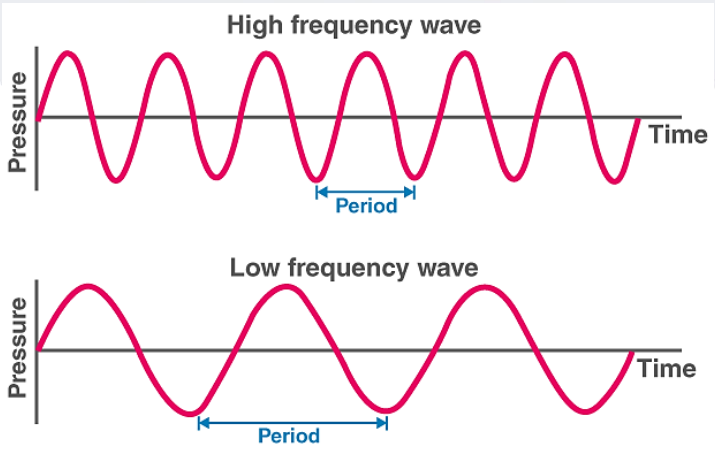
Introduction to waves



A wave is a disturbance in a medium which moves from one point to another and carries energy without a net movement of particles. It may take the form of elastic deformation or a variation of pressure.

E.g: Rubber cork on the water that goes up and down when a rock falls in the water creates a ripple.

Propagation of Sound

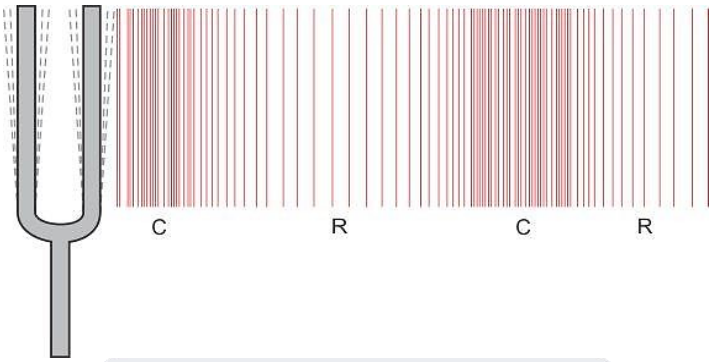


Propagation of sound

- A material medium is necessary for the propagation of sound. It can be solid, liquid or gas.
- The disturbance which moves through a medium when the particles of the medium set the neighbouring particles into motion is known as a **wave**.
- A sound wave can be considered the propagation of pressure or density variations in the medium, i.e. it propagates in a medium as a series of compressions and rarefactions.

- A region of compressed air (increased density or pressure) is called a **compression** (C) and that of rarefied air (decreased density or pressure) is called a **rarefaction** (R).
- A vibrating object produces a series of compressions and rarefactions in the medium.

  Example: When the prongs of a tuning fork move forward, compression is formed, and when the prongs move backwards, rarefaction is formed.

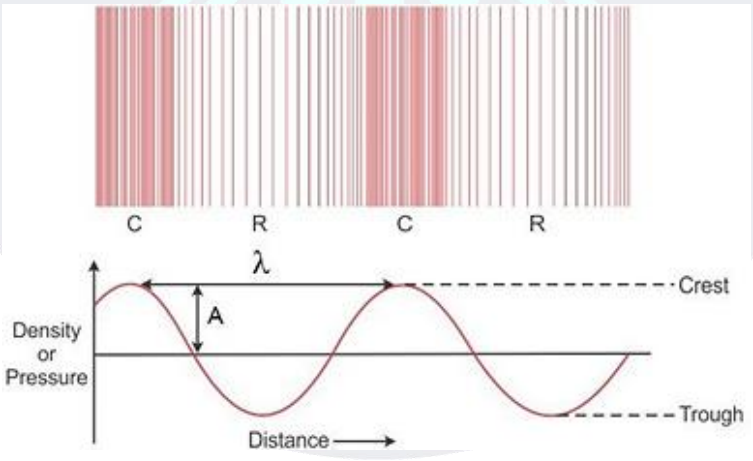


- As sound propagates, it is the sound energy which travels in the medium and not the particles of the medium.
- Sound waves are **longitudinal waves** as the particles of the medium through which the wave propagates vibrate in a direction parallel to the direction of propagation of waves.

  There are many types of waves like mechanical waves, electromagnetic waves, matter waves.

Mechanical Wave:

Mechanical wave is periodic disturbances which require material medium like solid, liquid and gas for its propagation.

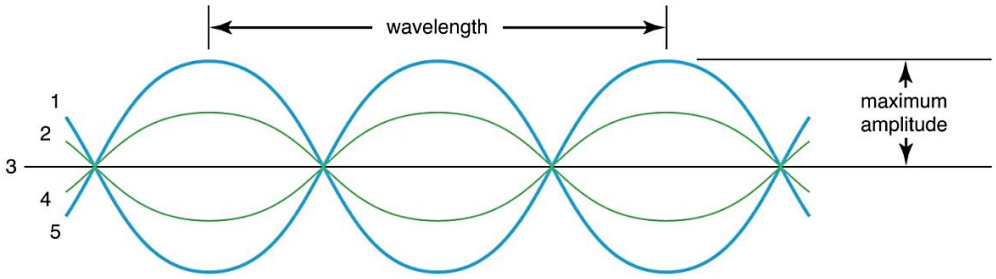


Some examples of mechanical waves includes

- Sound waves
- Water waves
- Waves produced in stretched string
- Waves produced in slinky or a long string

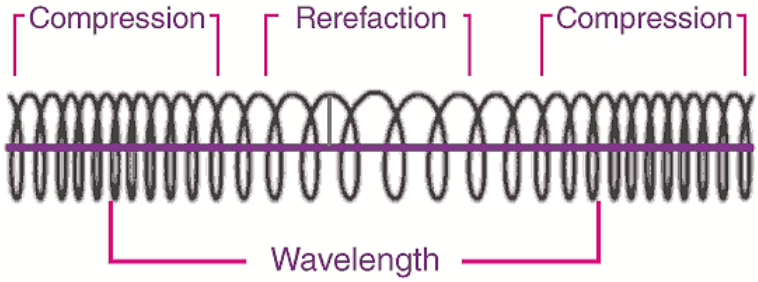
There are two types of mechanical waves

Transverse wave: In these waves the individual particles of the medium move in a direction perpendicular to the direction of propagation of the disturbance. The particles do not move from one place to another, but they simply oscillate back and forth about their position of rest



Longitudinal wave: In these waves the individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance. The particles do not move from one place to another, but they simply oscillate back and forth about their position of rest

Sound waves are longitudinal waves as in sound waves, particles moves in a direction parallel to the direction of propagation of the disturbance.



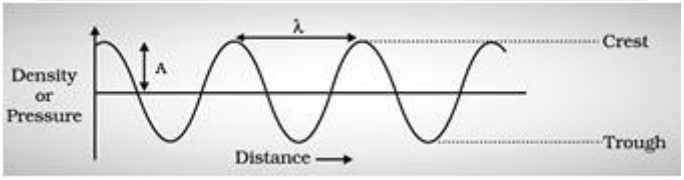
Introduction to sound waves

Sound needs a medium to propagate. The matter or material through which sound propagates is called a medium. When particles vibrate about their mean positions, it pushes a region of compressed air, creating a region of high pressure, followed by a region of low pressure as the particle retreats to its mean position. The sound wave propagates by compressions and rarefactions of particles in a medium. Sound propagation can be visualised as the propagation of pressure variations in the medium.

Characteristics of Sound Waves

Wavelength

The distance between two successive crests or troughs (or) successive compressions and rarefactions is called as wavelength (λ). The SI unit of wavelength is metre (m).



Time period

Time taken by two consecutive compressions or rarefactions to cross a fixed point is called a Time period (T). The SI unit of time in seconds (s).

Frequency

The number of compressions or rarefactions per unit time is called frequency (**ν**).

The SI unit of frequency is Hertz. The SI unit is Hertz (s−1)

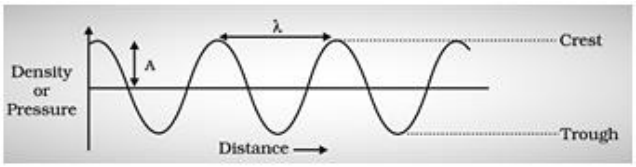
$$v = \frac{1}{T}$$

Speed (v), wavelength (λ) and frequency (**ν**) are related as v=λ**ν**

Amplitude

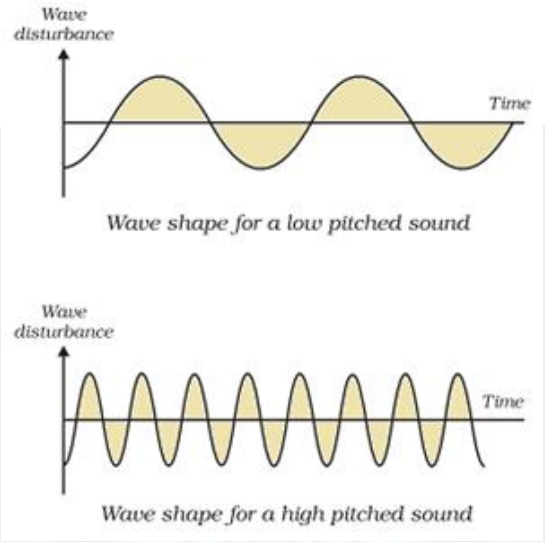
The magnitude of disturbance in a medium on either side of the mean value is called an amplitude (A).

As shown in the figure below, the unit of amplitude will be the density or pressure. Distance between mean position and crest (maximum displacement).



Pitch

The number of compressions or rarefactions per unit time. Directly proportional to frequency.



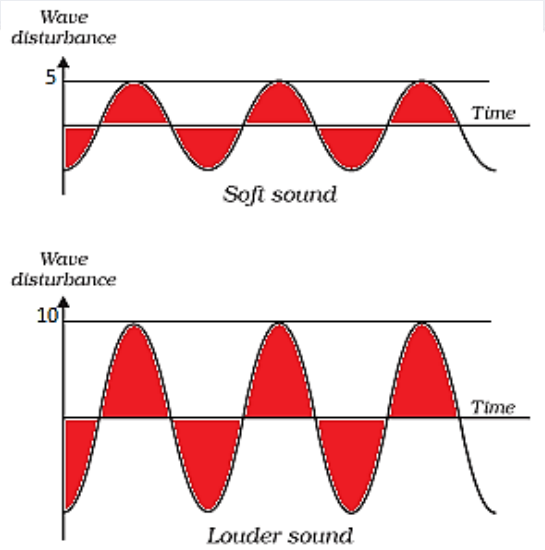
Representation of low and high pitch

Volume

Volume or loudness of a sound depends on the amplitude. The force with which an object is made to vibrate gives the loudness.

Higher force → higher amplitude → louder sound

The amount of sound energy flowing per unit time through a unit area is called the intensity of sound.



The Intensity of Sound

Note and Tone

A sound of a single frequency is called a tone. A sound produced with a mixture of several frequencies is called a note.

Quality of sound

The richness or timber of sound is called the quality. Sound with the same pitch and loudness can be distinguished based on the quality. Music is pleasant to the ears while noise is not. But they both can have the same loudness and pitch.

Speed of sound

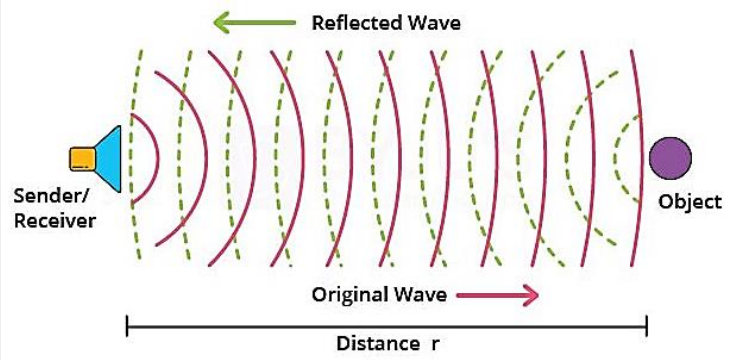
Sound travels through different media with different speeds. Speed of sound depends on the properties of the medium: pressure, density and temperature

Speed of sound: Solids > Liquids > Gases

Speed of sound in air = 331 m/s at 0^0C and 344 m/s at 22◦ C

When a source emits sound with a speed greater than the speed of sound in air, it creates a sonic boom which produces shockwaves with lots of energy. They produce a very loud noise which is enough to shatter glass and damage buildings.

Reflection of Sound Waves



Like light, sound also follows laws of reflection, it bounces off the surface of solid and liquid.

Echo

The phenomenon where a sound produced is heard again due to reflection is called an echo.

E.g: Clapping or shouting near a tall building or a mountain.

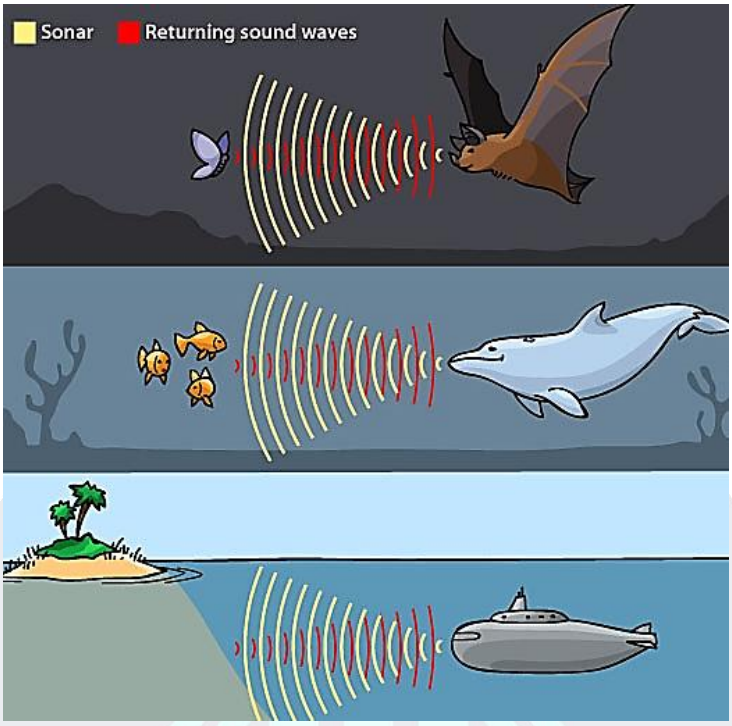
To hear distinct echo sound, the time interval between original and reflected sound must be at least 0.1s. As sound persists in our brain for about 0.1s. Minimum distance for obstruction or reflective surface to hear an echo should be 17.2 m. Multiple echoes can be heard due to multiple reflections.

Sonar and Radar

SONAR – Sound Navigation and Ranging.

It is a technique that uses sound or ultrasonic waves to measure distance. The human range of hearing is 20Hz-20kHz.

What are Ultrasonic sounds?



Ultrasonic sounds are high-frequency sound having a frequency greater than 20kHz (inaudible range).

Applications of Ultrasound

(i) Scanning images of human organs

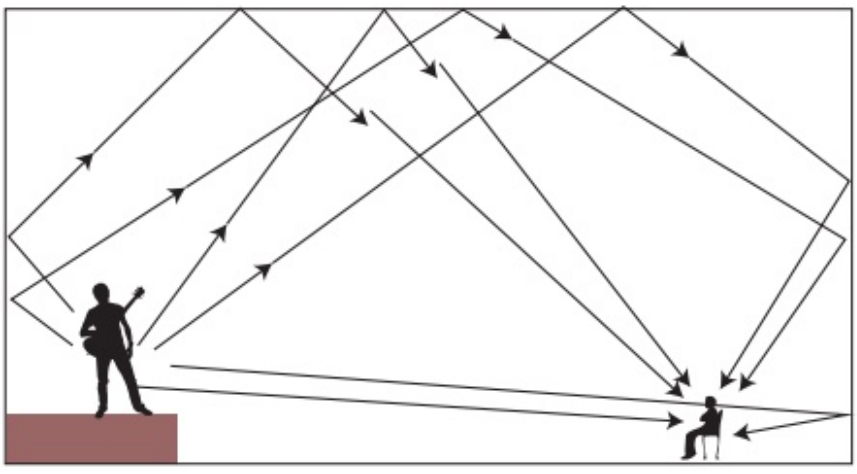
(ii) Detecting cracks in metal blocks

(iii) Cleaning parts that are hard to reach

(iv) Navigating, communicating or detecting objects on or under the surface of the water (SONAR).

Sonar consists of a transmitter and detector mounted on a boat or ship. The transmitter sends ultrasonic sound waves to the seabed which gets reflected back and picked up by the detector. Knowing the speed of sound in water, distance can be measured using: $2d = v \times t$. This method is called echolocation or echo ranging.

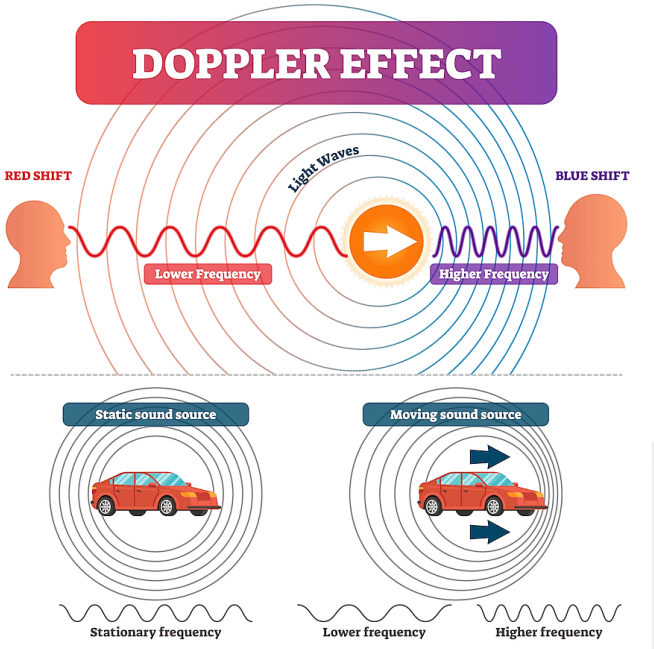
Reverberation



Persistence of sound because of multiple reflections is called reverberation. Examples: Auditorium and a big hall.

Excessive reverberation is undesirable and to reduce this, halls and auditoriums have sound-absorbing materials on the walls and roofs. E.g: Fibreboard and rough plaster.

Doppler's effect



If either the source of sound or observer is moving, then there will be a change in frequency and wavelength for the observer. The frequency will be higher when the observer moves towards the source and it decreases when the observer moves away from the source.

Example: If one is standing on a street corner and an ambulance approaches with its siren blaring, the sound of the siren steadily gains in pitch as it comes closer and then, as it passes, the pitch suddenly lowers.

Variations in Pressure and Density of a Medium due to Sound Waves

- The variations of pressure and density when a sound wave moves in a medium are as shown below:
- The portion of the medium where density (or pressure) has a value larger than its average value is called a **crest**.
- The portion of the medium where density (or pressure) has a value smaller than its average value is called a **trough**.
- The magnitude of maximum disturbance in the medium on either side of the mean position is called the **amplitude** (A).
- When a sound propagates through a medium, the density of the medium oscillates between a maximum value and a minimum value.
- The change in density (or pressure) from the maximum value to the minimum value and again to the maximum value is called an **oscillation**.
- The number of complete oscillations per second is called the **frequency** (ν) of the sound wave. Its unit is **hertz** (Hz).
- The time taken for one complete oscillation in the density (or pressure) of the medium is called the **time period** (T) of the wave.
- The distance between two consecutive compressions or two consecutive rarefactions is called **wavelength** (λ) of the wave. Its SI unit is **metre** (m).

- Frequency (ν) and time period (T) are related as:

$$\nu = \frac{1}{T}$$

- **Speed of sound** is the distance travelled by the sound wave per unit time.

$$\text{Speed, } v = \frac{\text{Distance } (\lambda)}{\text{Time } (T)}$$

- The relation between the speed of sound wave (v), its frequency (υ) and wavelength (λ) is $v = \upsilon \lambda$

Sound, travels as a wave

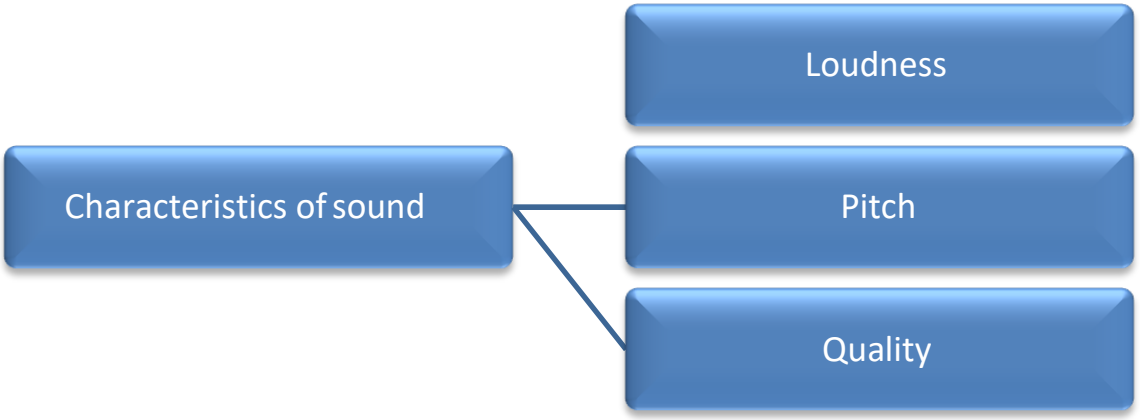
- From the previous section we have already established that sound is produced by vibrating objects. Term vibration refers to the rapid to and fro motion of an object.
- If we throw a piece of stone in a pond of still water then expanding circle of ripples or water waves are formed over the surface of water. These water waves moves on an outward direction on the surface of water.
- This happens because when stone hits water surface it disturbs the particles of water surface. As a result water particles began to vibrate about their means positions.
- These vibrating particles collide with the neighboring particles and make them vibrate.
- This process continues and the disturbance travels through the water.
- The disturbance travel in water due to the repeated periodic motion of the particles of water about their mean positions.

Speed of Sound in Different Media

- Speed of sound is **finite** and is **much less than the speed of light**.
- Speed of sound in solids > speed of sound in liquids > speed of sound in gases
- The speed of sound increases with increase in **temperature**.

Characteristics of Sound

- Sounds can be distinguished from each other by three characteristics—loudness (intensity), pitch (frequency) and quality (timbre).
- The **intensity of sound** at any point is the amount of sound energy passing per unit time per unit area in a direction perpendicular to the area. Its unit is watt/metre^2 (W/m^2).
- The physiological response of the ear to the intensity of sound is called **loudness**. It is determined by the **amplitude** of the wave.



- **Pitch** is the physiological sensation which helps in distinguishing a shrill sound from a flat sound. It is determined by the **frequency** of the wave.
- **Quality (timbre)** distinguishes one sound from another sound of the same pitch and loudness. It is determined by the **wave form** of the sound.
- A sound of single frequency is called a **tone**.
- The sound produced by a mixture of several frequencies is called a **note**.

Reflection of Sound

- The laws of reflection for sound are the same as those for light.
- The repetition of sound caused by reflection of sound waves from an obstacle is known as an **echo**.
- The time interval between the original sound and the reflected one must be at least 0.1 s for an echo to be heard distinctly.
- **Multiple echoes** are heard when sound is repeatedly reflected from several obstacles at suitable distances.
- The phenomenon of persistence or prolongation of audible sound after the source has stopped emitting it is called **reverberation**.

Uses of Multiple Reflection of Sound

- In megaphones, horns, musical instruments and stethoscopes, the mechanism of multiple reflection of sound is used.

Sound needs a medium to travel

- Sound cannot travel through vacuum.
- This is because when sound travels from one place to another then energy is transferred from one particle to another particle of the medium.
- This means that sound needs a material medium like solid, liquid or gas for its propagation.
- Visit this link for demonstration that shows sound waves cannot travel through vacuum.

Range of Frequencies

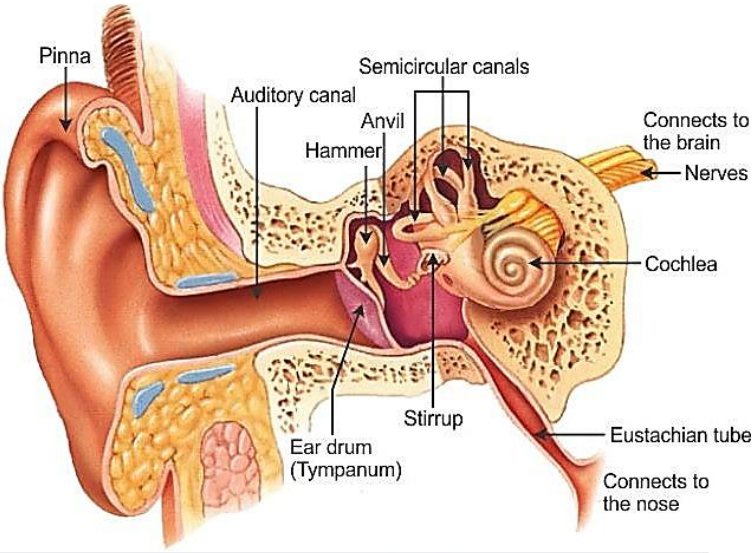
Applications of Ultrasound

- Ultrasound finds **applications** in industry, medical science and communication (SONAR).
- SONAR stands for **Sound Navigation And Ranging**. It is used to measure the distance, direction and speed of objects under the sea. It is also used in ship-to-ship communication.

Human Ear

The human ear can be divided into three parts:

✓ The **outer ear** which collects the sound waves.



✓ The **middle ear** which amplifies the sound waves about 60 times.

✓ The **inner ear** which converts the amplified sound energy into electrical energy and conveys it to the brain as nerve impulses for interpretation.

Range of Hearing

- Audible sounds are those that can be heard while inaudible sounds are those that cannot be heard.
- Human can hear sounds with frequency between 20Hz and 20,000Hz.
- Low frequency sounds which cannot be hear are called infrasonic.
- Rhinoceroses communicate using infrasound of frequency as low as 5 Hz. Whales and elephants produce sound in the infrasound range. It is observed that some animals get disturbed before earthquakes. Earthquakes produce low-frequency infrasound before the main shock waves begin which possibly alert the animals
- Objects that vibrate at frequencies of above 20,000Hz produce sound which also cannot be heard by us. Such sounds are called.

Ultrasonics

Ultrasound is produced by dolphins, bats and porpoises.

Human Ear Parts

The human ear parts are explained below:

External Ear

The external ear is further divided into the following parts:

Auricle (Pinna)

The auricle comprises a thin plate of elastic cartilage covered by a layer of skin. It consists of funnel-like curves that collect sound waves and transmits them to the middle ear. The lobule consists of adipose and fibrous tissues supplied with blood capillaries.

External Auditory Meatus

It is a slightly curved canal supported by bone in its interior part and cartilage in the exterior part. The meatus or the canal is lined with stratified epithelium and wax glands.

Tympanic Membrane

This membrane separates the middle ear and the external ear. This part receives and amplifies the sound waves. Its central part is known as the umbo.

Middle Ear

The middle ear comprises the following parts:

Tympanic Cavity

It is a narrow air-filled cavity separated from the external ear by tympanic membrane and from inner ear by the bony wall. The tympanic cavity has an auditory tube known as the eustachian tube in its anterior wall.

Eustachian Tube

The eustachian tube is a 4cm long tube that equalizes air pressure on either side of the tympanic membrane. It connects the tympanic cavity with the nasopharynx.

Ear Ossicles

These are responsible for transmitting sound waves from the eardrum to the middle ear. There are three ear ossicles in the human ear:

Malleus: A hammer-shaped part that is attached to the tympanic membrane through the handle and incus through the head. It is the largest ear ossicle.

Incus: An anvil-shaped ear ossicle connected with the stapes.

Stapes: It is the smallest ossicle and also the smallest bone in the human body.

Inner Ear

It comprises two parts:

Bony labyrinth

Membranous labyrinth

Bony Labyrinth

The bony labyrinth comprises a vestibule, three semi-circular canals, and spirally coiled cochlea. It is filled with perilymph.

Membranous labyrinth

The bony labyrinth surrounds the membranous labyrinth. It comprises sensory receptors responsible for balance and hearing. The membranous labyrinth is filled with endolymph and comprises three semi-circular ducts, cochlear duct, saccule and utricle. The sensory receptors include cristae, an organ of corti, and ampullaris maculae.

Function of Ear

Following are the important function of the ear:

Hearing

The mechanism of hearing involves the following steps:

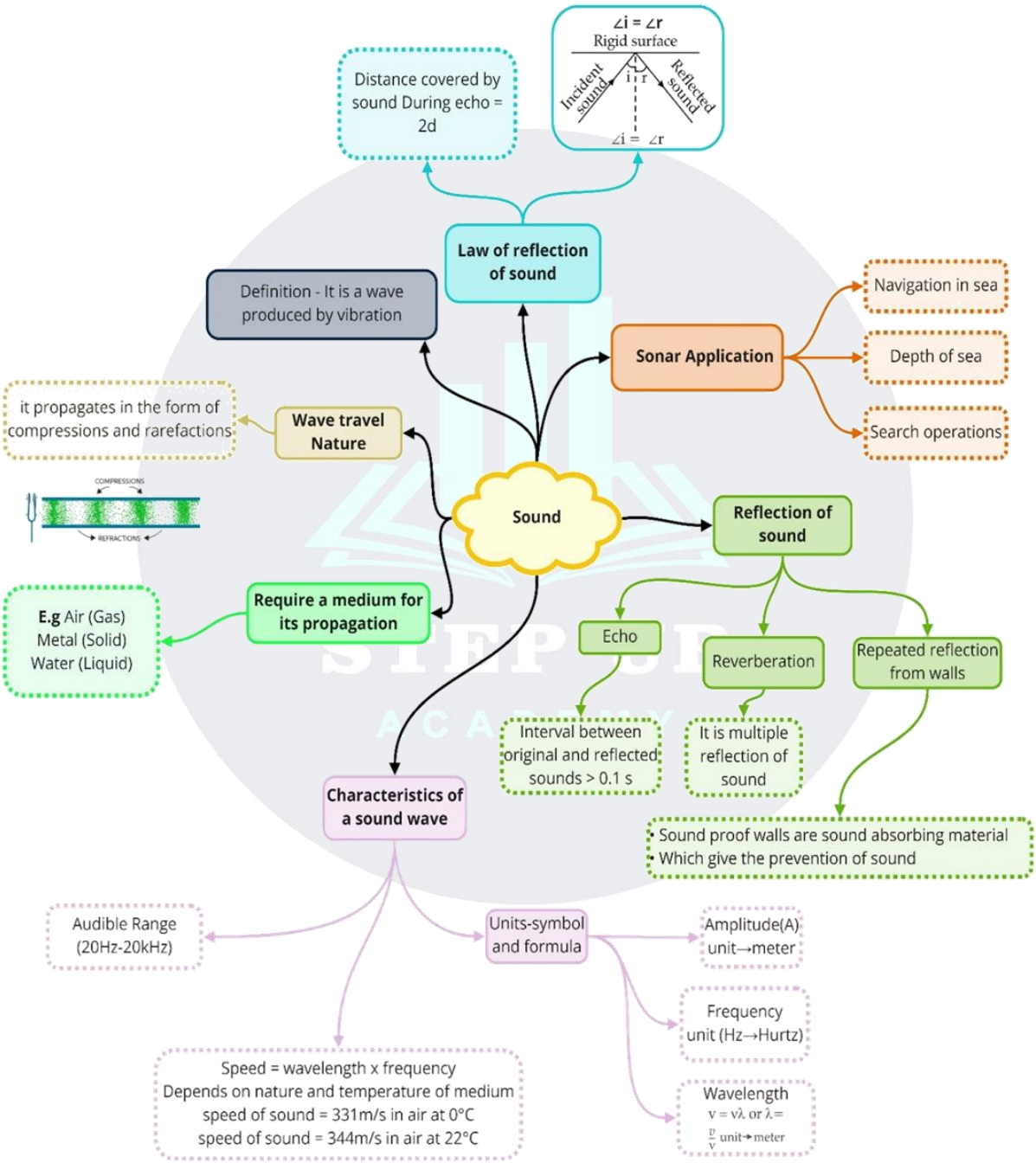
- The sound waves pass through the auditory canal and reach the eardrum.
- The vibrations produced pass through the tympanic membrane to the tympanic cavity.
- The ear ossicles in the tympanic cavity receive the vibrations and the stapes pushes the oval window in and out.
- This action is passed on to the organ of corti, the receptor of hearing, that contains tiny hair cells that translate the vibrations into an electrical impulse that are transmitted to the brain by sensory nerves.

Balance

The eustachian tube and the vestibular complex are the important parts of the ear responsible for the balance.

- The eustachian tube equalizes the air pressure in the middle ear and maintains the balance.
- The vestibular complex contains receptors that maintain body balance.

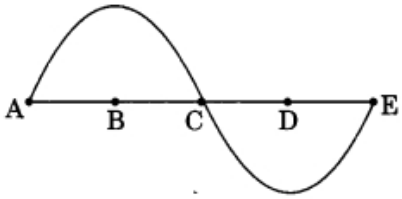
Class : 9th Science
Chapter- 12: Sound



Important Question

Multiple Choice Questions:

1. Note is a sound
   (a) of mixture of several frequencies
   (b) of mixture of two frequencies only
   (c) of a single frequency
   (d) always unpleasant to listen
2. A key of a mechanical piano struck gently and then struck again but mush harder this time. In the second case
   (a) sound will be louder but pitch will not be different
   (b) sound will be louder and pitch will also be higher
   (c) sound will be louder but pitch will be lower
   (d) both loudness and pitch will remain unaffected
3. In SONAR, we use
   (a) ultrasonic waves
   (b) infrasonic waves
   (c) radio waves
   (d) audible sound waves
4. Sound travels in air if
   (a) particles of medium travel from one place to another
   (b) there is no moisture in the atmosphere
   (c) disturbance moves
   (d) both particles as well as disturbance travel from one place to another.
5. When we change feeble sound to loud sound we increase its
   (a) frequency
   (b) amplitude
   (c) velocity
   (d) wavelength
6. In the curve half the wavelength is



   (a) AB
   (b) BD
   (c) DE
   (d) AE
7. Earthquake produces which kind of sound before the main shock wave begins
   (a) ultrasound
   (b) infrasound
   (c) audible sound
   (d) none of the above
8. Infrasound can be heard by
   (a) dog
   (b) bat
   (c) rhinoceros
   (d) human beings
9. Before playing the orchestra in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing so, he is adjusting
   (a) intensity of sound only
   (b) amplitude of sound only
   (c) frequency of the sitar string with the frequency of other musical instruments
   (d) loudness of sound

Very Short Question:

1. What are longitudinal waves?
2. What are transverse waves?
3. Define wavelength. What is its symbol and its SI unit?
4. Define frequency. What is its symbol and its SI unit?
5. What is one hertz?
6. Define amplitude. What is its symbol and its SI unit?
7. What is 'audible' sound?
8. What do you mean by an echo?
9. What do you understand by the terms "compression" and rarefaction?

   A region of low pressure of a medium when a sound wave travels through it is called rarefaction.
10. What do you understand by the pitch of a sound?

Short Questions:

1. State law of conservation of energy and law of conservation of mechanical energy.
2. Define (a) 1 joule (b) 1 watt.
3. Write down SI unit of the following quantities.
   (a) work
   (b) kinetic energy
   (c) potential energy
   (d) power
4. What is the sequence of energy change that takes place in the production of electricity from adam?
5. A light and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has larger kinetic energy?
6. Why a man does not do work when he moves on a level road while carrying a box on his head?
7. If an electric iron of 1200 W is used for 30 minutes every day, find electric energy consumed in the month of April.
8. What is work done by a force of gravity in the following cases?
   (a) Satellite moving around the Earth in a circular orbit of radius 35000 km.
   (b) A stone of mass 250 g is thrown up through a height of 2.5 m.

Long Questions:

1. State the conditions for positive, negative, and zero work. Give at least one example of each.
2. Give a reason for the following:
   (a) A bullet is released on firing the pistol.
   (b) An arrow moves forward when released from the stretched bow.
   (c) Winding the spring of a toy car makes it to run on the ground.
   (d) Falling water from a dam generates electricity.
   (e) Winding the spring of our watch, the hands of the watch movement.
3. State the law of conservation of energy. Show that the energy of a freely falling body is conserved.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: When any objects vibrates that time it produces sound.

   Reason: Vibration means a kind of rapid to and from motion of an object.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: When any objects vibrates that time it produces sound.

   Reason: vibration is the process in which two objects strikes on each other.

Case Study Questions:

1. Sound is produced by vibrating objects. The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Sound moves through a medium from the point of generation to the listener. When an object vibrates, it sets the particles of the medium around it vibrating. The particles do not travel all the way from the vibrating object to the ear. Sound waves are characterized by the motion of particles in the medium and are called mechanical waves. When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure; this region is called a compression(C).When the vibrating object moves backwards, it creates a region of low pressure called rare faction (R). Hence sound is longitudinal wave.

(i) Sound waves are:

(a) Mechanical waves

(b) Electromagnetic wave

(c) Transverse waves

(d) None of these

(ii) Sound travel in medium with:

(a) Compression and rare fraction

(b) Crest and trough

(c) Both can be possible

(d) None of these

(iii) Compression is the region of:

(a) High pressure

(b) Low pressure

(c) Medium pressure

(d) None of these

(iv) What is sound and how is it produced?

(v) Why sound wave is called as longitudinal wave?

2. The individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance. The particles do not move from one place to another but they simply oscillate back and forth about their position of rest. This is exactly how a sound wave propagates; hence sound waves are longitudinal waves. There is also another type of wave, called a transverse wave. In a transverse wave particles do not oscillate along the direction of wave propagation but oscillate up and down about their mean position as the wave travels. Thus, a transverse wave is the one in which the individual particles of the medium move about their mean positions in a direction perpendicular to the direction of wave propagation.

(i) Sound waves are:

(a) Transverse waves

(b) Longitudinal wave

(c) Both a and b

(d) None of these

(ii) Light is:

(a) Transverse waves

(b) Longitudinal wave

(c) Both a and b

(d) None of these

(iii) In case of Longitudinal waves:

(a) The particles do not move fromone place to another but they simply oscillateback and forth about their position of rest

(b) The particles move fromone place to another

(c) The particles move up and down.

(d) None of these

(iv) When stone is dropped in water; waves are generated of which types?

(v) Differentiate between longitudinal wave and transverse waves.

Answer Key

Multiple Choice Answers:

1. (c) of a single frequency
2. (a) sound will be louder but pitch will not be different
3. (c) radio waves
4. (d) both particles as well as disturbance travel from one place to another.
5. (b) amplitude
6. (b) BD
7. (a) ultrasound
8. (c) rhinoceros
9. (c) frequency of the sitar string with the frequency of other musical instruments

Very Short Answers:

1. **Answer:** A wave in which the particles of the medium vibrate back and forth in the 'same direction' in which the wave is moving, is called as a longitudinal wave.
2. **Answer:** A wave in which the particles of the medium, vibrate up and down 'at right angle' to the direction in which the wave is moving, is called a transverse wave.
3. **Answer:** The distance between two consecutive

compressions (C) or two consecutive rarefactions (R) is called the wavelength. The wavelength is denoted by (Greek letter 'lambda'). Its SI unit is the meter (m).

4. **Answer:** The number of complete waves (or cycles) produced per second is called a frequency of sound waves. It is denoted by f. The SI unit of frequency is hertz (Hz).
5. **Answer:** A vibrating body producing 1 wave per second is said to have a frequency of 1 Hz.
6. **Answer:** The magnitude of the maximum disturbance in the medium on either side of the mean value is called the amplitude of wave. It is denoted by A. The SI unit is the metre (m).
7. **Answer:** The sound which we are able to hear is called 'audible' sound. The audible range of sound for human beings extends from about 20 Hz to 20000 Hz.
8. **Answer:** The repetition of sound caused by the reflection of sound waves is called an 'echo'.
9. **Answer:** A region of high pressure of a medium when a sound wave travels through it is called compression.

   A region of low pressure of a medium when a sound wave travels through it is called rarefaction.
10. **Answer:** Pitch of a sound is the characteristic of sound that depends on the frequency received by a human ear.

Short Answers:

1. **Answer:** The sensation felt by our ears is called sound. A sound is a form of energy which makes us hear. When an object is set into vibrations, the sound is produced. For example, the vibrating diaphragm of a drum produces sound, the vibrating string of a guitar produces sound, the vibrating diaphragm of speakers of a radio produce sound, the vibrating end of a drilling machine produces sound, etc.
2. **Answer:** The conditions to hear an echo are:
   i. Echo can be heard only if it is produced at least $\frac{1}{10}$th of a second (0.1 s) after the original sound.
   ii. The speed of sound in air is 344 m/s. Let us calculate the minimum distance from the reflecting surface, which is necessary to hear an echo.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$$\text{Thus, } 344 = \frac{\text{Distance travelled}}{\frac{1}{10}}$$

$\therefore$ Distance travelled = 344 x $\frac{1}{10}$ = 34.4 metres

Thus, the distance travelled by the sound in $\frac{1}{10}$ th of a second is 34.4 m. This means that the minimum distance between the source of the sound and the listeners should be 17.2 metres.

iii. Echo can be heard only if the reflecting surface is large.

3. **Answer:** Bats search out prey and fly in the dark night by emitting and detecting reflections of ultrasonic waves. The high-pitched ultrasonic squeaks of the bat are reflected from the obstacles or prey and returned to bat's ear. The nature of reflections tells the bat where the obstacle or prey is and what it is like.
4. **Answer:** A certain amount of reverberation improves the quality of sound of orchestral and choral music. However excessive reverberation makes the speech or music indistinct.
5. **Answer:** A megaphone works on the principle of reflection of sound. In this instrument, a tube followed by a conical opening reflects sound successively to guide most of the sound from the source in the forward direction towards the audience.
6. **Answer:**

   Given,

   velocity of sound, υ = 340 m/s

   1. v = 256 Hz

      using, $\upsilon = \lambda\nu$

      $$\lambda = \frac{\upsilon}{\lambda} = \frac{340}{256} = 1.33\text{m}$$

   2. λ = 0.85

      using, u = λ v

      $$\lambda = \frac{\upsilon}{\lambda} = \frac{340}{0.85} = 400\text{Hz}$$

7. 30 waves pass through a point in 3 seconds. If the distance between two crests is 2 m. Calculate

   (a) frequency

   (b) wavelength.

8. **Answer:**

   30 waves in 3 seconds

   $\upsilon = \frac{30}{3} = 10\text{Hz}$

   $\therefore \lambda = 2\text{m}.$

9. What is the reflection of sound? State the laws of reflection.

10. **Answer:** The bouncing back of sound from a hard surface is called a reflection of sound. The laws of reflection are:

    i. The incident sound wave, the reflected sound wave and the normal at the point of incidence, all lie in the same plane.

    ii. The angle of incidence of sound is always equal to the angle of reflection of sound.

Long Answers:

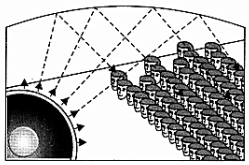
1. Answer:

i. **Megaphone and a bulb horn:** Megaphones or loudhailers, horns, musical instruments such as trumpets and she Hana is, are all designed to send sound in a particular direction without spreading it in all directions, as shown in the figure. In these instruments, a tube followed by a conical opening reflects sound successively to guide most of the sound waves from the source in the forward direction towards the audience.

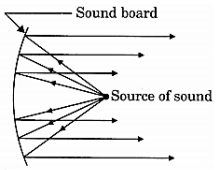
Megaphone **Horn**

ii. **Stethoscope:** Stethoscope is a medical instrument used for listening to sounds produced within the body, chiefly in the heart or lungs. In stethoscopes, the sound of the patient's heartbeat reaches the doctor's ears by multiple reflections of sound, as shown in the figure.

iii. **Soundboard:** Generally the ceiling of concert halls, conference halls and cinema halls are curved so that sound after reflection reaches all corners of the hall, as shown in the figure. Sometimes a curved soundboard may be placed behind the stage so that the sound, after reflecting from the soundboard, spreads evenly across the width of the hail (Fig).



Curved ceiling of a conference hall



Sound board used in a big hall

2. Answer:

Ultrasounds are high-frequency waves. Ultrasounds are able to travel along well-defined paths even in the presence of obstacles. Ultrasounds are used extensively in industries and for medical purposes.

i. Ultrasound is generally used to clean parts located in hard-to-reach places, for example, spiral tube, odd-shaped parts, electronic components, etc. Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned.

ii. Ultrasounds can be used to detect cracks and flaws in metal blocks. Metallic components are generally used in the construction of big structures like buildings, bridges, machines and also scientific equipment. The cracks or holes inside the metal blocks, which are invisible from outside reduces the strength of the structure.

Ultrasonic waves are allowed to pass

through the metal block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect.

iii. Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called 'echocardiography'.

vi. An ultrasound scanner is an instrument which uses ultrasonic waves from getting images of internal organs of the human body. A doctor may image the patient's organs such as liver, gall bladder, uterus, kidney, etc. It helps the doctor to detect abnormalities, such as stones in the gall bladder and kidney or tumours in different organs.

In This technique, the ultrasonic waves travel through the tissues of the body and get reflected from a region where there is a change of tissue density. These waves are then converted into electrical signals that are used to generate images of the organ.

These images are then displayed on a monitor or printed on a film. This technique is called 'ultrasonography'. Ulträsonography is also used for examination of the foetus during pregnancy to detect congenital defects and growth abnormalities.

v. Ultrasound may be employed to break small 'stones' formed in the kidneys into fine grains. These grains later get flushed out with urine.

Assertion Reason Answer:

1. (b) Both Assertion and Reason are correct, and reason is not the correct explanation for assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

Case Study Answers:

1. (i) (a) Mechanical waves

   (ii) (a) Compression and rare fraction

   (iii) (a) High pressure

   (iv) Sound is vibrations created by object. When body vibrates, it forces the adjacent particles of the medium to vibrate. This results in disturbance in the medium, which travels as waves an reaches the ear hence sound is produced.

   (v) The vibration of medium that travels parallel to direction of wave or along in the direction of the wave is called longitudinal wave. The direction of particles of medium vibrates parallel to direction of propagation of disturbance. Therefore a sound is called longitudinal waves.

2. (i) (b) Longitudinal wave

   (ii) (a) Transverse waves

   (iii) (a) The particles do not move from one place to another but they simply oscillate back and forth about their position of rest

   (iv) When stone is dropped in water. Waves are generated where water particles are moving up and down and propagated away from dropping point .hence this is sign of transverse waves. Hence transverse waves are produced when stone is dropped in water.

   (v) Following are differentiated points:

No	Longitudinal waves	Transverse waves
1	The medium, in the case of a longitudinal wave, moves in the same way to wave direction	The medium, in case of a transverse wave, moves perpendicular to wave direction
2	This wave is made up of compressions and rarefactions	This wave is made up of crests and troughs
3	example of a longitudinal wave is sound wave	An example of a transverse wave is the Light

CHEMISTRY

Matter in Our Surroundings 1

INTRODUCTION

All the substances around you have different shapes, sizes and textures. Everything in universe is made up of matter.

The air we breathe, the food we eat, the water we drink, the pen with which we write, the book we read, everything is made up of matter. In this chapter, we shall discuss the matter in our surroundings.

Matter

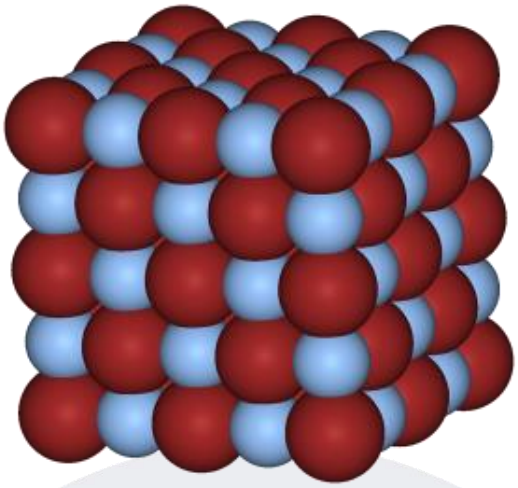
- All things which we see around us and use in our everyday life together constitute matter.
- Anything which occupies space and has mass is called matter.
- Matter is made up of particles.

States of Matter

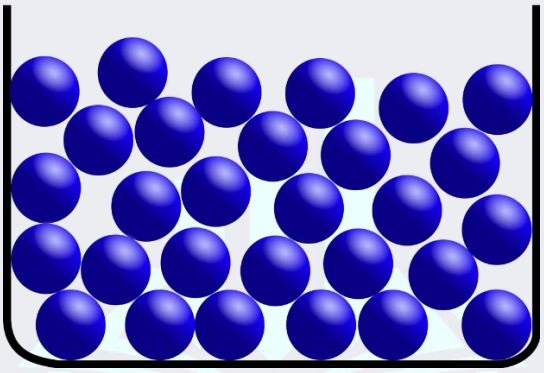
- Matter can be classified as solid, liquid and gas on the basis of interparticle forces and the arrangement of particles.
- These three forms of matter are interconvertible by increasing or decreasing pressure and temperature. For example, ice can be converted from solid to a liquid by increasing the temperature.

Property	Solid	Liquid	Gas
Shape and volume	Fixed shape and volume	No fixed shape but has volume	Neither definite shape nor volume
Energy	Lowest	Medium	Highest
Compressibility	Difficult	Nearly difficult	Easy
Arrangement of molecules	Regular and closely arranged	Random and little sparsely arranged	Random and more sparsely arranged
Fluidity	Cannot flow	Flows from higher to lower level	Flows in all directions
Movement	Negligible	Depends on interparticle attraction	Free, constant and random
Interparticle space	Very less	More	Large
Interparticle attraction	Maximum	Medium	Minimum
Density	Maximum	Medium	Minimum
Rate of diffusion	Negligible	It depends on interparticle attraction.	Maximum

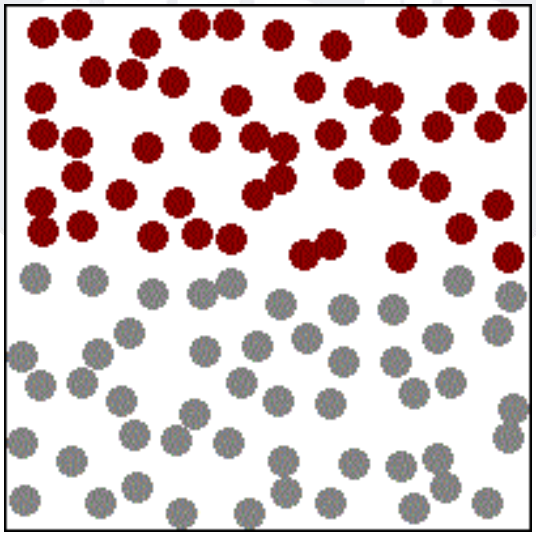
Atomic view of the three states of matter



Solid



Liquid



Gas

Physical Nature of Matter

A physical property is that aspect of the matter that can be observed or measured without changing its nature or composition.

It is independent of the amount of matter present.

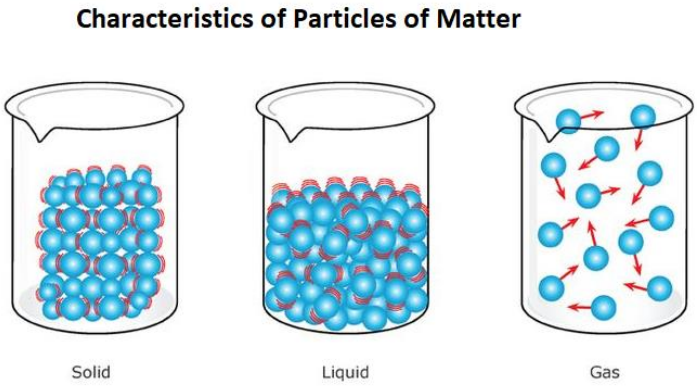
Physical properties include appearance, colour, odour, density, texture, melting point, boiling point, solubility, etc.

Characteristics of Particles of Matter

Matter

- Matter is anything that has mass and occupies space.
- Everything that we can touch, see, hear, taste and also smell is matter.
- It is made up of really tiny particles which cannot be seen through the eye.

The particles of which the matter is comprised influence its state and properties (physical and chemical).



(I) Particles of matter have spaces between them

This characteristic is one of the concepts behind the solubility of a substance in other substances. For example, on dissolving sugar in water, there is no rise in water level because the particles of sugar get into the interparticle spaces between the water particles.

Other example : When we dissolve $KMnO_4$ in water,

particles get evenly distributed in water. Similarly, when we prepare tea, coffee the particles of one type of matter get into space between particles of the other. This shows that there is enough space between particles of matter.

(II) Particles of matter are always in motion

Particles of the matter show continuous random movements due to the kinetic energy they possess.

A rise in temperature increases the kinetic energy of the particles, making them move more vigorously.

Experiment : To show the particles of matter are continuously moving.

Materials Required : Incense stick agarbati, match box.

Procedure :

- Put an unlit incense stick in a corner of your class.
- Go close to the incense stick to get its smell.
- Now light the incense stick. Now try to get the smell from a distance.

Observations : The smell of unlit incense stick can be observed only by going close to it whereas the smell of lighted incense stick can be observed from a distance. Conclusion : The particles of matter are continuously moving but the speed of particles is very slow. The speed of particles increases with the increase in temperature.

Diffusion :

The process of intermixing of particles of two or more substances on their own is called diffusion.

The rate of diffusion increases on heating that is why an incense stick gives smell only when we come close to it, but on lighting the stick we get smell even far away from it.

(III)Particles of matter attract each other

In every substance, there is an interparticle force of attraction acting between the particles. To break a substance, we need to overcome this force. The strength of the force differs from one substance to another.

It can be **explained** with the help of following game in the field.

- Make four groups and form human chains as follows.
- The first group should hold each other from back and lock arms like Bihu dancers.
- The second group should hold hands to form human chain.
- The third group should form a chain by touching each other with only their finger tips.
- The fourth group should run around and try to break three human chains one by one into groups as small as possible.

Observations and Conclusion:

- The third group is easiest to break because of least force of attraction. It is similar to particles in gaseous state.
- The first group is most difficult to break due to maximum force of attraction. It represents particles present in solid state.
- The second group requires little force to break which shows it has force of attraction less than first group but more than third group. It represents particles in the liquid state. Even in solids force of attraction differs from one substance to another. There is maximum force of attraction between particles of iron nail, less in a piece of chalk and least in rubber band.

It is difficult to cut a stream of water with the help of fingers due to force of attraction between particles of liquids. Thus, there is force of attraction between particles of matter which keeps the particles together. The strength of forces varies in different kinds of matter.

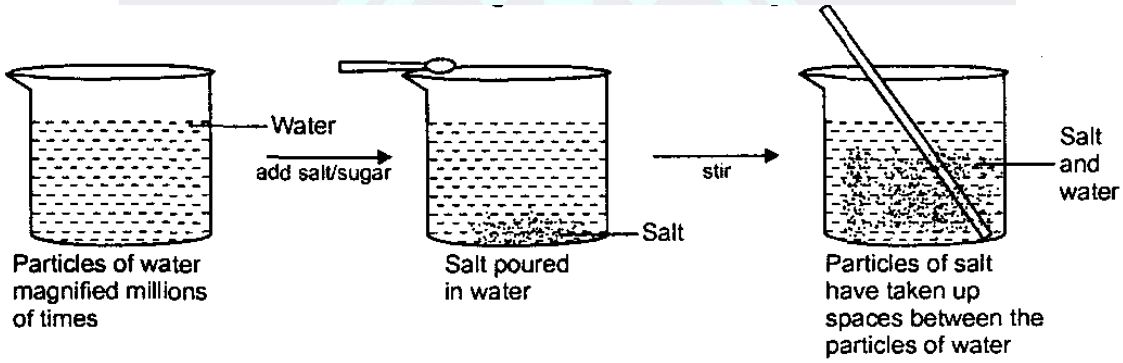
(IV) The particles of matter are very very small

Matter is made up of small particles. It can be proved with the help of following experiment.

Experiment: To show that matter is made up of small particles. Materials Required : 100 ml beaker, water, salt, glass rod. Procedure:

- Take a 100 ml beaker and fill it with water and mark the level of water.
- Dissolve the given salt with the help of glass rod.
- Observe the change in the water level and record your observations.

Observations: The salt gets dissolved in water. The particles of salt have entered the space between water molecules, therefore, the level of water does not change. Conclusion : The salt consists of large number of small particles.



To show— Matter is made up of small particles

Size of Particles of Matter : The particles of matter are extremely small in size which cannot be seen even with powerful microscope. Their size can be observed with the help of following experiment.

Experiment: To show that matter is made up of very small particles.

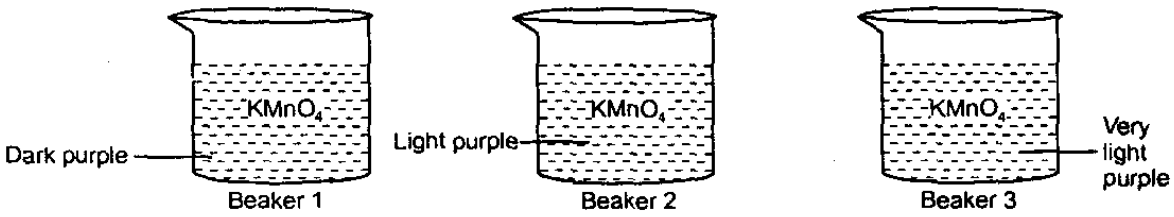
Materials Required : Crystals of $KMnO_4$ (potassium permanganate), water, beaker.

Procedure:

- Take 2-3 crystals of $KMnO_4$ and dissolve them in 50 ml of water.
- Take 5 ml of solution from above beaker and put it into 50 ml of water and observe the colour of solution.
- Take 5 ml of solution from above beaker and put it into 50 ml of water in third beaker and observe the colour of solution.

Observations : The colour of solution remains purple in all the beakers.

Conclusion : It shows that even 2-3 crystals of $KMnO_4$ consist of millions of small particles which dissolve in water giving purple colour to the solution.



To show—Matter is made up of very small particles

Diffusion

- Intermixing of particles of two different types of matter on their own is called diffusion.
- The rate of diffusion increases on increasing the temperature of the diffusing substance (by heating).

Examples of diffusion in gases:

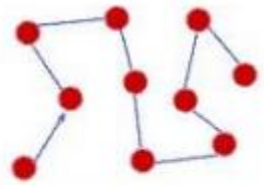
- The aroma of food being cooked in the kitchen reaches us even from a considerable distance due to diffusion.
- The fragrance of a burning incense stick spreads all around due to diffusion.
- The fragrance of a perfume spreads due to the diffusion of the perfume particles into air.

Examples of diffusion in liquids:

- Colour of potassium permanganate is acquired by water, on its own, due to the diffusion of potassium permanganate particles in water.
- The spreading of ink in water, on its own, is due to the diffusion of ink particles in the water.

Examples of diffusion in solids:

- If two metal blocks are bound together tightly and kept undisturbed for a few years, then the particles of one metal are found to have diffused into the other metal.
- If we write something on a blackboard and leave it undisturbed for atleast 10 to 15 days, we will find that it becomes quite difficult to clean the blackboard afterwards. This is due to the fact that some of the particles of chalk have diffused into the surface of the blackboard.



Brownian Movement of a Particle

Brownian movement
The random motion of particles suspended in a fluid (liquid or gas) results from their bombardment by the fast-moving atoms or molecules of the fluid (liquid or gas). This haphazard motion of the particles is known as Brownian motion.

The relation between Kelvin scale and Celsius scale of temperature

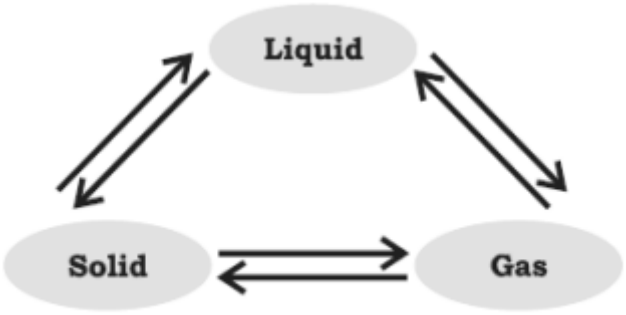
Temperature on Kelvin scale = Temperature on Celcius scale + 273

Thus, a temperature of 25°C on the Celsius scale is equal to 298 K on the Kelvin scale.

Change of State of Matter (Phase transition)

Interconversion of States of Matter

The phenomenon of change from one state of matter to another, and then back to the original state is called the interconversion of states of matter.



Interconversion of States of Matter

Change Of State Of Matter:

Matter can exist in three physical state: solid state,liquid state and gaseous state(vapour state)

We can change physical state of matter of matter in two ways:

a) By changing the temperature, and

b) By changing the pressure.

Change of state is affected by changes in conditions such as—

1. Changes in temperature.
2. Increasing or decreasing pressure.
3. Changes in both, the temperature and pressure.

a) By changing the temperature,

On increasing temperature, the kinetic energy of the particles of the matter increases and they begin to vibrate with a higher energy. Therefore, the interparticle force of attraction between the particles reduces and particles get detached from their position and begin to move freely.

As a result, the state of matter begins to change.

Solids undergo a phase change to form liquids.

Similarly, liquids also undergo a phase change to form gases.

Melting point (Solid → Liquid)

- The temperature at which a solid melts to become a liquid, at atmospheric pressure, is called its melting point.
- Melting point is the characteristic property of a substance. For example, melting point of ice is 0°C (273 K).
- The process, in which a liquid changes to its solid form, on cooling at a specific temperature, is called freezing or solidification.

Latent heat: The hidden heat which breaks the force of attraction between the molecules is known as the latent heat. Since, the heat energy is hidden in the bulk of the matter, it is called latent heat.

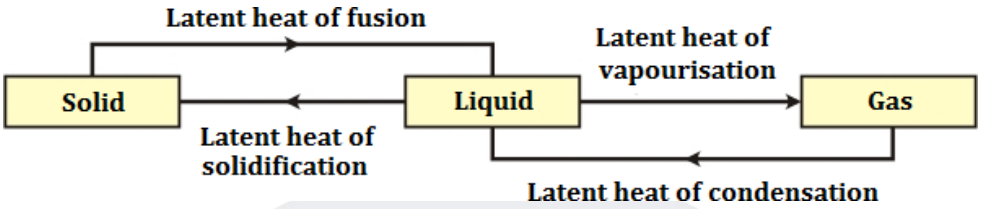
Latent heat of fusion: The heat energy required to convert 1 kilogram of a solid into liquid at atmospheric pressure, at its melting point, is known as the latent heat of fusion.

- When we supply heat energy to water, the particles start moving faster.
- At a certain temperature, a point is reached when the particles have enough energy to break free from the forces of attraction of each other.
- At this temperature, the liquid starts changing into a gas.

Boiling Point: (Liquid → Gas)

- The temperature at which a liquid starts boiling, at atmospheric pressure, is called its boiling point.
- Boiling is a bulk phenomenon.
- Particles from the bulk of the liquid gain energy to change into the gaseous state.
- For example, boiling point of water is 100^0C. (Or 100^0C = 273 + 100 = 373 K)

Latent heat of vapourisation: The heat energy required to convert 1 kilogram of liquid into gas, at atmospheric pressure, at its boiling point, is known as the latent heat of vapourisation.



Condensation (Gas → Liquid)

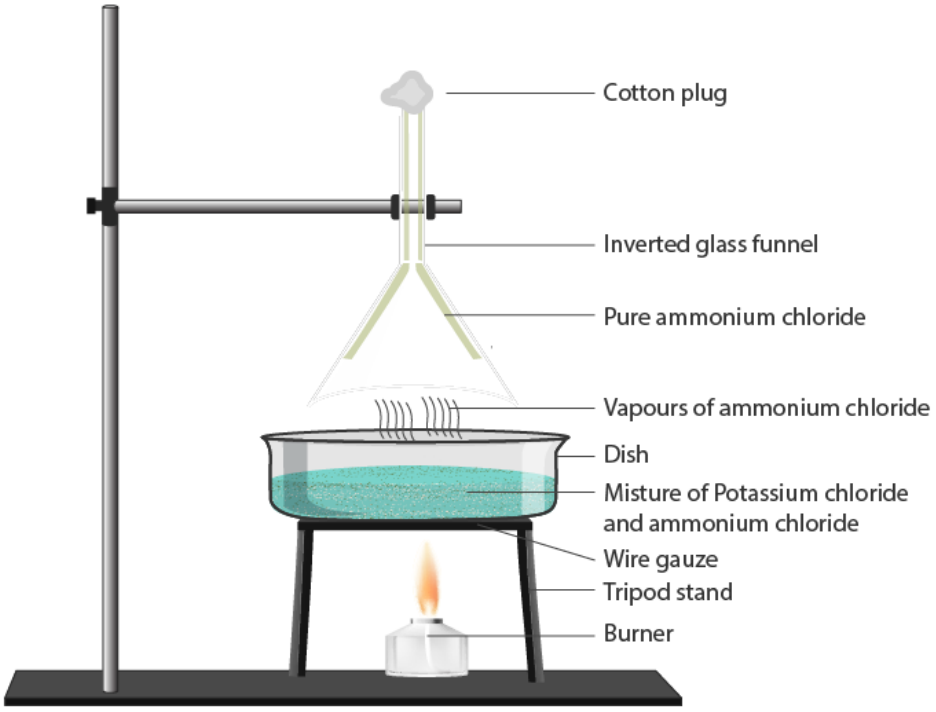
- The process, in which a gas, on cooling, turns into a liquid at a specific temperature is called condensation or liquefaction.
- Formation of clouds is due to the condensation of water vapour from the Earth's surface.
- The heat removed from the surface through evaporation is released into the atmosphere by the formation of clouds. This process cools the Earth's climate.

Freezing point (Liquid → Solid)

The temperature at which the state of a substance changes from a liquid to a solid is called the freezing point of that substance.

Sublimation

The transition of a substance directly from its solid phase to gaseous phase without changing into the liquid phase (or vice versa) is called sublimation.



Sublimation – Solid to Gas Phase Transformation

Sublimation (Solid $\rightleftharpoons$ Gas)

- The change of state of a substance directly from a solid to gas, without changing into the liquid state (or vice versa) is called sublimation.
- The common substances which undergo sublimation are camphor, naphthalene, ammonium chloride, solid carbon dioxide and iodine.

Experiment : To show the process of sublimation experimentally.

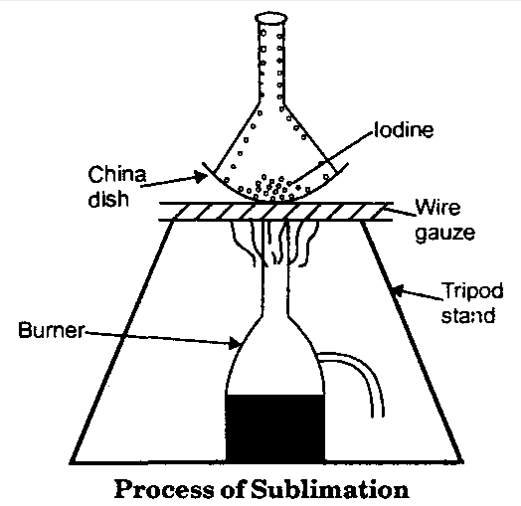
Materials Required : Iodine solid, funnel, tripod stand, china dish, wire guaze, burner or spirit lamp, cotton.

Procedure:

- Take 2 g of iodine in china dish.
- Put an inverted funnel over it whose stem is closed by cotton plug and set the apparatus as shown in diagram.
- Heat the china dish so that vapours are formed and record the observations.
- The vapours of iodine get condensed on the walls of the funnel.

Observations :The violet coloured vapours of iodine get condensed and change into solid iodine.

Conclusion : Iodine can sublime and can be purified by sublimation.



Process of Sublimation

b) Effect of Change of Pressure

- Gases can be liquefied by applying pressure and reducing the temperature.
- When a high pressure is applied to a gas, it gets compressed and if the temperature is lowered, the gas is liquefied.
- The process of conversion of a gas into liquid by increasing pressure or decreasing temperature bis called liquidification.

Evaporation

The phenomenon by which molecules in liquid state undergo a spontaneous transition to the gaseous phase at any temperature below its boiling point is called evaporation.

For example, the gradual drying of damp clothes is caused by the evaporation of water to water vapour.

Factors affecting evaporation

- **Temperature:** The rate of evaporation increases with an increase in temperature.
- **Surface area:** The rate of evaporation increases with an increase in surface area.
- **Humidity:** The rate of evaporation decreases with an increase in humidity.
- **Wind speed:** The rate of evaporation increases with an increase in wind speed.

Cooling due to evaporation

During evaporation, the particles of a liquid absorb energy from the surroundings to overcome the inter-particle forces of attraction and undergo the phase change. The absorption of heat from the surrounding makes the surrounding cool.

For example, sweating cools down our body.

The process of conversion of a substance from the liquid state to the gaseous state at any temperature below its boiling point is called **evaporation** or **vapourisation**.

Evaporation is a surface phenomenon.

Difference between Evaporation and Boiling

Evaporation	Boiling
• It is a surface phenomenon.	• It is a bulk phenomenon.
• It is a slow process.	• It is a rapid process.
• It takes place at all temperatures but below the boiling point.	• It takes place at a definite and constant temperature.

More to Know

Lately, scientists are talking about five states of matter or five phases of matter. These are - solids, liquids, gases, plasmas and the Bose–Einstein condensate.

Plasma

The state consists of super energetic and super excited particles. These particles are in the form of ionised gases. The fluorescent tube and neon sign bulbs consist of plasma.

Bose - Einstein Condensate

Indian physicist Satyendra Nath Bose made a study regarding the fifth state of matter. Based on his study, Albert Einstein predicted a fifth state of matter called the Bose-Einstein Condensate. The Bose-Einstein Condensate or BEC is formed by cooling a gas of extremely low density to super low temperatures.

Other important points to know more:

Volatile Liquids : Those liquids which can change into vapours easily are called volatile liquids, e.g., petrol, alcohol, acetone, ether, etc. evaporate easily because they have low boiling points due to weak intermolecular forces of attraction. Water has high boiling point due to strong intermolecular forces of attraction.

Liquification of Gases : Gases can be liquified at low temperature and high pressure, e.g., H_2, N_2 and O_2 can be liquified at low temperature and high pressure. NH_3 can be liquified at room temperature. CO_2 can be solidified at low temperature and high pressure. Solid CO_2 is also called dry ice.

Atmosphere (atm): It is unit of measuring pressure exerted by a gas. The pressure of air in atmosphere is called atmospheric pressure.

Pascal (Pa): It is the S.I. unit of pressure. 1 atm = 1.01×10^5 Pa

The atmospheric pressure at sea level is 1 atmosphere and is taken as normal atmospheric pressure. As we go higher, atmospheric pressure decreases.

Kinetic Energy : The energy possessed by particle by virtue of its motion is called kinetic energy.

Density : The mass per unit volume of a substance is called density.

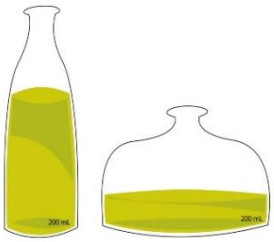
Density = mass / volume. The S.I. unit of density is kg/m^3 whereas common unit is g/cm^3. (C.G.S. unit)

FOR QUICK REVISION

- Matter is a substance which has mass and occupies space.
- Matter is made up of small particles.

- The particles of matter can be atoms, molecules or ions.
- Matter can exist as solid, liquid and gas.
- The size of particles of matter is very small.
- Intermolecular attraction is maximum in solids. They have fixed shape and fixed volume. They have minimum kinetic energy, high density due to least intermolecular space. They cannot be compressed easily. They diffuse very slowly.
- Intermolecular attraction in liquids is less than solids but more than gases. They do not have fixed shape but have fixed volume. They have higher kinetic energy than that of solids. They have lower density. They can be compressed more than solids but less than gases. They have fluidity.
- Intermolecular attraction is minimum in gases and intermolecular space is maximum. They have maximum kinetic energy. They have least density and can flow in all directions. They are most easily compressible.
- The arrangement of particles is most ordered in case of solids, in case of liquids layers of particles can slip and slide over each other and gases have no order and particles move at random.
- The states of matter are inter-convertible. The states of matter can be changed by changing temperature or pressure.
- Fusion or melting is the change of solid into liquid.
- Vapourisation is the change of liquid state to gaseous state.
- Solidification is the change of liquid state to solid state.
- Sublimation is a process in which solid changes into vapours directly and vice-versa without going through liquid state.
- Boiling is a bulk phenomenon. Particles from the bulk (whole) of the liquid change into vapour state.
- Evaporation is a surface phenomenon. Particles from the surface gain sufficient energy to overcome the intermolecular forces of attraction present in the liquid and change into the vapour state.
- Rate of evaporation depends upon surface area exposed to the atmosphere, temperature, humidity and wind.
- Greater the surface area, more will be the rate of evaporation.
- Higher the temperature, more will be the rate of evaporation.
- Lesser the humidity, more will be the rate of evaporation.
- Greater the wind speed, more will be the rate of evaporation.
- Evaporation causes cooling because surface molecules which have higher energy leave the surface, energy of remaining molecules becomes less and therefore, there is decrease in temperature.
- Plasma is fourth state of matter which consists of super energetic and super excited particles in the form of ionised gases.
- Latent heat of vapourisation is the heat energy required to change 1 kg of liquid to gas at atmospheric pressure.
- Latent heat of fusion is amount of heat energy required to change 1 kg of solid into liquid.

Class : 9th Science
Chapter- 1: Matter in Our Surroundings



Matter in Our Surroundings

Liquids

- Less dense than solids Molecules can move within the container
- Take shape of the container as it has no definite shape
  - as it has no definite shape
  - as it has definite volume
- Less compressible
- **Example:** Milk, water
- Condensation cool-down
- Evaporation-add heat
- Freeze-cool down
- melt
- Can be

Gases

- **Low density have** molecules spread out
- Occupy the shape of container
- compressed easily
- **Example:** Air, hydrogen

Solids

- **Have high density** Molecules are closely packed solid
- Definite shape and volume
- Hard to compress
- **Example:** ice, wood

less commonly known

- Plasma
  - Example: fluorescent lights in stars
  - gas carrying electrical charge
  - particles in excited state give of light
    - Example: lightning, Plasma Tvs

less commonly known

- Bose Einstein Condensates
  - Form just above absolute zero (–273°C)

Important Questions

Multiple Choice Questions:

1. In which of the following conditions, the distance between the molecules of hydrogen gas would increase?
   (i) Increasing pressure on hydrogen contained in a closed container
   (ii) Some hydrogen gas leaking out of the container
   (iii) Increasing the volume of the container of hydrogen gas
   (iv) Adding more hydrogen gas to the container without increasing the volume of the container
   (a) (i) and (iii)
   (b) (i) and (iv)
   (c) (ii) and (iii)
   (d) (ii) and (iv)
2. When a gas jar full of air is placed upside down on a gas jar full of bromine vapours, the red-brown vapours of bromine from the lower jar go upward into the jar containing air. In this experiment:
   (a) Air is heavier than bromine
   (b) Both air and bromine have the same density
   (c) Bromine is heavier than air
   (d) Bromine cannot be heavier than air because it is going upwards against gravity
3. A form of matter has no fixed shape but it has a fixed volume. An example of this form of matter is
   (a) Krypton
   (b) Kerosene
   (c) Carbon steel
   (d) Carbon dioxide
4. Which one of the following statements is not true?
   (a) The molecules in a solid vibrate about a fixed position
   (b) The molecules in a liquid are arranged in a regular pattern
   (c) The molecules in a gas exert negligibly small forces on each other, except during collisions
   (d) The molecules of a gas occupy all the space available
5. The correct procedure of heating iron-sulphur mixture to prepare iron sulphide is:
   (a) Heat the powder mixture at the base of the test tube using a blue flame throughout.
   (b) Heat the iron filings and sulphur mixture in the middle of the test tube using yellow flame throughout.
   (c) Heat the powder mixture at the top of the test tube using an orange flame throughout.
   (d) Heat the iron filings-sulphur mixture at 3/4 quarters of the test tube using a red flame throughout.
6. When water at 0°C freezes to form ice at the same temperature of 0°C, then it:
   (a) Absorbs some heat
   (b) Releases some heat
   (c) Neither absorbs nor releases heat
   (d) Absorbs exactly 3.34 x 105J/kg of heat
7. When heat is constantly supplied by a burner to boiling water, then the temperature of water during vaporisation :
   (a) Rises very slowly
   (b) Rises rapidly until steam is produced
   (c) First rises and then becomes constant
   (d) Does not rise at all
8. Which one of the following set of phenomena would increase on raising the temperature?
   (a) Diffusion, evaporation, compression of gases
   (b) Evaporation, compression of gases, solubility
   (c) Evaporation, diffusion, expansion of gases
   (d) Evaporation, solubility, diffusion, compression of gases
9. On converting 308 K, 329 K and 391 K to Celsius scale, the correct sequence of temperatures will be:
   (a) 33°C, 56°C and 118°C
   (b) 35°C, 56°C and 119°C
   (c) 35°C, 56°C and 118°C
   (d) 56°, 119°C and 35° C
10. Four students took separately the mixture of sand, common salt and ammonium chloride in

beakers, added water, stirred the mixture well and then filtered. They reported their observations as shown below

Student	As residue	In the filtrate
I	Ammonium chloride	Sand, Common salt
II	Common salt, Sand	Ammonium chloride
III	Sand, Ammonium chloride	Common salt
IV	Sand	Ammonium chloride, Common salt

Who reported the observations in the correct order of the components as residue and in the filtrate?

(a) I
(b) IV
(c) III
(d) II

11. Which of the following phenomena always results in the cooling effect?
    (a) Condensation
    (b) Evaporation
    (c) Sublimation
    (d) None of these
12. Which of the following cannot be considered a form of matter?
    (a) Atom
    (b) Water
    (c) Humidity
    (d) Electron
13. Which of the following causes the temperature of a substance to remain constant while it is undergoing a change in its state?
    (a) Latent heat
    (b) Lattice energy
    (c) Loss of heat
    (d) None of these
14. Which of the following statement is correct?
    (a) Materials existing as liquids at room temperature have their melting and boiling points lower than that of room temperature.
    (b) The phenomenon involving the transition of a substance from solid to liquid state is called sublimation.
    (c) To convert a temperature on the Celsius scale to Kelvin scale, subtract 273 from the given temperature
    (d) The density of ice is less than that of water.
15. Which of the following statement is not true regarding the characteristic of matter?
    (a) Particles of a matter are randomly moving in all directions.
    (b) Kinetic energy of the particles increases with a rise in temperature
    (c) Kinetic energy of the particles of all maters remains the same at a particular temperature.
    (d) Particles of matter diffuse into each other on their own.

Very Short Question:

1. Define matter.
2. State different states of matter with an example.
3. What is diffusion?
4. What happen to the rate of diffusion if the temperature is increased?
5. Name the state of matter that have the tendency to maintain their shape when subjected to outside force.
6. Define melting point.
7. Define boiling point.
8. Define latent heat of vaporization.
9. Define latent heat of fusion.
10. Define sublimation.

Short Questions:

1. Why do we see water droplets collected on the outer surface of a glass container, containing ice?
2. Explain why solids have fixed shape but liquids and gases do not have fixed shape.
3. Liquids and gases can be compressed but it is difficult to compress solids. Why?
4. A balloon when kept in sun, bursts after some time. Why?
5. Why do people perspire a lot on a hot humid day?
6. Why is it advisable to use pressure cooker at higher altitudes?

7. What are fluids?
8. 1 kg cotton and 1 kg sand, which is more denser? Why?

Long Questions:

1. Pressure and temperature determine the state of a substance. Ex-plane this in detail.
2. Explain giving examples the various factors on which rate of evaporation depends.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Sugar and Salt both are easily dissolved in water.

   Reason: Sugar and Salt are solid hence it is easily dissolved in water.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: When sugar pour in water, then taste of water became a sweet.

   Reason: sugar completely dissolved in water with giving its own character.

Case Study Question:

1. In an experimental activity, crushed ice was taken in a beaker. A thermometer is fitted in such a way that its bulb was thoroughly surrounded by ice. The beaker is now slowly heated and temperature was regularly noted. Temperature rises gradually as the heating is continued and becomes constant when ice starts changing into liquid.

   Select the correct answers for the following questions:

   i) What name is associated with conversion of ice into water?
      a) Evaporation
      b) Sublimation
      c) Freezing
      d) Fusion of Solid

   ii) What specific name is given to the constant temperature?
      a) latent heat of fusion
      b) Boiling Point
      c) Melting Point
      d) Condensation point

   iii) The heat added to the system at constant temperature is called
      a) specific heat
      b) latent heat
      c) residual heat
      d) none of the above

   iv) Where does the heat energy go when the temperature does not rise?
      a) It makes the molecular motion of the liquid faster
      b) It raises the temperature of the beaker only.
      c) It is utilised for bringing out the complete change of state
      d) It slows down the molecular motion
2. A hot air balloon has three major parts: the basket, the burner, and the envelope. The basket is where passengers ride. The basket is usually made of wicker. This ensures that it will be comfortable and add little extra weight. The burner is positioned above the passenger's heads. The envelope is the colourful fabric balloon that holds the hot air. The pilot can control the up-and-down movements of the hot air balloon.

1. What keeps a hot air balloon flying?
2. How the balloon's pilot can control the balloon's altitude?
3. Using the passage as a guide, it can be inferred that which of the following statements is not true?
   (a) Air goes up and out the top of a chimney when you light a fire.
   (b) Cool air collects about the ceiling when you open a refrigerator.
   (c) Smoke from a candle rises after you blow out the flame.
   (d) Cold air coming from an air conditioning vent settles about the floor
4. According to the author, wicker is
   I. Comfortable
   II. light weight
   III. Durable
   a) I only
   b) I and II only
   c) II and III only
   d) I , II and III

Answer Key

Multiple Choice Answers:

1. (c) (ii) and (iii)
2. (c) Bromine is heavier than air
3. (b) Kerosene
4. (b) The molecules in a liquid are arranged in a regular pattern
5. (a) Heat the powder mixture at the base of the test tube using a blue flame throughout.
6. (b) Releases some heat
7. (d) Does not rise at all
8. (c) Evaporation, diffusion, expansion of gases
9. (c) 35°C, 56°C and 118°C
10. (b) IV
11. (b) Evaporation
12. (c) Humidity
13. (a) Latent heat
14. (d) The density of ice is less than that of water.
15. (c) Kinetic energy of the particles of all maters remains the same at a particular temperature.

Very Short Answers:

1. **Answer:** Anything that occupies space and has mass is called matter.
2. **Answer:** Matter has 3 different states
3. **Answer.** The intermingling of molecules of one substance with that of the other is called diffusion.
4. **Answer:** With increased temperature, the rate of diffusion also increases as the particles gain energy and vibrate more.
5. **Answer:** Solid.
6. **Answer:** The temperature at which a solid melts to become liquid at the atmospheric pressure is called its melting point.
7. **Answer:** The temperature at which a liquid starts boiling at the atmospheric pressure is known as its boiling point.
8. **Answer:** Latent heat of vaporization is the heat energy required to change 1 kg of a liquid to gas at atmospheric pressure at its boiling point.
9. **Answer:** Latent heat of fusion is the amount of heat energy required to change 1 kg of solid into liquid at its melting point.
10. **Answer:** Sublimation is the change of gaseous state directly to solid state without going through liquid state and vice-versa.

Short Answer:

1. **Answer:** The water vapour present in air, comes in contact with the cold outer surface of the container thereby condensing it to form water droplets.
2. **Answer:** Solids have fixed shape due to strong intermolecular force of attraction between them. The liquids and gases have molecules with less intermolecular force of attraction and hence they can flow and take shape of the container.

3. **Answer:** Liquids and gases have intermolecular space, on applying pressure externally on them the molecules can come closer thereby minimizing the space between them. But in case of solids there is no intermolecular space to do so.
4. **Answer:** The balloon has air filled in it. The balloon when kept in sun gets heated and the air inside it also gets heated. The molecules of air get energy, and vibrate faster thereby exerting large force on the walls of the balloon. Due to this expansion of gases the balloon bursts.
5. **Answer:** On a hot, humid day, due to the heat our body starts sweating for the cooling mechanism i.e., by evaporation and gets cooling effect. But the air cannot hold any more water on a humid day and therefore the sweat or perspiration is seen.
6. **Answer:** At higher altitudes, the atmospheric pressure is low and the water boils very fast and evaporates at faster rate therefore the pressure is required to increase the cooking process and this is done by using pressure cooker which increases the pressure inside the container and cooks food faster.
7. **Answer:** The states of matter that can flow due to less intermolecular force of attraction, are liquids and gases and are called as fluids.
8. **Answer:** One kg sand is more denser than 1 kg cotton because density = mass/volume.

   The volume required by cotton is more than the sand and density and volume are inversely proportional.

Long Answer:

1. **Answer:**
   - Any matter i.e., solid, liquid or gas when experiences an increase in temperature then they change their state.

     Example:

     $$\underset{\text{Ice}}{\text{Solid}} \xrightarrow{\text{heat}} \underset{\text{Water}}{\text{Liquid}} \xrightarrow{\text{heat}} \underset{\text{Steam}}{\text{Gas}}$$

     Take ice cubes in a beaker or heat them slowly, the temperature increases and the ice melts to form liquid. Heat this liquid further it will become steam.
   - On lowering down the temperature of any matter, show change in their state.

     Example:

     $$\underset{\text{Steam}}{\text{Gas}} \xrightarrow{\text{cool}} \underset{\text{Water}}{\text{Liquid}} \xrightarrow{\text{cool}} \underset{\text{Ice}}{\text{Steam}}$$

     Take the steam that is coming out of a boiling water and allow it to cool down, it condenses to form water and on further cooling of this water we get ice.
   - On applying pressure and reducing temperature we can liquefy gases or change them into solid.

     Example: Take carbon-dioxide gas, reduce its temperature and apply lot of pressure on it so that it changes into solid carbon dioxide, called diy ice, which is used as refrigerant for cooling.

     If the pressure on it is decreased, it directly changes into gas.

     In LPG cylinders, the petroleum gas is cooled and with lot of pressure changes it into liquid state.

     While using this LPG, we release the pressure exerted on it and hence it comes out in the form of gas.
2. **Answer:** The rate of evaporation depends on the following factors:
   - **Surface area:** If the surface area is increased the rate of evaporation also increases.
     (a) To dry the clothes we spread them to dry faster.
     (b) Tea in saucer cools faster than in a cup.
   - **Temperature:** If the temperature is increased the rate of evaporation also increases. Due to increase in temperature the particles gain more kinetic energy and change their phase from liquid to gaseous. Water will evaporate faster in sun than in shade.
   - **Humidity:** It is the amount of water vapour present in air. The air can hold definite amount of water vapour, at a given temperature. If the amount of water vapour is high in the air then the rate of evaporation decreases. On hot and humid day, desert coolers are not effective as the air cannot hold any more moisture to get the cooling effect.

- **Wind speed:** With the increase in wind speed, the rate of evaporation increases. The particles of water vapour move away with the wind, decreasing the amount of water vapour in the surrounding.

Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

Case Study Answer:

1. **Answer:**
   i) d) Fusion of Solid
   ii) c) Melting Point
   iii) b) latent heat
   iv) d) It slows down the molecular motion
2. **Answer:**
   i) The Envelope colourful fabric keeps the hot air balloon flying.
   ii) Through the envelope that holds hot air the pilot can control the balloon aptitude.
   iii) (b) Cool air collects about the ceiling when you open a refrigerator.

   "Hot air rises and cold air falls." Therefore, the cool air inside a refrigerator would fall to the floor when you open the door, not collect about the ceiling. This means (B) is not true
   iv) a) I only

Atoms and Molecules 2

Important Terms

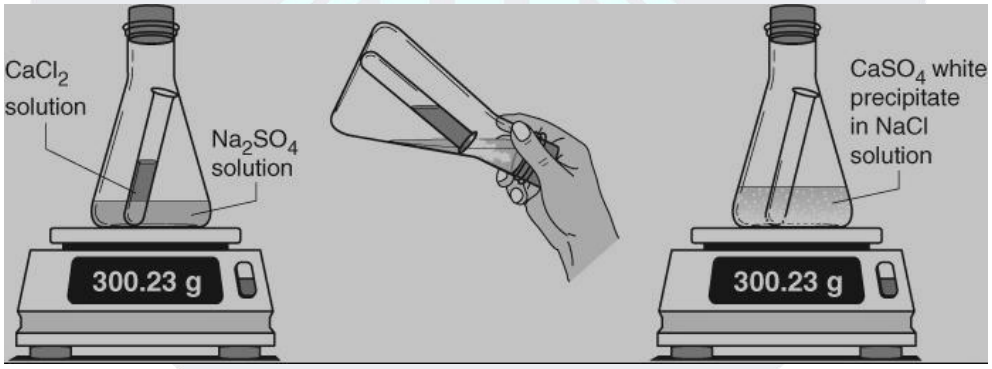
1. **Atom :** It is the smallest particle which takes part in chemical reaction. It may or may not exist independently or freely, e.g., Na, K, Fe, Ag, Zn, Ca, Ba, etc.
2. **Molecule :** It is made of two or more atoms and is capable of independent existence, e.g., H_2, Cl_2, Br_2, O_2,I_2, He, Ne, Ar, Kr, Xe, etc.

Laws of Chemical Combination

Law of Conservation of Mass

PRINCIPLE: The Law of Conservation of Mass states that mass can neither be created nor destroyed in a chemical reaction.

Total Mass of the Reactant = Total Mass of the Product DIAGRAM:



TECHNIQUE:

- Take a solution of calcium chloride in a flask labelled A and a solution of sodium sulphate in a test tube labelled B.
- Tie a thread to the test tube and carefully lower it into the flask. Seal the flask with a cork to make it airtight.
- Weigh the flask on a balance. It weighs around 300.23 grams.
- Tilt and swirl the flask and allow the contents of the test tube to come in contact with the contents of the flask.

OBSERVATION:

- Calcium chloride reacts with sodium sulphate to form a white precipitate of calcium sulphate and a solution of sodium chloride.
- Weigh the flask again. There will be no change in the weight of the flask. It is found to weigh 300.23 grams.

CONCLUSION:

- Scientists noticed that if chemical reactions were carried out in a closed container, there was no change in the mass.
- The total mass of the reactants was equal to the total mass of the products.

Law of Constant Proportion

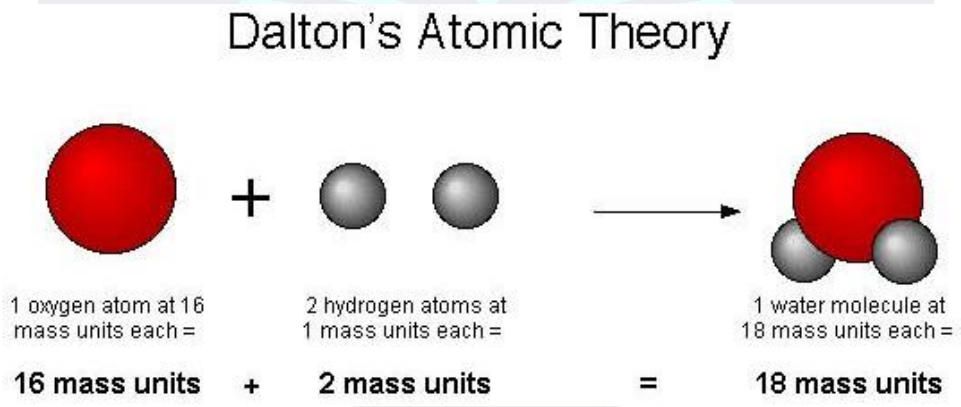
- The law of constant proportions was given by Proust in 1779.
- According to the Law of Constant Proportion,

  "in a chemical substance, elements are always present in a definite proportion by mass."

  OR

  "A chemical compound always consists of the same elements combined together in the same proportion by mass."
- For example, water (H_2O) obtained from any source will have the same two elements, namely hydrogen and oxygen present in it.
- 2 grams of hydrogen and 16 grams of oxygen form a molecule of water. The proportion of hydrogen and oxygen is 1 : 8 by mass. This proportion will always remain the same, irrespective of the source of water.
- Similarly, carbon dioxide(CO_2) obtained from any source will contain the same two elements, carbon and oxygen.
- 12 grams of carbon and 32 grams of oxygen form a molecule of carbon dioxide. Carbon dioxide obtained from any source will always have the proportion of masses of carbon and oxygen as 3 : 8.

Dalton's Atomic Theory



Dalton's theory is the basic theory about the nature of matter. According to his theory, all matter, whether a solid, liquid or gas or an element, compound or mixture, is composed of small particles called atoms.

The Postulates of Dalton's Atomic Theory

- All matter is made up of very tiny particles called atoms.
- Atoms are indivisible particles, which can neither be created nor destroyed in a chemical reaction.
- The atoms of a given element are identical in mass and chemical properties.
- Atoms of different elements have different masses and chemical properties.
- Atoms combine in the ratio of small whole numbers to form compounds.
- The relative number and types of atoms are constant in a given compound.

The Atom: Its Size, Mass and Symbol

- An atom is very small in size and consists of subatomic particles protons, neutrons and electrons.
- About one million atoms stacked up one over the other would roughly equal the thickness of a sheet of a paper.

Atomic radius is measured in nanometers.

$$\frac{1}{10^9}\ m = 1\ nm$$

$$1\ m = 10^9\ nm$$

Modern Day Symbols of Atoms of Different Elements

- Dalton was the first scientist to use symbols for elements. He used circles to represent elements.
- Berzelius suggested that the symbols of the elements can be made from one to two letters of the name of the element.
- Now, we use names and symbols as stated by IUPAC i.e. the International Union of Pure and Applied Chemistry.
- Many symbols are the first letter or the first two letters of the name of the element.

Name	Symbol
Carbon	C
Nitrogen	N
Calcium	Ca
Aluminium	Al

- The symbols of some elements are formed from the first letter of the name and a letter appearing later in the name.

Name	Symbol
Chlorine	Cl
Magnesium	Mg

- The symbols for some elements were derived from their Latin, German or Greek names.

English name of the element	Latin name of the element	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Copper	Cuprum	Cu
Silver	Argentum	Ag
Gold	Aurum	Au
Mercury	Hydrargyrum	Hg
Lead	Plumbum	Pb
Tin	Stannum	Sn

Modern Symbols of Elements

The modern symbols of elements are derived from their English or Latin names, which are made up of either the first letter, the first and second letter or the first letter and a letter appearing later in the name of the element.

Name of element	Symbol	Latin Name	Name of element	Symbol	Latin Name
Hydrogen	H	—	Nickel	Ni	—
Oxygen	O	—	Manganese	Mn	—
Boron	B	—	**Ca**lcium	Ca	—
Carbon	C	—	**Ch**l**o**rine	Cl	—
Fluorine	F	—	**Br**omine	Br	—
Iodine	I	—	**Ch**romium	Cr	—
Nitrogen	N	—	**Co**balt	Co	—
Phosphorus	P	—	Lead	Pb	**P**lum**b**um
Sulphur	S	—	Mercury	Hg	**H**ydrar**g**yrum
Barium	Ba	—	Phosphorus	P	—
Iron	Fe	**Fe**rrum	Sodium	Na	**Na**trium
Gold	Au	**Au**rum	Potassium	K	**K**alium
Silver	Ag	**Ar**gentum	Tin	Sn	**S**tannum
Tungsten	W	**W**olfram (German name)	**U**ranium	U	—
Lithium	Li	—	Zinc	Zn	—

Significance of Symbol of an Element

The symbol of an element signifies

The name of the element.

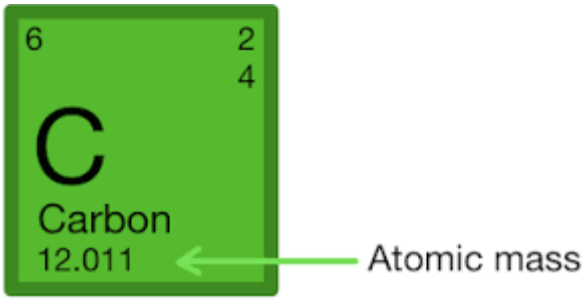
1. An atom of the element.

For example-

The symbol N stands for,

1. The element nitrogen.
2. An atom of the element nitrogen.

Atomic Mass



- Earlier, hydrogen was taken as a standard for measuring the atomic masses of elements.
- Later, carbon-12 isotope was chosen as a standard for measuring the atomic masses of elements.
- Similarly, the relative atomic mass of the atom of an element is defined as the average mass of the atom, as compared 1/12th the mass of one carbon-12 atom.
- The masses of all other atoms are determined relative to the mass of an atom of carbon–12 as the standard.
- Carbon–12 atom has been assigned an atomic mass of exactly 12 atomic mass units, abbreviated as amu, i.e. 12 amu. Recently, the unit of atomic mass, amu was replaced by u, meaning unified mass.
- Now, since carbon–12 atom has been assigned an atomic mass of 12 amu, therefore, the atomic mass unit should be equal 1/12th (one twelfth) of the mass of a carbon–12 atom.

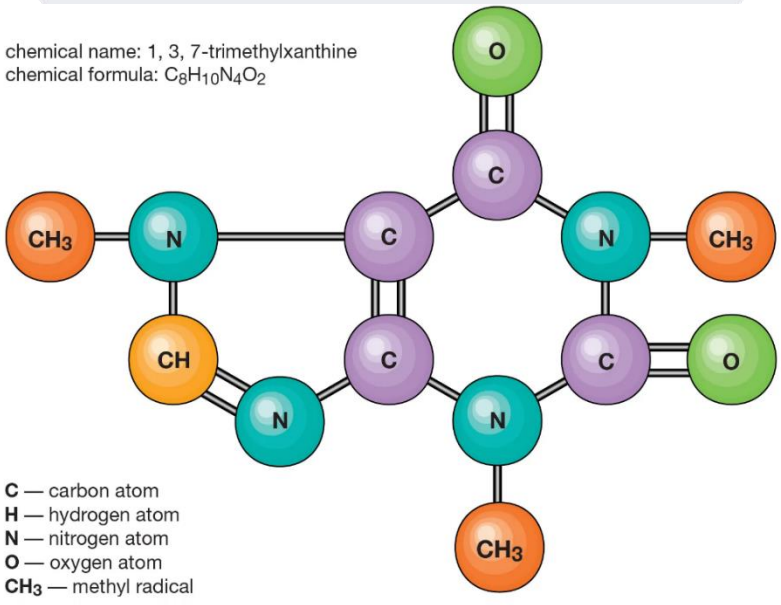
1 atomic mass unit (amu) or 1 u = $\frac{1}{12}$th the mass of carbon–12 atom

Definition of the atomic mass unit (amu or u):
One atomic mass unit is a mass unit equal to exactly one twelfth $\frac{1}{12}$th the mass of one atom of carbon–12.

How do Atoms Exist?

- Atoms of a few elements such as noble gases like helium, neon, argon and krypton etc. exist in the free state, that is as single atoms.
- But most elements, being chemically reactive, do not exist in the free state. They either exist as molecules or ions.
- For example, an iodine crystal is a collection of many iodine molecules. These molecules are so tiny that they are not visible to the naked eye. But, what is visible is the entire iodine crystal.
- Similarly, in sodium chloride, the sodium ions and chloride ions being very tiny are not visible. But, we see the compound sodium chloride as a white powder which is made up of several sodium and chloride ions.

Molecule



- A molecule is a group of two or more atoms chemically bonded together. A molecule is the smallest particle

of an element or a compound which has properties of the element or the compound and can exist in a free state.

- Molecules can be formed either by the combination of atoms of the same element or of different elements.
- Thus, there are two types of molecules — molecules of elements and molecules of compounds.

Molecules of Elements

- A molecule of an element contains two or more similar atoms combined together.
- They are classified as diatomic, triatomic, tetra-atomic and poly-atomic molecules, depending on the number of atoms present in them.

Atomicity

Atomicity is the total number of atoms present in one molecule.

Table showing atomicity of some elements

Name	Formula of molecule	Atomicity	
Helium	He	1	. Monoatomic
Hydrogen	H_2	2	Diatomic
Nitrogen	N_2	2	Diatomic
Ozone	O_3	3	Triatomic
Phosphorous	P_4	4	Tetra-atomic
Sulphur	S_8	8	Poly-atomic

Molecules of Compounds

- A molecule of a compound contains two or more different types of atoms, chemically combined together.
- The atoms of different elements join together in definite proportions to form the molecules of compounds.

Compound	Molecular Formula	Combining Elements	Simplest ratio
Water	H_2O	Hydrogen, oxygen	1 : 8
Ammonia	NH_3	Nitrogen, hydrogen	14 : 3
Carbon dioxide	CO_2	Carbon, oxygen	3 : 8

Ions and Radicals

An atom or a group of atoms can exist independently with charge(s). These are formed by the loss or gain of electron(s). They are called radicals or more commonly ions.

Types of Ions or Radicals

Ions are either positively charged or negatively charged.

Positively charged ions are called cations. Example: Sodium ion (Na+)

$$\underset{\text{Sodium atom}}{Na} \xrightarrow{-1\,\text{electron}} \underset{\text{Sodium ion (A cation)}}{Na^+}$$

$$\underset{\text{Sodium atom}}{Na} \xrightarrow{-1\,\text{electron}} \underset{\text{Sodium ion}}{Na^+}$$

Protons = 11 (+ charge) Protons = 11 (+ charge)

Electrons = 11 (– charge)	Electrons = 10 (– charge)
Overall charge = 0	Overall charge = 1+

Formation of a Sodium ion

Negatively charged ions are called anions. Example: Chloride ion (Cl-)

$$Cl \xrightarrow{+1\ electron} Cl^-$$

Chlorine atom → Chloride ion (An anion)

$$Cl \xrightarrow{+1\ electron} Cl^-$$

Chlorine atom → Chloride ion (An anion)

Protons = 17 (+ charge)	Protons = 17 (+ charge)
Electrons = 17 (– charge)	Electrons = 18 (– charge)
Overall charge = 0	Overall charge = 1–

Formation of a Chloride ion

Sometimes, groups of atoms also give or accept electrons forming positive or negative groups of ions. Such groups of atoms having a positive or negative charge are called radicals

What does the charge indicate?

The charge indicates the valency of an ion.

Magnesium ion is written as Mg^{2+}, where the 2+ charge indicates that its valency is +2.

Sulphate ion is written as SO_4^{2-}, where the 2- charge indicates that its valency is -2.

The valencies of ions and radicals are useful in writing the chemical formulae of the compounds.

Variable Valency

Sometimes, the same element may exhibit one valency in one compound and another valency in some other compound. This property is called variable valency.

Example

Element	Symbol	Valencies exhibited (variable valencies)	
Copper	Cu	1, 2	Cu^{+1}, Cu^{+2}
Silver	Ag	1, 2	Ag^{+1}, Ag^{+2}
Gold	Au	1, 3	Au^{+1}, Au^{+3}
Iron	Fe	2, 3	Fe^{+2}, Fe^{+3}

Writing Chemical Formulae

Step 1 : Write the symbol of a basic radical (element with a positive valency) on the left hand side and that of the acidic radical (element with a negative valency) on the right hand side.

Step 2 : Write the valency number/charge of each of the respective ions at the bottom of its symbol.

Step 3 : Interchange the valency number. Ignore the (+) and (-) sign.

Step 4 : Write the interchanged number.

Step 5 : Write the compound's formula.

Step 6: Cross the reduced valencies. If 1 appears, ignore it. And if a group of atoms receives a valency number more than 1, enclose it within brackets.

Formulae of Simple Compounds

Using the valency of ions, we can write the formulae of compounds.

Formula of Aluminum chloride

Symbols	Al	Cl
Valency	3+	1-
Formula	$AlCl_3$	

Formula of Carbon dioxide

Symbols	C	O
Valency	4+	2-
Formula	$C_2O_4 = CO_2$	

Formula of Sodium phosphate

Symbols	Na	PO_4
Valency	1+	3-
Formula	Na_3PO_4	

Formula of Magnesium sulphate

Symbols	Mg	SO_4
Valency	2+	2-
Formula	$Mg_2(SO_4)_2 = MgSO_4$	

Formula of Ammonium bicarbonate

Symbols	NH_4	HCO_3
Valency	1+	1-
Formula	NH_4HCO_3	

Formula of Ammonium sulphate

Symbols	NH_4	SO_4
Valency	1+	2-
Formula	$(NH_4)_2SO_4$	

As we know that, if a group of atoms receives a valency number more than 1, we enclose it within brackets. Therefore, the molecular formula of ammonium sulphate is $(NH_4)_2SO_4$.

Significance of Molecular Formula

The molecular formula of a compound has a quantitative significance. It represents the following:

(1) The name of the substance.

(2) Both, the molecule and the molecular mass of the compound.

(3) The respective numbers of different atoms present in one molecule of a compound.

(4) The ratios of the respective masses of the elements present in the compound. Let us consider an example of carbon dioxide.

The formula CO_2 means that

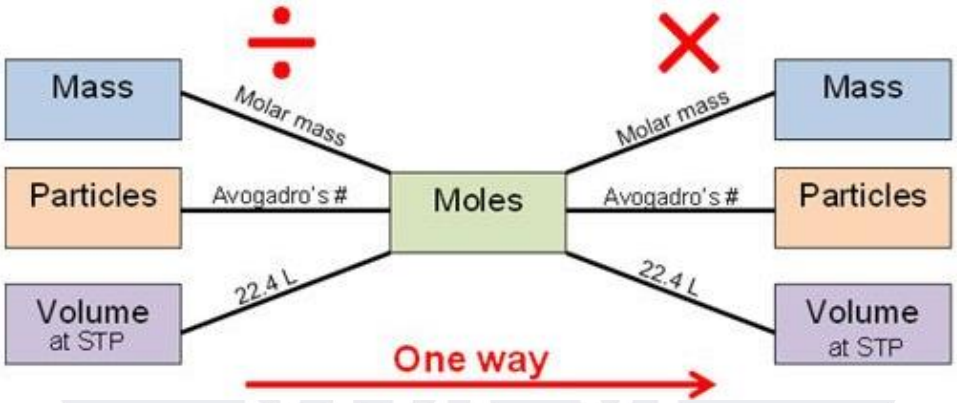
(1) It represents carbon dioxide.

(2) The molecular formula of carbon dioxide is CO_2.

(3) Each molecule contains one carbon atom joined by chemical bonds with two oxygen atoms.

The molecular mass of carbon dioxide is 44, given that the atomic mass of carbon is 12 and that of oxygen is 16.

Molecular Mass and Mole Concept



Molecular Mass

- The molecular mass of a substance is the sum of all the atoms present in one molecule of the substance. It is expressed in atomic mass unit (u).

How to determine molecular mass?

Example: Let us determine the molecular mass of water.

The molecular mass of water (H_2O) is the sum of the masses of two hydrogen atoms and one oxygen atom.

Therefore, the molecular mass of water (H_2O) = 2 × (Atomic mass of hydrogen) + 1 × (Atomic mass of oxygen).

We know that the atomic mass of hydrogen is 1 unit and that of oxygen is 16 units.

$= 2 \times (1) + 1 \times (16)$

$= 2 + 16$

$= 18$ u

Therefore, the molecular mass of water is **18 u**.

Formula Unit Mass

- The formula unit mass of a substance is the sum of the atomic masses of all the atoms in a formula unit of a compound.
- We do not use term molecular mass for ionic compounds. Thus, we use term formula unit for those substances whose constituent particles are ions.

How to determine formula unit mass?

The formula unit mass is calculated in the same manner as we calculate the molecular mass. The only difference is that we use the term formula unit for those substances whose constituent particles are ions.

Mole Concept

- We know that a dozen is a collection of 12 substances, a century is a collection of 100 substances and a gross is a collection of 144 substances.
- We use the terms dozen, century, gross etc. to express a certain quantity of a substance.
- Similarly, a mole is a word used to describe a collection of particles i.e. atoms, molecules or ions.

Definition of a Mole

1 mole of a substance is equal to its atomic mass or molecular mass expressed in grams.

- The atomic mass expressed in grams is the gram atomic mass.
- The molecular mass expressed in grams is the gram molecular mass. For example
- The atomic mass of sodium is 23 grams.

Therefore, 23 grams of sodium is equal to one mole of sodium atoms.

- Similarly, the molecular mass of oxygen (O_2) = 2 × Atomic mass of oxygen

= 2 × 16 = 32 g

Avogadro experimentally found that one mole of any substance always contained 6.022×10^{23} particles. This number is called the Avogadro's number, denoted by N_0.

1 mole (of anything) = 6.022×10^{23} in number

For Example

How many molecules will be present in 2 grams of hydrogen gas (H_2)?

1 mole of hydrogen molecules = molecular mass of hydrogen

= 2 grams

We know that 1 mole of hydrogen molecules contains 6.022×10^{23} hydrogen molecules.

$\therefore$ 2 grams of hydrogen gas will also contain 6.022×10^{23} hydrogen molecules.

Important Formulae

Number of moles = n Given mass = m

Molar mass = M

Given number of particles = N Avogadro number of particles = N_0

(1) The number of moles (n) $= \frac{Given\ mass}{Molar\ mass} = \frac{m}{M}$

(2) (For the problems based on Avogadro number)

The number of moles (n) $= \frac{Given\ number\ of\ particles}{Avogadro\ number} = \frac{N}{N_0}$

(3) To find mass

Mass (m) = Molar mass (M) × Number of moles (n)

(4) To find the number of atoms when Avogadro number is given in the question

The number of atoms $= \frac{Given\ mass \times Avogadro\ number}{Molar\ mass}$

$$N = \frac{m \times N_0}{M}$$

(5) The number of particles (atoms) = Number of moles of particles × Avogadro number

$N = n \times N_0$

Important Questions

Multiple Choice Questions:

1. Which of the following correctly represents 360g of water?
   (i) 2 moles of water
   (ii) 20 moles of water
   (iii) 6.022×10^{23} molecules of water
   (iv) 1.2044×10^{25} molecules of water
   (a) (i)
   (b) (i) and (iv)
   (c) (ii) and (iii)
   (d) (ii) and (iv)
2. Which of the following statements is not true about an atom?
   (a) Atoms are not able to exist independently.
   (b) Atoms are the basic units from which molecules and ions are formed.
   (c) Atoms are always neutral in nature.
   (d) Atoms aggregate in large numbers to form the matter that we can see, feel or touch.
3. 1 u or 1 amu means
   (a) 1/12th mass of C-12 atoms
   (b) Mass of C-12 atom
   (c) Mass of O-16 atom
   (d) Mass of Hydrogen molecule
4. Which of the following contains maximum number of molecules?
   (a) 19 CO_2
   (b) 1g N_2
   (c) 1g H_2
   (d) 1g CH_4
5. A sample of NH3 molecule irrespective of source contains 82.35% Nitrogen and 17.65% of Hydrogen by mass. This data supports:
   (a) Law of Conservation of Mass
   (b) Las of Multiple Proportions
   (c) Law of Definite Proportions
   (d) Avogadro's Law
6. An element X is divalent and another element Y is tetravalent. The compound formed by these two elements will be:
   (a) XY
   (b) XY_2
   (c) X_2Y
   (d) XY_4
7. The molecular formula of potassium nitrate is _____.
   (a) KNO_3
   (b) KNO
   (c) KNO_2
   (d) KON
8. 3.42 g of sucrose are dissolved in 18 g of water in a beaker. The numbers of oxygen atoms in the solution are:
   (a) 6.68 × 1023
   (b) 6.09 × 1022
   (c) 6.022 × 1023
   (d) 6.022 × 1021
9. Molecular mass is defined as the:
   (a) Mass of one molecule of any substance compared with the mass of one atom of C – 12
   (b) Mass of one atom compared with the mass of one atom of hydrogen
   (c) Mass of one atom compared with the mass of one molecule
   (d) None of the above
10. A change in the physical state can be brought about
    (a) only when energy is given to the system
    (b) only when energy is taken out from the system
    (c) When energy is either given to, or taken out from the system
    (d) Without any energy change

11. The atomic mass of sodium is 23. The number of moles in 46g of sodium is _____.
    (a) 4
    (b) 2
    (c) 0
    (d) ½
12. Which of the following represents a correct chemical formula?
    (a) CaCl
    (b) $BiPO_4$
    (c) $NaSO_4$
    (d) NaS
13. What is the formula mass unit of ZnO?
    (a) 18 u
    (b) 81 u
    (c) 88 u
    (d) 188 u
14. How many atoms of oxygen are present in 300 grams of CaCO3?
    (a) 54.207 × 1023
    (b) 6.207 × 1023
    (c) 12.207 × 1023
    (d) 22.2 × 1023
15. Which of the following represents the correct relation between Avogadro's number (No), number of particles (N) and moles (n)?
    (a) $n = N / N_o$
    (b) n = No / N
    (c) $n = N N_o$
    (d) all are correct

Very Short Question:

1. Define law of conservation of mass.
2. Explain law of constant proportion.
3. Who coined the term atom?
4. Define atom.
5. Define molecule.
6. Define atomicity.
7. What is atomic mass unit?
8. How do atoms exist?
9. Give the atomicity of phosphorous and nitrogen.
10. What is an ion?

Short Questions:

1. Give the unit to measure size of atom and give size of hydrogen atom.
2. What is IUPAC, give its one function?
3. Give the Latin name for sodium, potassium, gold and mercury.
4. What is the ratio by mass of combining elements in H_2O, CO_2 and NH_3?
5. Define valency and give the valency for the following elements:
6. What is polyatomic ton? Give one example.
7. Write down the formula for:

   Copper nitrate, calcium sulphate and aluminium hydroxide.
8. What is formula unit mass? How is it different from molecular mass?

Long Questions:

1. (a) How do atoms exist?
   (b) What is atomicity?
   (c) What are polyatomic ions?
2. Calculate
   (a) the mass of one atom of oxygen
   (b) the mass of one molecule of oxygen
   (c) the mass of one mole of oxygen gas
   (d) the mass of one ion of oxygen
   (e) the number of atoms in 1 mole of oxygen molecule
3. What is meant by atomic mass, gram atomic mass of an element? Why is the mass have different expressions i.e., 'u' and 'g'?

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

Assertion: Atom is the smallest unit of molecule

Reason: Atom is not seen by our naked eyes.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Atom is the smallest unit of molecule

   Reason: Atoms are combined with each other forming molecule.

Case Study Question:

1. Read the passage and answer any four questions:

   The simplest compounds, which are made up of two different elements are called binary compounds. While writing the chemical formulae for compounds, the constituent elements and their valencies are written. Then crossover the valencies of the combining atoms. For the ionic compound, the symbol of cation written first followed by the symbol of the anion. Then their charges are criss-crossed to get the formula. The positive and negative charges must balance each other and the overall structure must be neutral. The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance.

   i. Which of the following statement correctly justifies that crystallisation technique considered better than simple evaporation to purify solid?
      a. Solid decompose or get charred on heating to dryness.
      b. Impurities may remain dissolved in the solution even after filtration.
      c. Both (a) and (b)
      d. Impurities are easily removed in solution.

   ii. In magnesium chloride, chloride ions for each magnesium ion.
      a. one
      b. two
      c. three
      d. four

   iii. The molecular mass of HNO_3 is
      a. 63u
      b. 7u
      c. 54u
      d. 45u

   iv. The formula unit mass of $CaCl_2$ is
      a. 111u
      b. 342u
      c. 213u
      d. 122u

   v. The formula unit mass of a substance is:
      a. the sum of the atomic masses of all atoms.
      b. the sum of the atomic mass of only one atom
      c. both (a) and (b)
      d. none of these

2. Atoms are too small, or they are smaller than anything that we can imagine or compare with. Our entire world is made up of atom. Dalton was the first scientist to use the symbols for elements in a very specific sense. When he used a symbol for an element he also meant a definite quantity of that element, that is, one atom of that element. In the beginning, the names of elements were derived from the name of the place where they were found for the first time. For example, the name copper was taken from Cyprus. Many of the symbols are the first one or two letters of the element's name in English. The first letter of a symbol is always written as a capital letter (uppercase) and the second letter as a small letter (lowercase)

   i. 1m is equal to nm
      a. 1010
      b. 109
      c. 108
      d. 106

ii. is the symbol of
   a. sulphur
   b. iron
   c. silver
   d. mercury

iii. Who suggested the symbol of elements are made from one or two-letter of the atom?
   a. Proust
   b. Berzelius
   c. Boyle
   d. Robert

iv. Law of constant proportion is given by
   a. Proust
   b. Lavoisier
   c. Dalton
   d. Berzelius

v. Full form of IUPAC
   a. International Union of Pure and Applied Chemistry
   b. International Unity of Pure and Applied Chemistry
   c. Indian Union of Pure and Applied Chemistry
   d. none of these

Answer Key

Multiple Choice Answers:

1. (d) (ii) and (iv)
2. (d) Atoms aggregate in large numbers to form the matter that we can see, feel or touch.
3. (a) 1/12th mass of C-12 atoms
4. (c) 1g H_2
5. (c) Law of Definite Proportions
6. (b) XY_2
7. (a) KNO_3
8. (a) 6.68×10^{23}
9. (a) Mass of one molecule of any substance compared with the mass of one atom of C – 12
10. (c) When energy is either given to, or taken out from the system
11. (b) 2
12. (b) $BiPO_4$
13. (b) 81 u
14. (a) 54.207×10^{23}
15. (a) $n = N / N_o$

Very Short Answers:

1. **Answer:** In a chemical reaction mass can neither be created nor destroyed.

   E.g., $2Na + Cl_2 \rightarrow 2NaCl$

   $2 \times 23 + 2 \times 35.5 \rightarrow 2(23 + 35.5)$

2. **Answer:** In a chemical substance the elements are always present in definite proportions by mass.

   E.g., In water, the ratio of the mass of hydrogen to the mass of oxygen H : O is always 1:8

3. **Answer:** John Dalton coined the term atom.
4. **Answer:** The smallest particle of matter, which can take part in a chemical reaction is called atom.
5. **Answer:** The smallest particle of an element or compound which can exist independently is called molecule.
6. **Answer:** The number of atoms constituting a molecule is known as its atomicity.
7. **Answer:** The sum of the atomic masses of all the atoms in a molecule of the substance is expressed.in atomic mass unit. E.g., $H_2O = 1 \times 2 + 16 = 18$ amu
8. **Answer:** Atoms exist in the form of atom, molecule or ions.
9. **Answer:** The atomicity of phosphorus is P_4 i.e., 4.

   The atomicity of nitrogen is N_2 i.e., 2.
10. **Answer:** Charged atom is called as an ion. The ion can be positively charged called cation or negatively charged called anion.

Short Answer:

1. **Answer:** The unit to measure size of atom, is nanometer, size of hydrogen atom is 10^{-10}m.

2. **Answer:** IUPAC is International Union for Pure and Applied Chemistry. It approves the names of elements.

3. **Answer:**
   - Sodium → Natrium, Gold → Aurum
   - Potassium → Kalium, Mercury → Hydrargyrum

4. **Answer:**
   - H_2O ratio by mass of combining elements 2 : 16 → 1 : 8 (H : O)
   - CO_2 ratio by mass of combining elements 12 : 32 → 3 : 08 (C : O)
   - NH_3 ratio by mass of combining elements 14 : 3 → 14 : 3 (N : H)

5. **Answer:** Valency: The combining capacity of an element is called its valency. Valency of the following elements:

   Magnesium – 2

   Aluminium – 3

   Chlorine – 1

   Copper – 2

6. **Answer:** A group of atoms carrying a charge is known as a polyatomic ion.

   E.g., Ammonium – NH_4^+

   Nitrate – $N0_3^-$

   Copper nitrate, calcium sulphate and aluminium hydroxide.

7. **Answer:** Chemical formula:

   Copper nitrate → $Cu(N0_3)$

   Calcium sulphate → $CaS0_4$ Aluminium hydroxide $Al(OH)_3$

8. **Answer:** The formula unit mass of a substance is a sum of the atomic masses of all atoms in a formula unit of a compound. The constituent particles of formula unit mass are ions and the constituent particles of molecular mass are atoms.

Long Answer:

1. **Answer:**

   (a) Atoms of some elements are not able to exist independently. For such elements atoms form molecules and ions. In case of metals and inert gases atoms can exist independently.

   Atoms of metals and inter gases:

   $$\frac{Na, Mg, Al}{Metals} \quad \frac{He, Ne, Ar}{Inert\ gases}$$

   Non-metals: E.g. H_2, Cl_2, P_4, S_8

   Exceptional non-metal C

   (b) The number of atoms constituting a molecule is known as its atomicity.

   E.g., O_3 → atomicity is 3

   O_2 → atomicity is 2

   (c) Polyatomic ions: When more than two atoms combine together and act like an atom with a charge on it is called polyatomic ion.

   E.g., OH^-, NO_3^-, NH_4^+

2. **Answer:**

   (a) Mass of one atom of oxygen

   1 mole of oxygen atom = 16 gm

   = 6.022×10^{23} atoms.

   ∴ Mass of one atom of oxygen

   $$= \frac{16}{6.022 \times 10^{23}} = 2.65 \times 10^{-23}$$

   (b) Mass of one molecule of oxygen

   1 molecule of oxygen = O_2

   $= 2 \times 16$

   $= 32$ u

   (c) Mass of one mole of oxygen gas

   1 mole of oxygen gas is O_2 = 32 u

   (d) Mass of one ion of oxygen

   One mole of oxygen = 6.022×10^{23} = 16g

   Mass of one ion of oxygen

   $$= \frac{16}{6.022 \times 10^{23}} = 2.65 \times 10^{-23}$$

   (e) Number of atoms in one mole of oxygen molecule

   1 mole of oxygen molecule *i.e.*,

   $O_2 = 6.022 \times 10^{23}$ molecules

   1 molecule of O_2 = 2 atoms

3. **Answer:** The atoms are very tiny and their individual mass cannot be calculated as it is negligible. Hence the mass of atoms is expressed in units with respect to a fixed standard. Initially hydrogen atom with mass 1 was taken as

standard unit by Dalton. Later, it was replaced by oxygen atom (0=16). But due to the isotopes the masses were found in fractions instead of whole number. Hence, carbon (C=12) isotope was taken as standard unit and was universally accepted.

The atomic mass unit is equal to one twelfth (1/12) the mass of an atom of carbon-12, its unit is u.

Gramatomic mass: When the atomic mass of an element is expressed in grams, it is called the gramatomic mass of the element.

The mass of atoms, molecules is expressed in 'u' and the mass of moles i.e., molar mass is expressed in g.

Assertion Reason Answer:

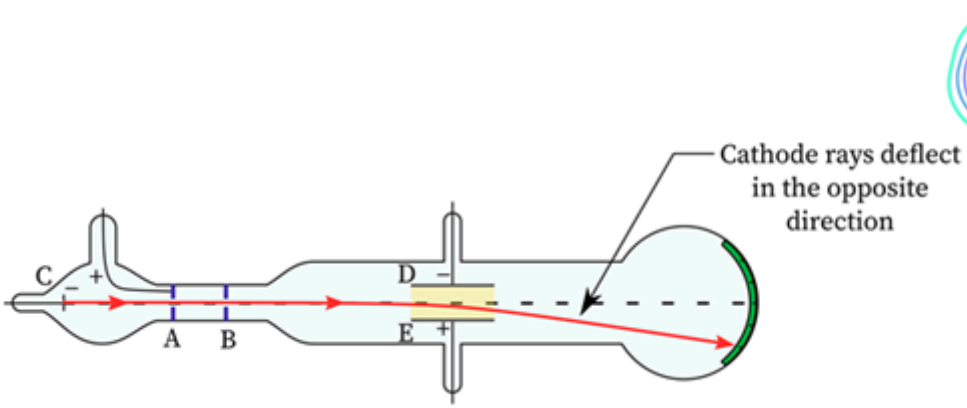
1. (b) Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
2. (b) Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

Case Study Answer:

1. **Answer:**
   - i) c) Both (a) and (b)
   - ii) b) two
   - iii) a) 63u
   - iv) a) 111u
   - v) a) sum of atomic masses of all element
2. **Answer:**
   - i) b) 10^9
   - ii) a) sulphur
   - iii) b) Berzelius
   - iv) a) proust
   - v) a) International Union of Pure and

Structure of The Atom 3

Charged Particles in Matter



The phenomenon of static electricity and conduction of electricity through some substances hints at the presence of charged particles in matter.

Discovery of the Electron

- J.J. Thomson performed an experiment by passing electricity at a high voltage through a discharge tube containing a gas at a very low pressure. A green fluorescence was seen emitting out from the other end of the discharge tube.
- This fluorescence is the result of rays emitted from the cathode (negative plate) towards the anode (positive plate) in the discharge tube. Hence, these rays are called cathode rays.
- From his experiment, Thomson arrived at the conclusion that cathode rays are nothing but a stream of negatively charged particles. These negatively charged particles are called **electrons**.

Discovery of the Proton

- A German scientist, E. Goldstein in 1886, modified the discharge tube and passed electric current through it.
- He found that the positively charged rays were emitted from the anode in the discharge tube. These rays were called **canal rays**.
- When an electric field was applied, these rays deflected towards the negatively charged plate. Thus, Goldstein concluded that an atom contains positively charged particles along with electrons.
- These positively charged particles were named as **protons** by a British scientist, Ernest Rutherford.
- Canal rays were also called **anode rays** since they were emitted from the anode (electrode connected to the positive terminal of high voltage source) in the gas discharge experiments using a perforated cathode.

Discovery of the Neutron

- In 1932, James Chadwick observed that when beryllium was exposed to α-particles, different kinds of particles were emitted.
- These particles had about the same mass as protons and carried no electrical charge. Hence, Chadwick named these particles **neutrons**.

- These were present in the nucleus along with protons.
- Neutrons are present in the nucleus of all the atoms except hydrogen.
- As protons and neutrons are both present in the nucleus, they are together known as **nucleons**

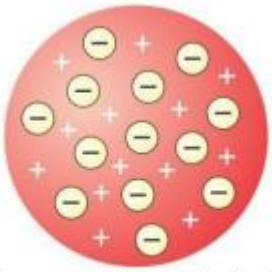
Properties of Electron, Proton and Neutron

Sub-atomic particle	Symbol	Location in the atom	Relative Charge	Relative mass	Actual mass	Absolute Mass
Electron	e^-	Outside the nucleus	-1	$\frac{1}{1840}$ a.m.u.	9.1×10^{-31} kg	9×10^{-28} grams
Proton	P^+	Inside the nucleus	+1	1 a.m.u.	1.673×10^{-27} kg	1.6×10^{-24} grams
Neutron	n	Inside the nucleus	0	1 a.m.u.	1.675×10^{-27} kg	1.6×10^{-24} grams

The Structure of an Atom

Thomson's Model of an Atom

- Thomson's model of an atom is popularly known as the plum pudding or Christmas pudding model of an atom.



Thomson's model of an Atom

Plum pudding

- According to the Thomson's plum pudding model, an atom is a positively charged sphere in which the electrons are embedded.
- The negative charge of the electrons and the positive charge of the sphere is equal in magnitude. Thus, an atom as a whole is electrically neutral.
- But, his model could not explain the results of experiments carried out by other scientists such as Rutherford and Bohr.

Limitations of Thomson's Atomic Model

- Although Thomson's atomic model explained why an atom is electrically neutral, it could not explain the distribution of electrons in the atom.
- If we accept that electrons are embedded in the positive charge, then the opposite electric charges should cancel each other out and the charged sphere would be uncharged.

Thomson's model could not explain why different elements have different chemical properties.

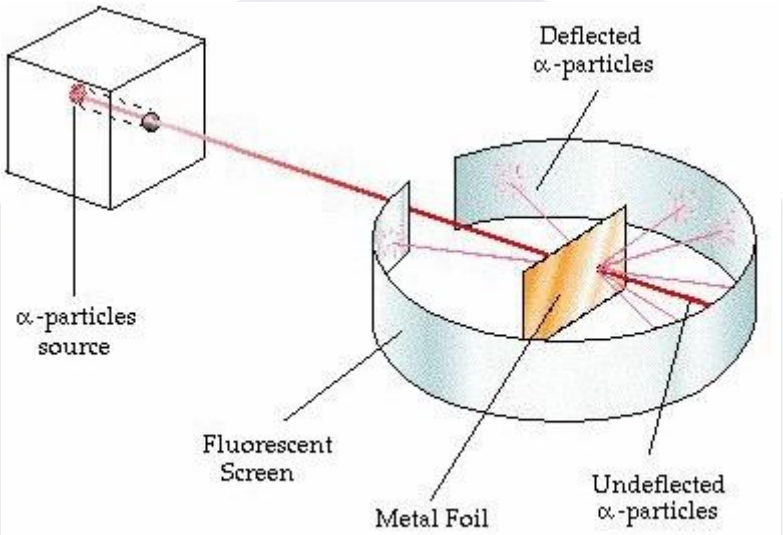
Rutherford's Model of an Atom

In 1911, Earnest Rutherford, a scientist from New Zealand, overturned Thomson's atomic model by his gold foil experiment.

Rutherford's Scattering Experiment

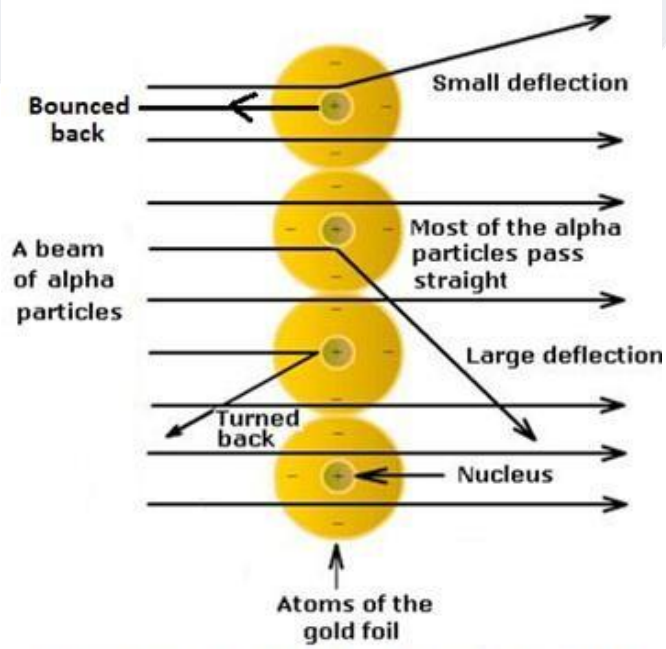
- Rutherford selected a gold foil as he wanted a very thin layer.
- The gold foil used by Rutherford was 0.004 millimetres in thickness. That is, the foil was about 1000 atoms thick.
- In his experiment, fast moving α-particles (alpha particles) were made to fall on a thin gold foil.
- The α-particles are helium ions with a +2 charge. Their atomic mass is 4 u. Hence, a high velocity beam of α-particles has a lot of energy.
- These particles were studied by means of flashes of light they produced on striking a zinc sulphide screen.
- The α-particles are much heavier than the sub-atomic particles present in gold atoms.
- Hence, he expected the α-particles to pass through the gold foil with little deflection and strike the fluorescent screen.

  But the observations he made were quite unexpected.



Rutherford's α-Particle Scattering Experiment

Explanation of the Results of Rutherford's Gold Foil Experiment

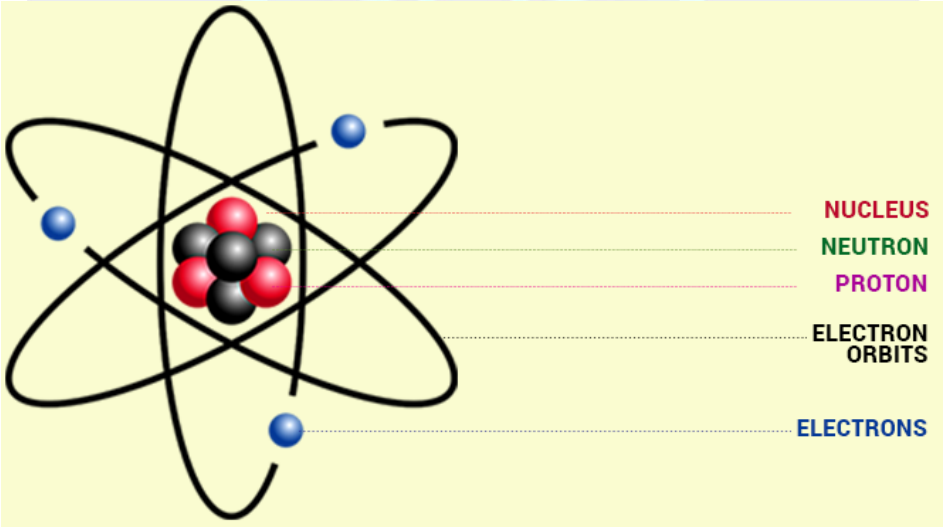


Deflection of α-particles from the Gold foil

- Rutherford postulated that the atom must contain large empty spaces as most of the α-particles passed through it without getting deflected.
- Some α-particles were deflected by the foil through small angles, while some were deflected through very large angles. Thus, Rutherford concluded that the positively charged particles in an atom must be concentrated in a very small space.
- One out of every 12,000 particles were deflected through 180° showing a full rebound. Thus, Rutherford came to the conclusion that all the positive charges of the atom and most of the mass of the atom is concentrated in a very small volume within the atom.
- Rutherford named this small space inside the atom as the **nucleus of the atom** or the **atomic nucleus**.
- On the basis of these observations, Rutherford calculated that the atomic nucleus is 10^5 times smaller than the total area of the atom.
- The radius of the atom is 10^{-8} centimetres while the radius of the nucleus is 10^{-13} centimetres.
- Thus, we can say that the atom is relatively hollow with a heavy nucleus at its centre. The electrons arranged around the nucleus possess negligible mass.
- Based on his observations, he formulated the **Theory of atom**.

Rutherford's Atomic Model

- Based on the results of the α-particle scattering experiments, Rutherford put forth his atomic model.
- An atom contains a positively charged centre called the nucleus of the atom. Almost all the mass of the atom is concentrated in the nucleus.
- The electrons of the atom revolve around the nucleus in fixed, circular orbits.
- The size of the nucleus is many times smaller than the size of the atom. The nucleus of an atom is 10,000 times smaller than the atom.



Drawbacks of Rutherford's Model of an Atom

- Rutherford's atomic model could not explain how moving electrons could remain in their orbits.
- Any charged particle during acceleration would radiate energy, and while revolving, it would lose its energy and eventually fall into the nucleus.
- This means that the atom would be highly unstable.
- But, matter is composed of stable atoms.
- Thus, the major drawback of Rutherford's atomic model was that it could not explain the stability of atoms.

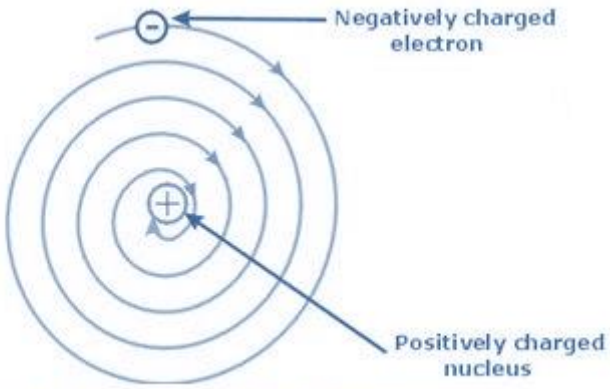
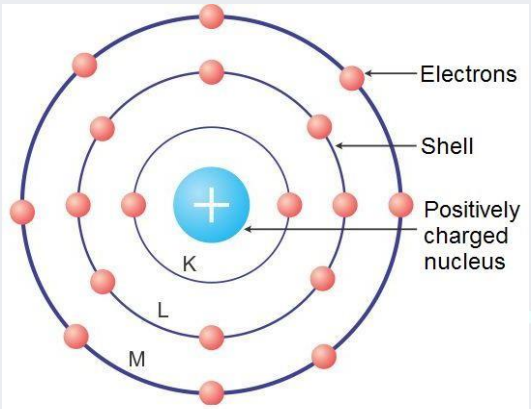


Diagram showing the atom losing energy

Bohr's Model of an Atom

- Niels Bohr, revised Rutherford's atomic model and put forth the following suggestions:
- Neils Bohr proposed that the electrons possess a specific amount of energy which allows them to revolve around the nucleus.



Niels Bohr's Atomic Model

- The electrons are confined to these energy levels. While revolving in these discrete orbits, the electrons do not radiate energy. Hence, these orbits are also known as **stationary orbits** or **stationary shells**. Smaller the size of the orbit, smaller is its energy.
- As we move away from nucleus, the energy of the orbit increases progressively.
- The transfer of an electron from one orbit to another is always accompanied with absorption or emission of energy.
- When an electron jumps from a lower energy level to a higher energy level, it **absorbs energy**.
- When an electron returns from a higher energy level to a lower energy level, it **emits energy**.

Distribution of Electrons in the Orbits

- According to Bohr's model, electrons occupy certain stable orbits or shells. Each shell has a definite energy.
- These orbits or shells are represented by the letters K, L, M, N... or the numbers 1, 2, 3, 4...
- The maximum number of electrons present in the shell is given by the formula ($2n^2$), where n is the orbit number or shell number.
- The maximum number of electrons in different shells is as follows:
  - ✓ The first orbit or K shell will have $2 \times 1^2 = \mathbf{2}$ electrons.

- ✓ The second shell will have $2 \times 2^2 = \mathbf{8}$ electrons.
- ✓ The third shell will have $2 \times 3^2 = \mathbf{18}$ electrons.
- ✓ The fourth shell will have $2 \times 4^2 = \mathbf{32}$ electrons and so on.

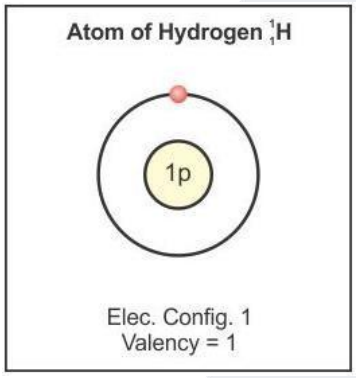
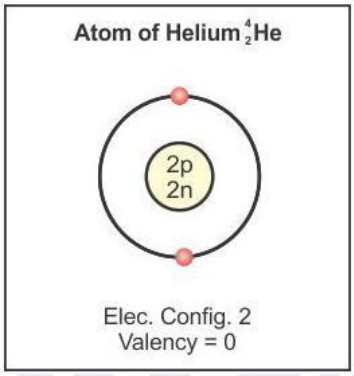
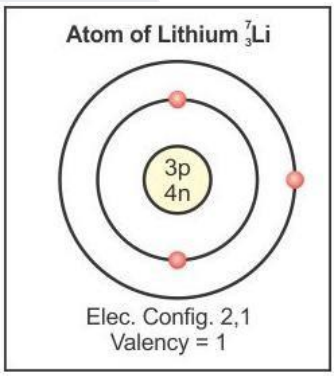
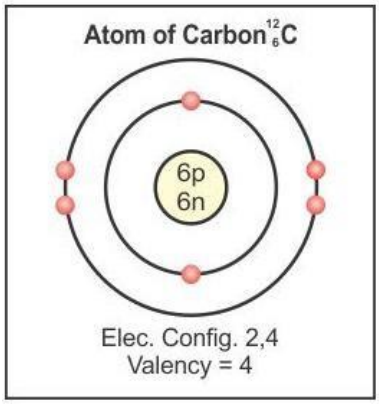
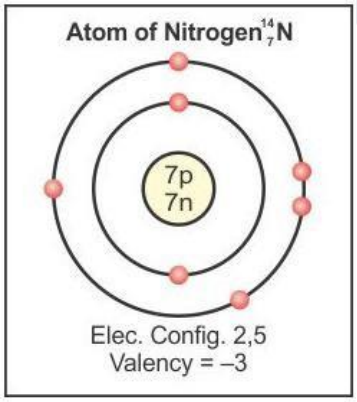
- The maximum number of electrons which can be accommodated in the outermost orbit is 8.
- The orbits or shells are filled in a step-wise manner.
- Electrons are not accommodated in a given shell unless the inner shells are filled.

Octet Rule

The Octet rule states that- 'The maximum number of electrons that the outermost shell of an electrically neutral and chemically stable atom can have is 8.'

Exception: If the atom has only one shell, it can hold only 2 electrons. For example, hydrogen and helium can have only 2 electrons (duplet).

Examples: (Distribution of electrons)

Electronic configuration		
		
Hydrogen	**Helium**	**Lithium**
		
Carbon	**Nitrogen**	

- The symbol of hydrogen is H and its atomic number is 1. The total number of electrons is 1. Therefore, the electronic configuration is also 1. Since it has only one electron, it will occupy the Kshell.

K	L	M	N
1	-	-	-

- The symbol of helium is He and its atomic number is 2. Therefore, the electronic configuration is also 2. Both these electrons will occupy the K shell **(duplet)**.

K	L	M	N
2	-	-	-

- The symbol of lithium is Li. The atomic number is 3. Therefore, the electronic configuration is (2, 1). This means that there are two electrons in the K shell and one electron in the L shell.

K	L	M	N
2	1	-	-

- The symbol of carbon is denoted by the capital letter C. The atomic number is 6. The number of electrons present in carbon atom is 6. Therefore, the electronic configuration is (2, 4). This means that there are 2 electrons in the K shell and 4 electrons in the L shell.

K	L	M	N
2	4	-	-

- The symbol of nitrogen is N and its atomic number is 7. The number of electrons is 7. Therefore, the electronic configuration is (2, 5). This means that there are two electrons in the K shell and 5 electrons are in the L shell.

K	L	M	N
2	5	-	-

- All noble gases except helium have eight electrons in the outermost shell. This arrangement is known as an **octet**.

Electronic Configuration of Elements

- The energy of every electron depends on the shell it occupies.
- Electrons in the K shell have minimum energy. Electrons in subsequent shells have higher energies.
- The arrangement of electrons of each element is called the electronic configuration of the element.

Valency

- The valency of an element represents the combining capacity of the element.
- It can also be defined as the number of electrons lost, gained or shared by its atom during a chemical combination.

Valence Shell

The outermost shell or orbit of an atom is known as the valence shell or valence orbit.

Valence Electrons

- The electrons present in the outermost valence shell of an atom are called valence electrons.
- The number of valence electrons varies from 1 to 8 for the atoms of different elements.
- The valence electrons of an atom determine the valency of that element.

Atomic Number and Atomic Mass Number

- The number of protons present in the nucleus of an atom is the atomic number of that atom. It is represented by the **symbol Z**.

Atomic number (Z) = Number of protons (p)

- All atoms of an element have the same atomic number. The number of protons and electrons in an atom is equal. Thus, the atom of an element is electrically neutral.
- Atomic mass number is defined as the sum of the number of protons and neutrons contained in the nucleus of an atom of that element. It is denoted by the **symbol A**.

Atomic mass number (A) = Number of protons (p) + Number of neutrons (n)

The atomic number, atomic mass number and symbol of an element are written as - $^{\text{Mass number}}_{\text{Atomic number}}X$ or $^{Z}_{A}X$

Isotopes

- Atoms of the same element differing in the number of neutrons in their nuclei are known as **isotopes**. Thus, isotopes of an element have the same atomic number but different atomic mass numbers.
- Isotopes are identified by their mass numbers.
- For example, the isotopes of carbon are referred to as carbon-12, carbon-13 and carbon-14.
- Isotopes of an element have **similar chemical properties but different physical properties**.

Average Atomic Mass of Chlorine

The isotopes of chlorine, found in nature are in the ratio 3 : 1.

Examples of Isotopes		
Element	**Number of Isotopes**	
Hydrogen	Three	Protium ($^{1}_{1}H$) Deuterium ($^{2}_{1}H$) Tritium ($^{3}_{1}H$)
Carbon	Three	$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$
Oxygen	**Two**	$^{16}_{8}O$ $^{17}_{8}O$
Uranium	Two	$^{235}_{92}U$ $^{238}_{92}U$

So, in any sample of chlorine, $^{35}_{17}Cl$ will constitute 75% and $^{37}_{17}Cl$ will constitute 25%.

The proportion in which the isotopes are found in the nature is always constant. Therefore, in any sample of chlorine, the average atomic mass will be

Average atomic mass of chlorine
= (35 x 75/100) + (37 x 25/100)
= 105/4 + 37/4
= 142/4
= 35.5 u
The average atomic mass of chlorine is equal to 35.5 u.

Radioactive Isotopes

- Isotopes can be stable or unstable depending on the presence of extra neutrons in their nuclei.
- The unstable isotopes which emit various types of radiations are known as radioactive isotopes.
- A few commonly used radioactive isotopes are carbon-14, arsenic-74, sodium-24, iodine-131, cobalt- 60 and uranium-235.

Applications of Isotopes

- Radioactive isotopes are used in nuclear reactors as a fuel. The nuclear reactors are used to generate electricity.
- Uranium-235 isotope is the fuel of choice for nuclear power plants.
- They are also used as diagnostic tools in medicine.
- Cobalt-60 is the isotope of choice for radiotherapy.
- Phosphorus-30 is used in the treatment of leukemia or blood cancer.
- Iodine-131 radioisotope, used as a 'tracer', is injected into the body to check the activity of the thyroid gland. It helps in detecting the amount of iodine taken up by the thyroid gland. It is an important tool in the diagnosis and treatment of diseases such as goitre.

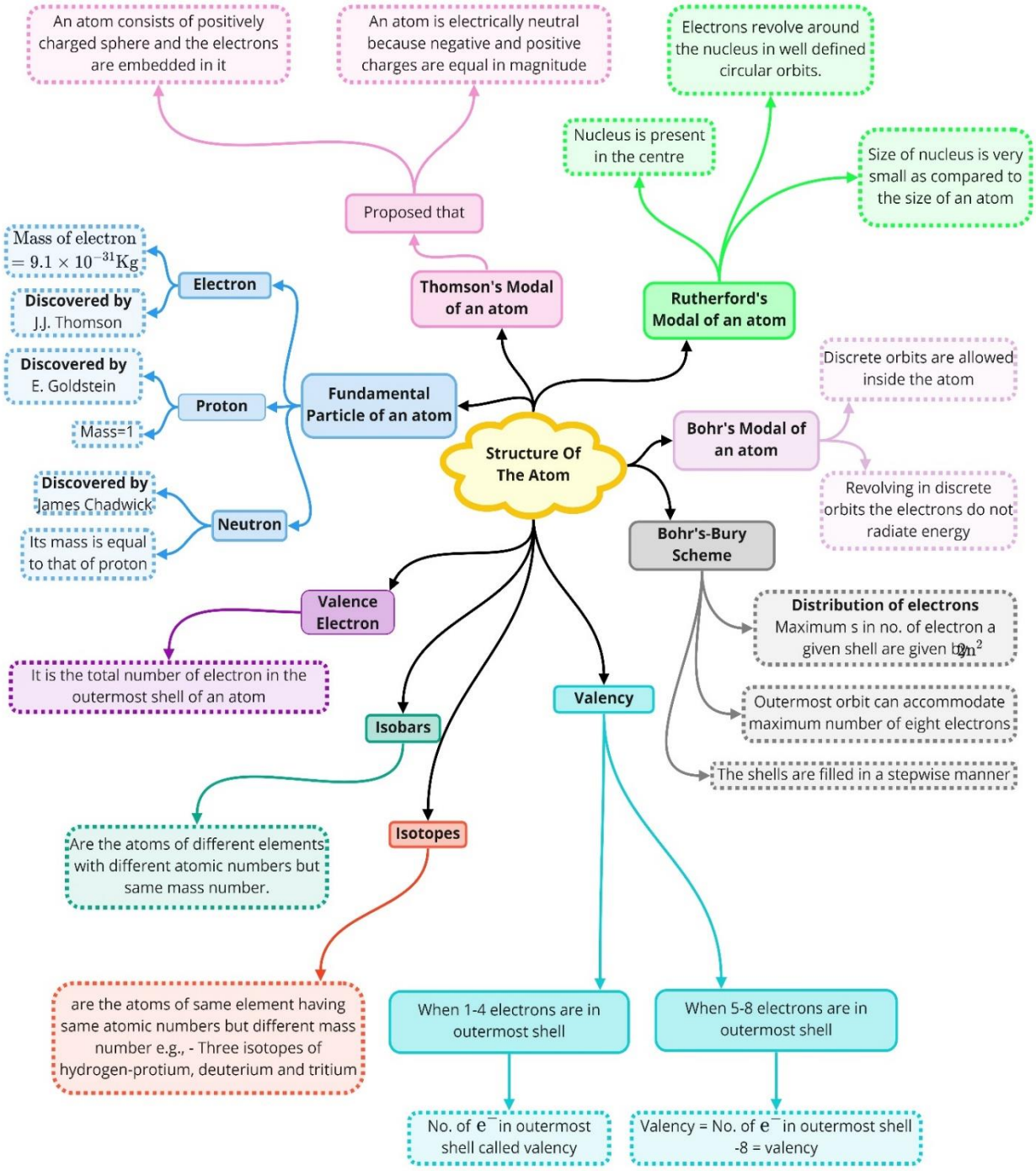
Isobars

The atoms of different elements having different atomic numbers but the same mass number are known as isobars.

Examples of Isobars

Isobars	Number of protons	Number of neutrons	Mass number
Chlorine-37	17	20	37
Argon-37	18	19	
Cerium-76	32	44	76
Selenium-76	34	42	
Iron-58	26	32	58
Nickel-58	27	31	

Class : 9th Science
Chapter- 4 : Structure Of The Atom



Important Question

Multiple Choice Questions:

1. Who discovered the electron?
   (a) Rutherford
   (b) Chadwick
   (c) Thomson
   (d) Goldstein
2. Which isotope is used in the nuclear power plants to generate electricity?
   (a) Uranium 235
   (b) Iodine 131
   (c) Cobalt 60
   (d) Uranium 238
3. Why was the Thomson's Model of an atom failed?
   i. It could not explain the screening of negative charges from that of positive
   ii. It did not tell about the presence of electrons
   iii. It did not give an idea about the discrete energy levels
   iv. It explained the atom as a whole to be electrically neutral

   Choose the correct option from the following:
   (a) Only (iii)
   (b) Both (i) & (iii)
   (c) Only (i)
   (d) Both (ii) & (iv)
4. What was the source of alpha particles in Rutherford scattering experiment?
   (a) Hydrogen nucleus
   (b) Argon nucleus
   (c) Helium nucleus
   (d) None of these
5. What property of an element determines its chemical behaviour?
   (a) Size of an element
   (b) Valency of an element
   (c) Molar mass of the element
   (d) None of these
6. Which of the following does not match the characteristics of an Isotope?
   (a) Isotopes of some elements are radioactive
   (b) Isotopes are the atoms of different elements
   (c) Isotopes differ in number of neutrons
   (d) Isotopes have similar chemical properties
7. Which of the two will be chemically more reactive, Sulphur(S) with atomic number 16 or Chlorine (Cl) with atomic number 17?
   (a) Chlorine
   (b) Sulphur
   (c) Both are equally reactive
   (d) Can't say
8. Which of the following elements does not exhibit the electrovalencey?
   (a) Sodium
   (b) Calcium
   (c) Carbon
   (d) Chlorine
9. Which of the following statements is incorrect about the structure of an atom?
   i. The whole mass of an atom is concentrated in the nucleus
   ii. The atom is an indivisible particle
   iii. The atom as a whole is neutral
   iv. All the atoms are stable in their basic state

   Choose the right option among the following:
   (a) (i) and (iii)
   (b) only (ii)
   (c) (ii) and (iv)
   (d) none of these
10. Which scientist gave the concept of fixed energy levels around the nucleus?
    (a) Ernest Rutherford
    (b) Neils Bohar
    (c) J.J.Thomsan
    (d) None of these

11. What prevents an atom from being collapsed?
    (a) The nuclear forces
    (b) Movement of electrons in discrete energy levels
    (c) The electron-electron repulsions
    (d) All of these
12. Which of the following pairs are isobars?
    (a) $_{17}Cl^{35}$ & $_{17}Cl^{37}$
    (b) $_{18}Ar^{40}$ & $^{20}Ca^{40}$
    (c) $_{6}C^{12}$ & $_{6}C^{14}$
    (d) None of these
13. Which of the following is an incorrect statement in reference with observation in Rutherford's α-particle scattering experiment?
    (a) Some of the α-particles rebound after hitting the gold foil
    (b) Some of the particles deflected from their path
    (c) Some of the particles not pass through the gold foil
    (d) Most of the particles pass straight through the gold foil
14. Which radioactive element is used in the treatment of cancer?
    (a) Iodine-131
    (b) Uranium-234
    (c) Plutonium-239
    (d) Cobalt-60
15. Why do most of the elements try to participate in the chemical combinations?
    i. To gain more electrons
    ii. To achieve Inert Gas configuration
    iii. To complete their octet
    iv. To complete their inner shells

    Choose the correct option among the following
    (a) Both (i) & (iii)
    (b) Both (ii) & (iii)
    (c) Only (ii)
    (d) Both (i) & (iv)

Very Short Question:

1. Draw the atomic structure of hydrogen atom.
2. Why are some elements chemically inert?
3. Why is atom electrically neutral?
4. What is the charge and mass of a-particles?
5. What are valence electrons?
6. An atom has atomic number 12, what is its valency and name the element?
7. Find the number of neutrons in $^{27}{}_{13}X$.
8. Where is the mass of atoiji concentrated?
9. Name two elements with same number of protons and neutrons?
10. Draw the atomic structure of sodium atom.

Short Questions:

1. Name the scientist who discovered protons and neutrons in an atoms.
2. What is the contribution of Bohr and Bury together in the structure of atom's explanation?
3. Draw the atomic structure of (i) an atom with same number of sub-atomic particles, (ii) an atom with same number of electrons in L and M shell.
4. What is an octate? Why would atoms want to complete their octate?
5. Find the valency of $^{14}{}_{7}N$ and $^{35}{}_{17}Cl$.
6. Pick up the isotopes among the following and state reason.

   $_{7}^{14}X$ $_{17}^{35}X$ $_{14}^{24}X$ $_{17}^{37}X$
7. Pick up atoms which have same number of neutrons from the following:

   $_{11}^{23}Y$ $_{14}^{28}Y$ $_{12}^{24}Y$ $_{13}^{27}Y$
8. What are nucleons? What is the name given to those atoms which have same number of nucleons in it?

Long Questions:

1. Give an activity to understand the implications of Rutherford's a scattering experiment by a gold foil.
2. What are isotopes? State its characteristics, give uses of isotopes?
3. Explain Rutherford's α-particle scattering experiment and give its observation and conclusion drawn.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.

b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

c. Assertion is true but Reason is false.

d. Both Assertion and Reason are false.

Assertion: No. of electrons always equal to the proton no. of atom.

Reason: Atom is always made-up of proton and electron.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.

b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

c. Assertion is true but Reason is false.

d. Both Assertion and Reason are false.

Assertion: No. of electrons always equal to the proton no. of atom.

Reason: Atoms are always made up of proton, electron, and neutron.

Case Study Questions:

1. Dalton's atomic theory suggested that the atom was indivisible and indestructible. But the discovery of two fundamental particles (electrons and protons) inside the atom, led to the failure of this aspect of Dalton's atomic theory. It was then considered necessary to know how electrons and protons are arranged within an atom. For explaining this, many scientists proposed various atomic models. J.J. Thomson was the first one to propose a model for the structure of an atom.

   J.J. Thomson (1856- 1940) was a British physicist, He was awarded the Nobel Prize in Physics for his work on the discovery of electrons. Thomson proposed the model of an atom to be similar to that of a Christmas pudding. The electrons, in a sphere of positive charge. We can also think of a watermelon, the positive charge in the atom is spread all over like the red edible part of the watermelon, while the electrons are studded in the positively charged sphere, like the seeds in the watermelon. Thomson proposed that: An atom consists of a positively charged sphere and the electrons are embedded in it. The negative and positive charges are equal in magnitude. So, the atom as a whole is electrically neutral.

   (i) Identify the correct statement

   Statement 1 – Dalton's atomic theory suggested that the atom was indivisible and indestructible.

   Statement 2 – Electrons and protons are present inside the atom.

   Statement 3 – J.J. Thomson was the first one to propose a model for the structure of an atom.

   Statement 4 – Protons are positively charged particle.

   (a) Only 2

   (b) Both 3 & 4

   (c) Both 1 & 2

   (d) All of the above

   (ii) According to Dalton's Atomic Theory, matter consists of indivisible _____

   (a) Molecules

   (b) Atoms

   (c) Ions

   (d) Mixtures

   (iii) Who was the first to propose atomic theory?

   (a) J.J. Thomson

   (b) John Dalton

   (c) E. Rutherford

   (d) Neilsbhore

   (iv) "Atom is indivisible and indestructible" why this aspect of Dalton's atomic theory leds to the failure?

   (vi) Explain the J.J. Thomson's model for the structure of an atom?

2. Rutherford (1871-1937) was known as the 'Father' of nuclear physics. He is famous for his work on radioactivity and the discovery of the

nucleus of an atom with the gold foil experiment. Ernest Rutherford was interested in knowing how the electrons are arranged within an atom. Rutherford designed an experiment for this. In this experiment, fast moving alpha (α)-particles were made to fall on a thin gold foil. On the basis of his experiment, Rutherford put forward the nuclear model of an atom, which had the following features:

- There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.
- The electrons revolve around the nucleus in circular paths.
- The size of the nucleus is very small as compared to the size of the atom.

Drawbacks of Rutherford's model of the atom: The revolution of the electron in a circular orbit is not expected to be stable. Any particle in a circular orbit would undergo acceleration. During acceleration, charged particles would radiate energy. Thus, the revolving electron would lose energy and finally fall into the nucleus. If this were so, the atom should be highly unstable and hence matter would not exist in the form that we know. We know that atoms are quite stable.

(i) Which of the following scientist was known as the 'Father of nuclear physics?

(a) J.J. Thomson
(b) John Dalton
(c) E. Rutherford
(d) Neilsbhore

(ii) Positively charged centre in an atom is termed as

(a) Nucleus
(b) Molecule
(c) Atom
(d) Protons

(iii) Identify the correct statement

Statement 1 – Positively charged centre in an atom called the nucleus.

Statement 2 – The electrons revolve around the nucleus in circular paths.

Statement 3 – Nearly all the mass of an atom resides in the nucleus.

Statement 4 – The size of the nucleus is very small as compared to the size of the atom.

(a) Only 2
(b) Both 3 & 4
(c) Both 1 & 2
(d) All of the above

(iv) Write the features of Rutherford's nuclear model of an atom?

(v) Define Nucleus.

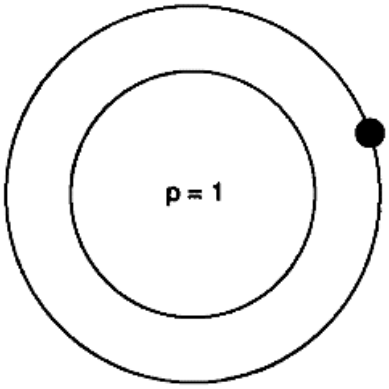
Answer Key

Multiple Choice Answers:

1. (c) Thomson
2. (a) Uranium 235
3. (b) Both (i) & (iii)
4. (c) Helium nucleus
5. (b) Valency of an element
6. (b) Isotopes are the atoms of different elements
7. (a) Chlorine
8. (c) Carbon
9. (c) (ii) and (iv)
10. (b) Neils Bohar
11. (b) Movement of electrons in discrete energy levels
12. (b)18Ar40 & 20Ca40
13. (a) Some of the α-particles rebound after hitting the gold foil
14. (d) Cobalt-60
15. (b) Both (ii) & (iii)

Very Short Answers:

1. **Answer:**



Hydrogen atom

2. **Answer:** Because their outermost shell is completely filled.
3. **Answer:** It has same number of protons and electrons, (positive charge = negative charge).
4. **Answer:** Charge is + 2

   Mass is 4 a.m.u.
5. **Answer:** Electrons present in the outermost shell of an atom are called valence electrons.
6. **Answer:** Atomic number = 12

   ∴ Protons = Electrons = 12 Electrons Configuration = K L M -2 8 2

   ∴ Valency = 2

   Element is magnesium.
7. **Answer:** Mass number = 27

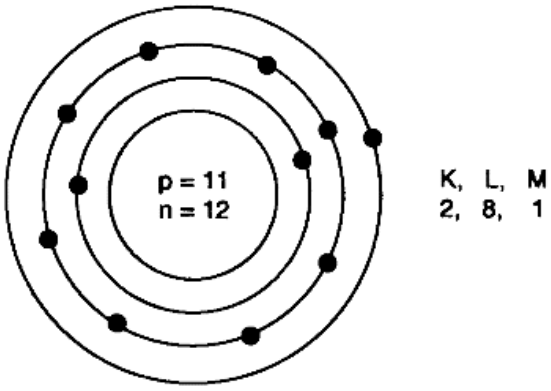
   ∴ p + n = 27 p = 13, (Atomic No. = Number of protons)

   ∴ 13 + n = 27

   ∴ n = 14

   ∴ Neutron =14
8. **Answer:** Mass of an atom is concentrated in nucleus.
9. **Answer:** Carbon (Protons = Neutrons = 6)

   Oxygen (Protons = Neutrons = 8)
10. **Answer:**



Na atom

Short Answer:

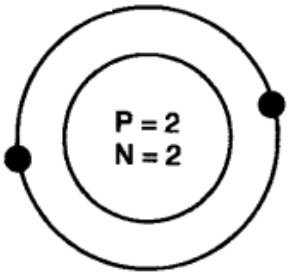
1. **Answer:** Protons were discovered by E. Goldstein in 1866 and neutrons were discovered by J, Chadwick in 1932.
2. **Answer:** Both Bohr and Bury gave the distribution of electrons into different atoms by giving the formula $2n^2$, where n = shell number.
3. **Answer:**

   (i) An atom with same number of sub-atomic particles is 24He

   No. of protons = 2

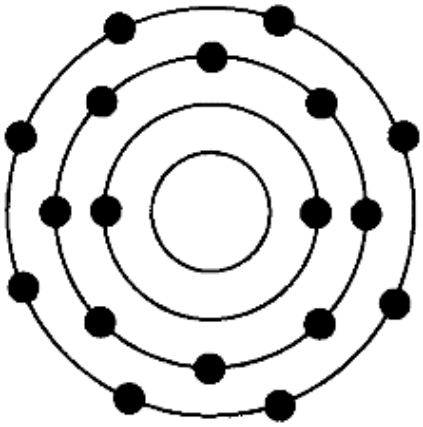
   No. of electrons = 2

   No. of neutrons = 2



Helium atom

   (ii) An atom with L and M shell filled → K L M- 2 8 8



Argon

4. **Answer:** When the outermost shell of an atom i.e., L, M or N are completely filled with 8 electrons in the shell, it is said an octate. Atoms would want to complete their octate because they want to become stable.

5. **Answer:** The atomic number of nitrogen = 7, No. of protons = 7, No. of electrons = 7

   Electronic configuration = K L M =2 5 –

   Valency = 3

   Because either it will gain three electrons or share 3 electrons to complete its octate.

   The atomic number of chlorine = 17, p = 17, e=17

   Electronic configuration = K L M= 2 8 7

   Valency = 1

   Because it will gain 1 electron to complete its octate.

6. **Answer:** The isotopes are 3517X and 3717X as both the atoms show same atomic number but different mass number.

7. **Answer:**

   $^{23}_{11}Y$ and $^{24}_{12}Y$ have same number of neutrons, 12 in each.

   $^{28}_{14}Y$ and $^{27}_{13}Y$ have same number of neutrons, 14 in each.

8. **Answer:** Protons and neutrons present in the nucleus are called nucleons Isobaric elements have same number of nucleons in it.

E.g.,	**Element**	**Protons**	**Neutrons**	**(Protons + Neutrons)**
	Argon	18	22	40
	Calcium	20	20	40
	Potassium	19	21	40

Long Answer:

1. **Answer:** To understand the implications of Rutherford's a-particle scattering experiment:

   Activity: Let a child stand in front of a wall with his eyes closed. Let him throw stones at the wall from a distance. He will hear sound for each strike of stone on the wall. This is like a nucleus of the atom. But if a blind-folded child has to throw stones at a barbed-wire fence, most of the stones would not hit the fencing and no sound would be heard.

   This is because there are lots of gap in the fence which allows the stone to pass through them. This is like empty space in an atom through which a-particles will pass through. Based on the above activity and similar reasoning Rutherford concluded the a-particle scattering experiment as:

   - Most of the space inside the atom is empty as a-particles passed through the foil.
   - Very few particles deflected from their path, this show that positive charge occupies less space.
   - A very small fraction of a-particles are deflected by 180°, this shows that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.

2. **Answer:** Atoms of same element with same atomic number but different mass number are isotopes.

   Characteristics:

   - Physical properties of the isotopes are different e.g. mass, density.
   - Chemical properties of the isotopes are same due to same number of electrons.

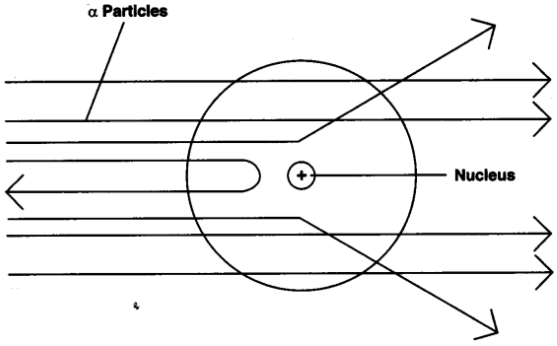
   Uses:

   - Uranium isotope is used as a fuel in nuclear reactor (U-235).
   - Cobalt isotope is used for treatment of cancer (Co-60).
   - Iodine isotope is used in the treatment of goitre.

3. **Answer:** Rutherford's α-particle scattering experiment:

   Fast moving α-particles were made to fall on a

thin gold foil. Particles have + 2 charge and 4u mass, and considerable amount of energy.



Observations:

- Most of the α-particles passed straight through the foil.
- Some of the α-particles were deflected by small angles by the foil.
- One out of every 12000 particles rebounded.

Conclusion from observation:

- Most of the space inside the foil is empty.
- Positive charge of atom occupies very less space.
- Mass of the atom is concentrated in the centre with all positive charge concentrated in small volume within the atom.

Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (b) Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

Case Study Answers:

1. (i) (d) All of the above
   (ii) (b) Atoms
   (iii) (b) John Dalton
   (iv) Dalton's atomic theory suggested that the atom was indivisible and indestructible. But the discovery of two fundamental particles (electrons and protons) inside the atom, led to the failure of this aspect of Dalton's atomic theory.
   (v) Thomson was the first one to propose a model for the structure of an atom:

   Postulate 1: An atom consists of a positively charged sphere with electrons embedded in it.

   Postulate 2: An atom as a whole is electrically neutral because the negative and positive charges are equal in magnitude

   Thomson atomic model is compared to watermelon. Where he considered:

   - Watermelon seeds as negatively charged particles.
   - The red part of the watermelon as positively charged.

2. (i) c
   (ii) a
   (iii) d
   (iv) Rutherford put forward the nuclear model of an atom, which had the following features:
   - There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.
   - The electrons revolve around the nucleus in circular paths.
   - The size of the nucleus is very small as compared to the size of the atom.

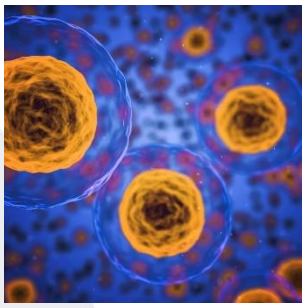
   (v) There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.

BIOLOGY

The Fundamental Unit of Life 1

Cells are the basic structural and functional unit of life. Cell was discovered by Robert Hooke. A number of cells can work together to form tissues and organs.

History of Cell



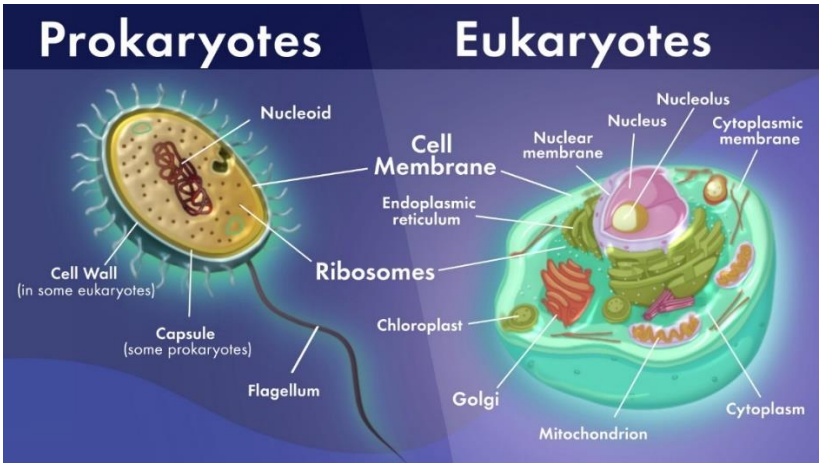
- The **cell** is the basic structural and functional unit of all living organisms. It is the smallest part of the body of an organism which is capable of independent existence and is able to perform all the essential functions of life.
- The history of cell science began in **1665**, with the observation of a thin section of bottle cork by the English scientist **Robert Hooke**.
- In **1838**, **Matthias Schleiden** and **Theodor Schwann** proposed a basic cell theory. In 1858, another scientist, Virchow, made an addition to the existing cell theory.
- The **postulates of the modern cell theory** are
  - The cell is the smallest unit of structure of all living things.
  - The cell is the unit of function of all living things.
  - All cells arise from pre-existing cells.
- Cells vary in **number**. Examples: Single-celled *Amoeba,* few-celled *Spirogyra* and multi-celled human being. They vary in **size**. Examples: Bacteria are the smallest, nerve cells are the longest and the ostrich egg is the largest. They vary in **shape**. Example: Columnar epithelial cells.

Cellular respiration

Cellular respiration is the process by which the food releases energy in the mitochondria. Cells absorb glucose from the food and burn it to produce energy.

Structural Organization of Cells

Prokaryotic & Eukaryotic cells



Two types of cells Prokaryotic and Eukaryotic cells.

Prokaryotic cells

They are primitive and lack well defined nucleus. Eukaryotic cells are more advanced and have well defined nucleus.

Cell structure in Eukaryotic cells

Eukaryotic cells have the most well-defined structure. These cells have cell membrane, membrane bound cell organelles and a well-defined nucleus. The nucleus has its own membrane called nuclear membrane.

Cell membrane

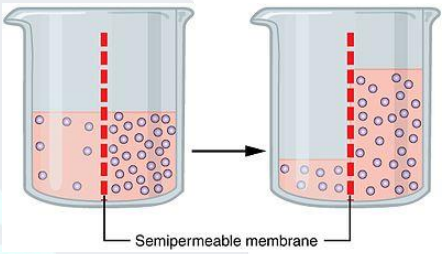
- Cell membrane is the outer covering of a cell.
- It is made up of phospho-lipid bilayer membrane.
- It is selectively permeable in nature.
- The structure of a cell membrane is best described by the fluid mosaic model.

Diffusion

The movement of molecules from a region of their high concentration to a region of their lower concentration is known as diffusion.

Osmosis in selectively permeable membrane

Osmosis is the movement of water across a semi-permeable membrane. Osmosis is a selective process since the membrane does not allow all molecules to pass through it. Water is usually the only free flowing molecule across this membrane.



Isotonic, hypotonic solutions, hypertonic solutions

- **Isotonic solutions** are those which have the same solute and pH concentration as the surrounding body fluid or the cytoplasm.
- **Hypotonic solutions** contain lesser amount of solute concentration compared to the surrounding fluid and can force the cell to rupture due to excess input of water into the cell.
- **Hypertonic solutions** contain higher concentration of solute compared to the surrounding fluid and thus push water out of cell, shrinking it.

Types of Organisms

UNICELLULAR ORGANISMS	MULTICELLULAR ORGANISMS
1. Made of one cell.	1. Made of many cells.
2. There is no division of labour.	2. Cells are specialised to perform specific functions.
3. A single cell participates in reproduction.	3. Only some cells (germ cells) participate in reproduction.
4. Lifespan is short.	4. Lifespan is long.
5. Examples: *Amoeba*, *Paramoecium*	5. Examples: Fungi, plants, animals

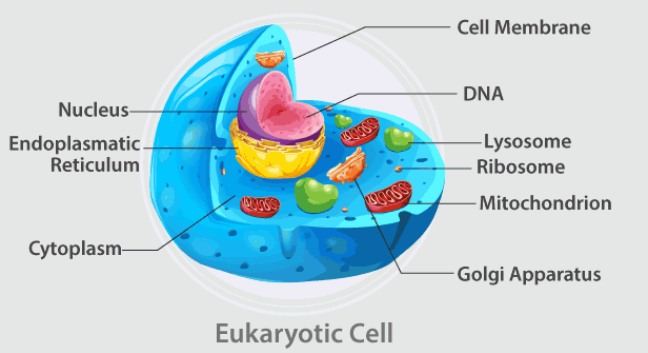
Differences between Prokaryotic and Eukaryotic Cells

PROKARYOTIC CELL	EUKARYOTIC CELL
1. Absence of a well-defined nucleus.	1. Presence of a well-defined nucleus with a nuclear membrane.
2. Nucleolus is absent.	2. Nucleolus is present.
3. Presence of a single length of only DNA.	3. Presence of several lengths of DNA, wound around certain proteins.
4. Presence of smaller ribosomes.	4. Presence of larger ribosomes.
5. Examples: Bacteria, blue-green algae	5. Examples: *Amoeba*, plants, animals

Eukaryotic Cell

The term "Eukaryotes" is derived from the Greek word "eu", (meaning: good) and "karyon" (meaning: kernel), therefore, translating to "good or true nuclei." Eukaryotes are more complex and much larger than the prokaryotes. They include almost all the major kingdoms except kingdom monera.

Structurally, eukaryotes possess a cell wall, which supports and protects the plasma membrane. The cell is surrounded by the plasma membrane and it controls the entry and exit of certain substances.



The nucleus contains DNA, which is responsible for storing all genetic information. The nucleus is surrounded by the nuclear membrane. Within the nucleus exists the nucleolus, and it plays a crucial role in synthesising proteins. Eukaryotic cells also contain mitochondria, which are responsible for the creation of energy, which is then utilized by the cell.

Present in only plant cells, chloroplasts are the subcellular sites of photosynthesis. Endoplasmic reticulum helps in the transportation of materials. Besides these, there are also other cell organelles that perform various other functions and these include ribosomes, lysosomes, Golgi bodies, cytoplasm, chromosomes, vacuoles and centrosomes.

Examples of eukaryotes include almost every unicellular organism with a nucleus and all multicellular organisms.

Prokaryotic Cell

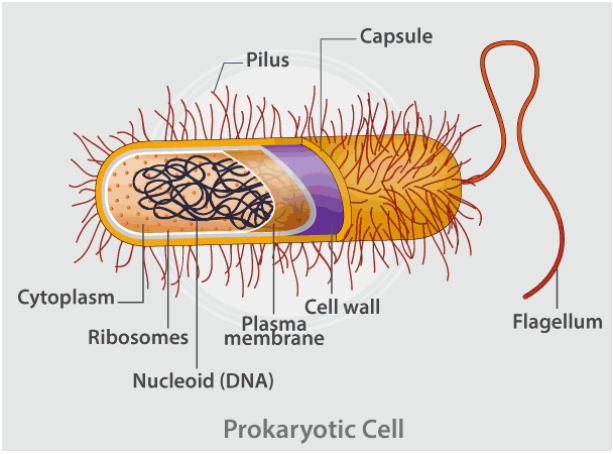
The term "prokaryote" is derived from the Greek word "pro", (meaning: before) and "karyon" (meaning: kernel). It translates to "before nuclei. "

Prokaryotes are one of the most ancient groups of living organisms on earth, with fossil records dating back to almost 3.5 billion years ago.

These prokaryotes thrived in the earth's ancient environment, some using up chemical energy and others using the sun's energy. These extremophiles thrived for millions of years, evolving and adapting. Scientists speculate that these organisms gave rise to the eukaryotes.

Prokaryotic cells are comparatively smaller and much simpler than eukaryotic cells. The other defining characteristic of prokaryotic cells is that it does not possess membrane-bound cell organelles such as a nucleus. Reproduction happens through the process of binary fission.

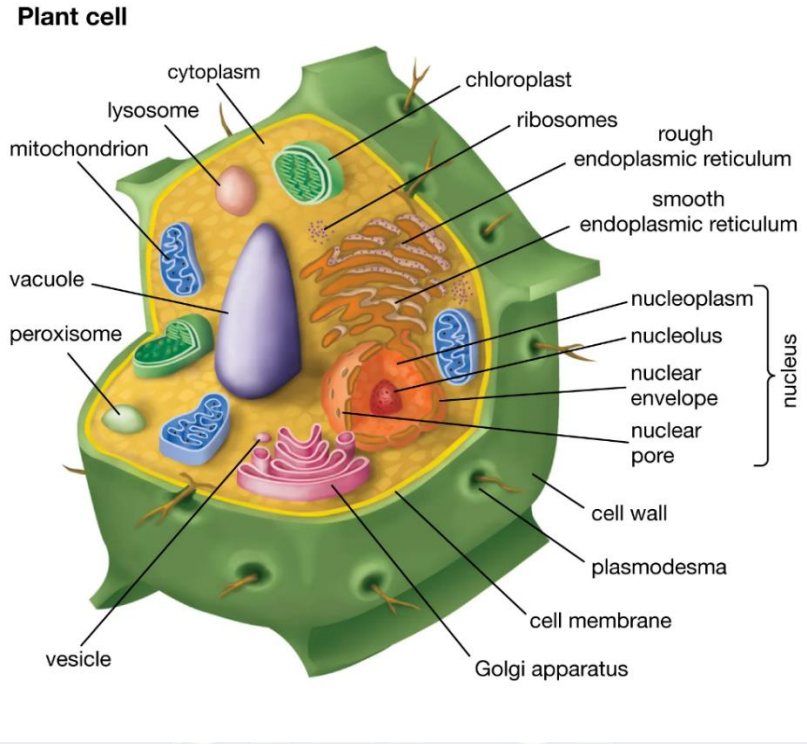
Structurally, prokaryotes have a capsule enveloping its entire body, and it functions as a protective coat. This is crucial for preventing the process of phagocytosis (where the bacteria gets engulfed by other eukaryotic cells, such as macrophages) The pilus is a hair-like appendage found on the external surface of most prokaryotes and it helps the organism to attach itself to various environments. The pilus essentially resists being flushed, hence, it is also called attachment pili. It is commonly observed in bacteria.



Right below the protective coating lies the cell wall, which provides strength and rigidity to the cell. Further down lies the cytoplasm that helps in cellular growth, and this is contained within the plasma membrane, which separates the interior contents of the cell from the outside environment. Within the cytoplasm, ribosomes exist and it plays an important role in protein synthesis. It is also one of the smallest components within the cell.

Some prokaryotic cells contain special structures called mesosomes which assist in cellular respiration. Most prokaryotes also contain plasmids, which contains small, circular pieces of DNA. To help with locomotion, flagella are present, though, pilus can also serve as an aid for locomotion. Common examples of Prokaryotic organisms are bacteria and archaea. Also, all members of Kingdom Monera are prokaryotes.

Cell walls in plants



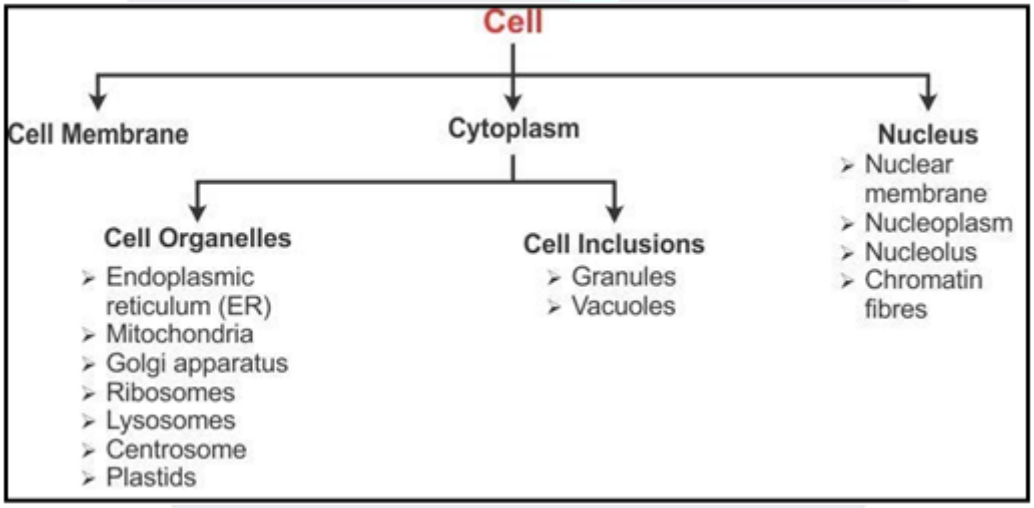
Plant cells are different from animals cells due to the presence of a cell wall. The cell wall is made of cellulose and gives a rigid structure to the plant cell.

Cell Organelles

- **Endocytosis:** Endocytosis is the invagination of cell membrane, followed by pinching off forming a membrane bound vesicle. This is commonly seen in Amoeba.
- **Nucleus in cells:** Nucleus is the processing unit of the cell. It is a double membrane bound organelle which contains the genetic material for inheritance.
- **Chromosomes:** During the growth phase of the cell, the chromatin condenses into a much thicker structure called chromosome.
- **Chromatin:** Chromatin is a thread like structure which serves as the genetic material present inside the nucleus of the cell. It is made up of DNA and protein molecules. The DNA contains the hereditary information needed for the structure and function of the organism.
- **Cytoplasm:** Cytoplasm is the fluid found inside the cell. It gives the structure to the cell and houses different organelles of the cell.
- **Organelles:** Organelles are structures present in the cytoplasm of the cell that help in several functions of the cell.
- **Endoplasmic Reticulum:** Endoplasmic reticulum is a membrane like cell organelle that plays an integral role in the interpretation of the genetic information present in the nucleus.

- **Rough ER:** Rough ER are the ones that have ribosomes on it. The ribosome is made up of nucleic acids and proteins. They are the site of protein synthesis. The Rough ER is also involved in the modification and folding of protein.
- **Smooth ER:** Smooth ER do not have ribosomes and thus are not involved in protein synthesis. They are however, involved in the lipid metabolism and detoxifying poisonous molecules.
- **Golgi Apparatus:** Golgi Apparatus is also called the post office of the cell. They package and transport the proteins across the cytoplasm.
- **Lysosomes:** They are referred to as suicide bags of the cell as they contain potent enzymes that can digest a cell. Lysosome also help in defense by attacking a foreign object.
- **Mitochondria:** Mitochondria are also called power plant of the cell. They generate ATP via the electron transport chain. They also have a DNA called mtDNA, which makes them semi-autonomous organelle.
- **Plastids:** There are various types of plastids in different cells based on the pigment they contain. The chloroplast is the plastid where the photosynthesis occurs. Some of the other plastids are leucoplast and chromoplast.
- **Vacuoles** Vacuoles are large vesicles that hold water or air in them and give structural rigidity to the cell. Vacuoles are common in plant cells. In animals the vacuoles are either very small or absent.

Structural Organisation of a Cell



CHARACTERISTICS	FUNCTIONS
Plasma membrane	
Very thin, flexible and delicate living semi- permeable membrane	Acts as an effective barrier and regulates the entry of certain solutes and ions
Cell wall	
Freely permeable, mainly composed of cellulose	Gives rigidity and shape to the plant cells and provides protection
Cytoplasm	
Contains a mixture of water and soluble organic and inorganic compounds and various cell organelles	Seat of occurrence of glycolysis (production of pyruvic acid)
Endoplasmic reticulum	
May be smooth (SER) or rough (RER)	Acts as a supportive framework of the cell

Mitochondria	
Double-walled, inner wall thrown into folds called cristae	Seat of aerobic respiration and synthesises respiratory enzymes and energy-rich compounds
Golgi apparatus (in animal cells) Dictyosomes (in plant cells)	
Consists of a set of membrane-bounded, fluid-filled vesicles and vacuoles	Synthesis of the plasma membrane, cell wall etc. and synthesis and secretion of enzymes and hormones
Ribosomes	
Single-walled, dense, spherical bodies composed mainly of RNA and proteins	Synthesis of proteins
Lysosomes	
Contains 40 different types of enzymes	Intracellular digestion

CHARACTERISTICS	FUNCTIONS
Centrosomes	
Contains one or two centrioles which are surrounded by radiating microtubules to form an aster shape	Initiates and regulates cell division
Plastids	
Double membrane, proteinaceous matrix containing DNA and disc-like structures called thylakoids containing chlorophyll	Chromoplasts: Impart colour to flowers and fruits Chloroplasts: Trap solar energy for photosynthesis Leucoplasts: Store starch
Nucleus	
Mostly spherical and dense, surrounded by nuclear membrane with pores	Regulates cell cycle and cell functions
Nucleolus	
Round, one or more in number	Participates in protein synthesis by forming and storing RNA
Chromatin fibres	
Network of thread-like structures which are made of DNA	Chromosomes carry hereditary information or genes
Vacuoles	
Non-living structures	Storage of water and other substances, food, pigments and waste products
Granules	
Small particles, crystals or droplets	Starch (in plant cells), glycogen (in animal cells) and fat-containing granules serve as food for the cell

Differences between Plant and Animal Cells

PLANT CELL	ANIMAL CELL
1. Presence of a definite cell wall made of cellulose	1. Absence of a cell wall
2. Cell membrane present internal to the cell wall	2. Cell membrane forms the boundary of the cell
3. Absence of centrosome	3. Presence of centrosome
4. Absence of centriole	4. Presence of centriole
5. Presence of plastids	5. Absence of plastids

Difference Between Plant cell and Animal cell

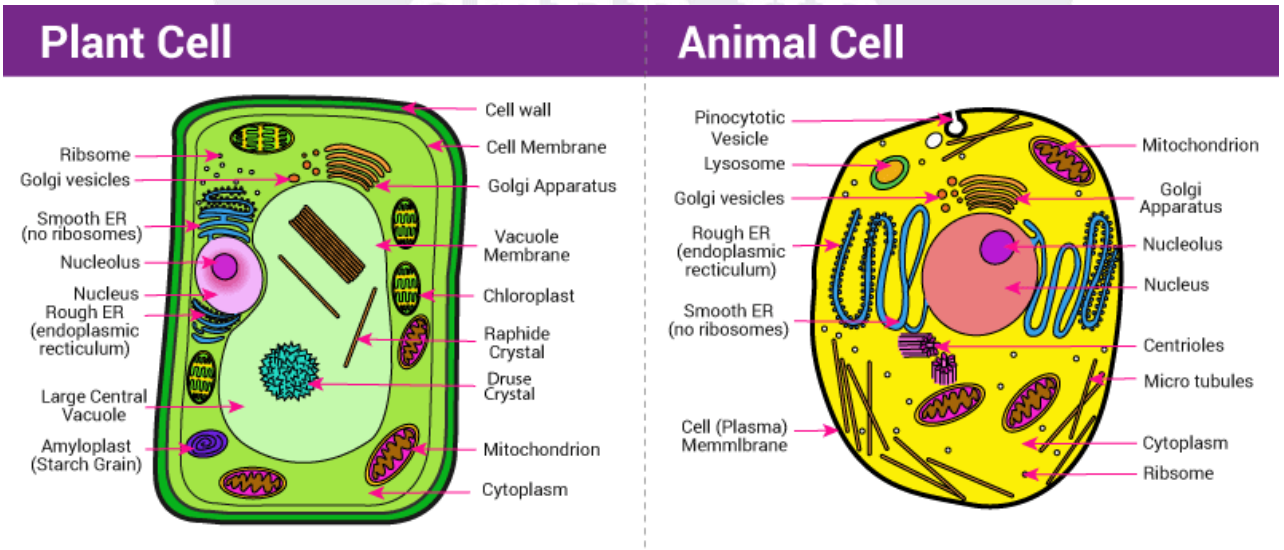
The cell is the fundamental unit of life. All the life activities are carried out by cells. The organisms are classified based on the number of cells present in them. Unicellular organisms are single-celled, while multicellular organisms have a large number of cells.

Unicellular organisms are believed to be one of the earliest forms of life on earth. Eventually, more complex multicellular organisms evolved from these unicellular life forms over the years. Multicellular organisms have specialized cells with complicated cell organelles, which unicellular organisms typically lack.

In an ecosystem, plants have the role of producers while animals have taken the role of consumers. Hence, their daily activities and functions vary, so do their cell structure. Cell structure and organelles vary in plants and animals, and they are primarily classified based on their function. The difference in their cell composition is the reason behind the difference between plants and animals, their structure and functions.

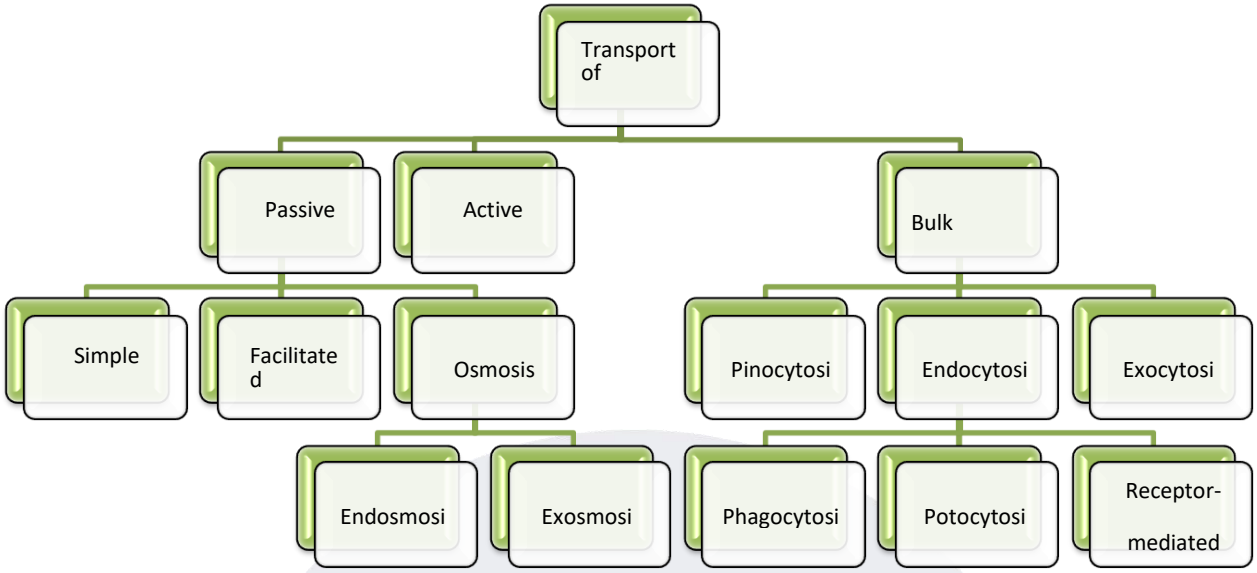
Each cell organelle has a particular function to perform. Some of the cell organelles are present in both plant cell and the animal cell, while others are unique to just one. Most of the earth's higher organisms are eukaryotes, including all plant and animals. Hence, these cells share some similarities typically associated with eukaryotes.

For example, all eukaryotic cells consist of a nucleus, plasma membrane, cytoplasm, peroxisomes, mitochondria, ribosomes and other cell organelles.



As stated above, both plant and animal cells share a few common cell organelles, as both are eukaryotes. The function of all these organelles is said to be very much similar. However, the major differences between the plant and animal cells, which significantly reflect the difference in the functions of each cell.

Transport of Materials across Cells



- **Passive transport** is a kind of diffusion in which an ion or a molecule crossing the cell membrane moves against its electrochemical or concentration gradient.
- In **simple diffusion**, molecules of gases such as oxygen and carbon dioxide enter the cell without the help of transport proteins such as permeases.
- In **facilitated diffusion**, ions or molecules cross the membrane rapidly by using specific proteins called transport proteins or permeases which are present in the membrane.
- The spontaneous passage of water molecules from a region of high water concentration to a region of low water concentration through a selectively permeable membrane is called **osmosis**.
- The process by which water molecules enter a cell is called **endosmosis**.
- The process by which water molecules move out of the cell is called **exosmosis**.
- In plant cells, when excess of exosmosis occurs, the cytoplasm and plasma membrane shrink away from the cell wall. This is known as **plasmolysis**.
- **Active transport** is the movement or transport of substances through a biological membrane such as the cell membrane. This process requires energy.
- Large molecules are continuously imported or exported into the cells across the plasma membrane. The process where the cells either release or absorb fluids and particles through their outer membrane is called **bulk transport**.
- Materials enter a cell by invagination and formation of vesicles. As the materials leave the cell, the membrane of a vesicle fuses with the plasma membrane and extrudes its contents to the surrounding medium. This outward transport of materials by using carrier molecules is called **exocytosis**.
- **Endocytosis** is the intake or ingestion of materials by cells through the plasma membrane.
- **Phagocytosis**, also known as **cell eating**, is a common method in which substances are taken up in the solid form.
- In **potocytosis**, small molecules or ions are specifically internalised into the cell.
- **Receptor-mediated endocytosis** is a pathway for selective uptake of large molecules such as ligands in clathrin-coated pits.
- In **pinocytosis**, also known as **cell drinking**, substances are taken up by the cell in the fluid form.

Cellulose In Digestion

Cellulose is a complex organic compound that occurs abundantly in nature. It is a polymeric carbohydrate molecule consisting of a linear chain having thousands of glycosidic linkages.

It consists of unbranched chains of glucose (linked D-Glucopyranose). They are straight chains linked by hydrogen bonds producing a substance that is inert and insoluble in water, in their pure form.

Modified cellulose and pure cellulose are different in their chemical compositions. They are components of the plant cell wall and have no odour or taste. It is crystalline in nature and does not dissolve water and other solvents. Termites and herbivorous animals lack the enzyme for cellulose digestion.

Digestion of Cellulose in Termites

Termites have mastigophorans (microbes) in their gut which brings about digestion of cellulose. Herbivorous animals, on the other hand, are ruminants. They have different compartments in their stomach to carry out digestion.

The rumen is the first compartment where ingested food containing cellulose is stored temporarily and later regurgitated to chew their cud. They are able to digest cellulose because of the presence of bacteria and enzymes in the rumen where anaerobic bacterial digestion occurs. A by-product of this type of digestion releases methane which is foul-smelling and causes the destruction of the ozone layer of the Earth.

Digestion of Cellulose in Humans

Cellulose is a fibre which is not digestible by the human digestive system. It, however, helps in the smooth functioning of the intestinal tract.

The presence of beta acetal linkages in cellulose makes it different from starch and is a deciding factor in its digestibility. Humans lack the enzyme required to breakdown the linkages. Furthermore, it forms a major part of the human diet from plant foods.

Fruits and vegetables contain cellulose in small amounts which are easily digestible. Fibres contain cellulose which acts as roughage, adding bulk to consumed food and helps in the smooth passage of the food efficiently and at a much faster pace. High fibre diet reduces the risk of colon cancer as fibre in the diet helps reduce the time the faeces stay in the colon wall.

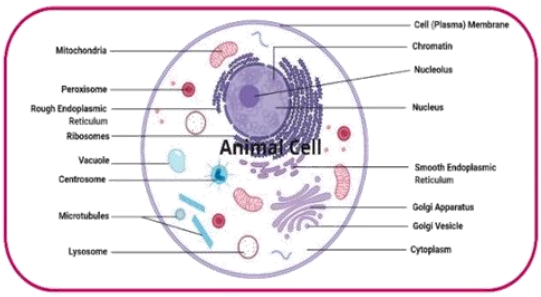
Since it is insoluble in water it binds with other components adding bulk helping to move through the intestines by aiding bowel movements. Consuming food that does not contain cellulose over a period of time results in the bowel becoming weak leading to constipation.

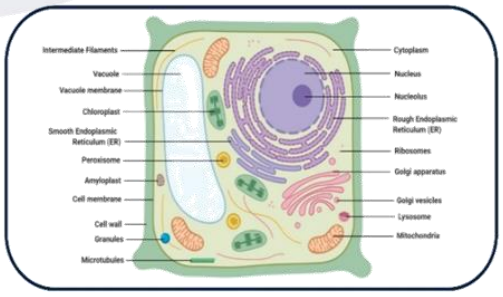
These fibres aid in the growth of bacteria in the gut which feeds on sugars and fibres. They maintain the health of the gut and checks for bacteria causing illness. Fibres also prevent weight gain and aids in weight loss.

Class : 9th Science
Chapter- 5: The Fundamental Unit Of Life

The Fundamental Unit Of Life

- Cell Theories
  - Robert Brown
    - discovered nucleus in cell
  - Schleiden and schwann
    - Gave cell theory and stated that all plants and animals are composed of cells
  - Leavenhock
    - observed the cells in cork-slice with the help of primitive microscope
  - Virchow
    - expended cell theory by suggestion that cell arise from pre-existing cell
  - Robert Hooke
    - discovered and named the cells
- Types of cell
  - Prokaryotic Cell
  - Eukaryotic Cell
- Nucleus
  - Nuclear Membrane
  - Nucleolus
  - Chromatin network
- Cell Organelles
  - Endoplasmic reticulum
  - Golgi apparatus
  - Lysosomes
  - Mitochondria
  - Plastids
- Plasma membrane or cell membrane
  - Lies outside the plasma membrane
    - Cell Wall
- Animal Cell
- Plant Cell





Important Question

Multiple Choice Questions:

1. The basic unit of life is:
   (a) tissue
   (b) cell
   (c) both
   (d) none of them
2. Who discovered the cell?
   (a) Robert Hooke
   (b) Leeuwenhoek
   (c) Robert Brown
   (d) T. Schwann
3. The cell wall of a plant cell is made up of:
   (a) glucose
   (b) fructose
   (c) protein
   (d) cellulose
4. Which of the following controls all biological activities of a cell?
   (a) Protoplasm
   (b) Cell wall
   (c) Nucleus
   (d) All of these
5. Which of the following is known as the 'Power House' of a cell?
   (a) Nucleus
   (b) Golgi Bodies
   (c) Ribosome
   (d) Mitochondria
6. Digestive Enzymes are found in:
   (a) Protoplasm
   (b) Cell wall
   (c) Lysosomes
   (d) Mitochondria
7. Which is the longest cell of the human body?
   (a) Nerve cell
   (b) Liver cell
   (c) Kidney cell
   (d) Cardiac cell
8. Which of the following cell organelles functions both as an intracellular transport system and as a manufacturing surface?
   (a) Nucleus
   (b) Mitochondria
   (c) ER
   (d) None of these
9. Which of the following cell organelles help in the storage, modification, and packaging of substances manufactured in the cell?
   (a) Golgi apparatus
   (b) Nucleus
   (c) Mitochondria
   (d) Chloroplasts
10. Who proposed the "Black Reaction"?
    (a) Benda
    (b) Camillo Golgi
    (c) Schleiden
    (d) None of them
11. Who discovered the nucleus in the cell?
    (a) Leeuwenhoek
    (b) Robert Brown
    (c) Schleiden
    (d) Robert Hooke
12. Which of the following are formed in bone marrow?
    (a) RBC
    (b) Cartilage cell
    (c) Blood platelets
    (d) Fibres
13. Which of the following can be made into crystal?
    (a) A bacterium
    (b) An amoeba
    (c) A virus
    (d) A sperm
14. Chromosomes are made up of:
    (a) DNA
    (b) Protein
    (c) DNA and protein
    (d) RNA

15. Which of the following are covered by a single membrane?
    (a) Mitochondria
    (b) Vacuole
    (c) Ribosome
    (d) Plastid

Very Short Question:

1. What are plastids? Name the different types of plastids found in plant cell.
2. What is plasma membrane made up of?
3. What did Robert Hooke observed first in cork cell?
4. Name the autonomous organelles in the cell.
5. What does protoplasm refer to?
6. Name two cells which keep changing their shape.
7. Name the smallest cell and the longest cell in human body.
8. Name 3 features seen/ present in almost every cell.
9. What is diffusion?
10. What is osmosis? This takes place from high water concentration to low water concentration.

Short Questions:

1. State two conditions required for osmosis.
2. What is plasmolysis?
3. How does fungi and bacteria can withstand much greater changes in the surrounding medium than animal cells?
4. Give the function of nuclear membrane.
5. Name the cell-organelles that have their own DNA and ribosomes.
6. State the difference between smooth endoplasmic reticulum and rough endoplasmic reticulum.
7. What is endocytosis?
8. What is the function of vacuoles?

Long Questions:

1. Give five points of differences between plant cell and animal cell.
2. Give five points of differences between prokaryotic cell and eukaryotic cell.
3. Draw a neat labelled diagram of plant cell and label its parts.
4. Draw a neat labelled diagram of animal cell.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
    b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
    c. Assertion is true but Reason is false.
    d. Both Assertion and Reason are false.

    Assertion: All plants and animals are composed of cells.

    Reason: Plants and animals made up of DNA.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
    b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
    c. Assertion is true but Reason is false.
    d. Both Assertion and Reason are false.

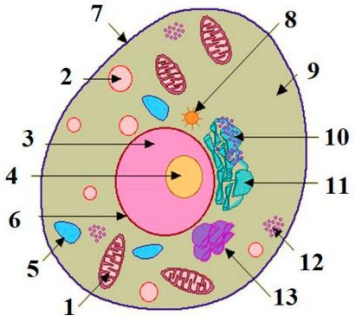
    Assertion: All plants and animals are composed of cells.

    Reason: All plants and animals are composed of cells.

Case Study Question:

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

    Study the given diagram and answer the following questions.



(i) Identify the given diagram.
   (a) Structure of animal cell
   (b) Structure of plant cell
   (c) Bacterial cell
   (d) Prokaryotic cell

(ii) The function of part labelled as 1 is
   (a) Release of energy
   (b) Protein synthesis
   (c) Transmission of heredity characters
   (d) Storage

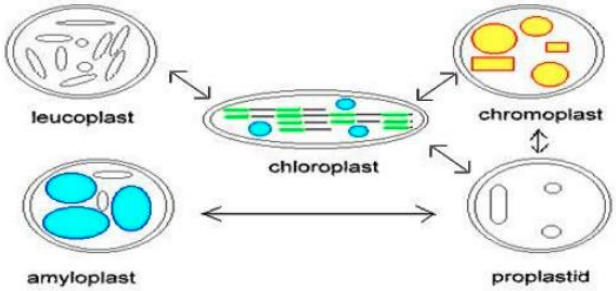
(iii) Mention any two structures which are not found in above cell.
   (a) Cell wall and ribosomes
   (b) Cell wall and golgi apparatus
   (c) Cell membrane and Golgi apparatus
   (d) Plastids and cell wall

(iv) Chromosomes are present in
   (a) Cell membrane
   (b) Golgi apparatus
   (c) Endoplasmic reticulum
   (d) Nucleus

(v) Lysosomes are also called
   (a) suicide bags
   (b) digestive bags
   (c) demolition squads
   (d) all the above

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

Leucoplasts are colourless plastids. They store starch, oil, proteins. Chromoplasts are coloured plastids. They contain pigments. e.g. Chloroplasts contain green pigment present in the plant cell. Chromoplasts provide colour to various flowers and fruits.



(i) What is the function of leucoplasts?
   (a) They store starch, oil, proteins.
   (b) They provide colour various flowers and fruits.
   (c) They help in photosynthesis.
   (d) They give support to the plants.

(ii) Which plastids provide colour to fruits and flowers?
   (a) Leucoplasts
   (b) Chromoplasts
   (c) Chloroplasts
   (d) Proteinoplast

(iii) Which of the following statement is true?
   (a) Plastids are present in both plant and animal cell.
   (b) Plastids are absent in plant as well as animal cell.
   (c) Plastids are present only in plant cell.
   (d) Plastids are present only in animal cell.

(iv) Which plastids contain green pigment?
   (a) Leucoplasts contain green pigment.
   (b) Chloroplasts contain green pigment.
   (c) Chromoplasts mainly contain green pigment.
   (d) None of the plastids contain green pigment.

(v) Which plastids bring about the process of photosynthesis?
   (a) Leucoplasts
   (b) Chromoplasts mainly
   (c) Chloroplasts
   (d) None of the plastids bring about photosynthesis.

Answer Key

Multiple Choice Answers:

1. (b) cell
2. (a) Robert Hooke
3. (d) cellulose
4. (c) Nucleus
5. (d) Mitochondria
6. (c) Lysosomes
7. (a) Nerve cell
8. (c) ER
9. (a) Golgi apparatus
10. (b) Camillo Golgi
11. (b) Robert Brown
12. (a) RBC
13. (c) A virus
14. (c) DNA and protein
15. (b) Vacuole

Very Short Answers:

1. **Answer:** Plastids are organelles found only in plants. They are:
   (a) Chloroplast-Containing chlorophyll
   (b) Chromoplast-Containing carotenoids and xanthophyll (coloured plastids)
   (c) Leucoplast-Wllite or colourless plastids
2. **Answer:** Plasma membrane is made up of proteins and lipids.
3. **Answer:** Robert Hooke observed that cork consists of box like compartments which formed a honeycomb structure.
4. **Answer.** Chloroplasts and mitochondria are the autonomous organelles in the cells.
5. **Answer:** Protoplasm refer to cytoplasm and nucleus.
6. **Answer:** Amoeba and white blood cells.
7. **Answer:** The smallest cell is the red blood cell or sperm cell in male. Longest cell is the nerve cell.
8. **Answer:** Plasma membrane, nucleus and cytoplasm.
9. **Answer:** When gases like CO_2, O_2, move across the cell membrane, this process is called diffusion.
10. **Answer:** The movement of water molecules through a selectively permeable membrane is called osmosis. This takes place from high water concentration to low water concentration.

Short Answer:

1. **Answer:**
   (i) The difference in the concentration of water, one should have higher concentration than the other.
   (ii) Semi-permeable membrane is also required through which water will flow.
2. **Answer:** When a living plant cell loses water through osmosis there is shrinkage or contraction of the contents of the cell away from the cell wall. This phenomenon is known as plasmolysis.
3. **Answer:** The cell wall present in fungi and bacteria permits these cells to withstand very dilute external medium without bursting.
   The cells take up water by osmosis, swells, and builds the pressure against the cell wall. The wall exerts an equal pressure against the swollen cell. It is because of the cell wall, such cells can withstand much greater changes in the surrounding medium than animal cells.
4. **Answer:** The nuclear membrane present as outer covering in the nucleus allows the transfer of material inside and out of the nucleus to cytoplasm.
5. **Answer:** The cell organelles with their own DNA and ribosomes are mitochondria and plastids.
6. **Answer:**

Smooth Endoplasmic Reticulum	Rough Endoplasmic Reticulum
1. It looks smooth.	1. It looks rough.
2. SER helps in the manufacture of fat molecules or lipids.	2. Ribosomes are attached to RER which synthesise proteins.

7. **Answer:** The cell membranes flexibility allows the cell engulf in food and other material from its external environment. This process is known as

endocytosis. E.g., Amoeba acquires its food through such processes.

8. Answer: Vacuoles are storage sacs for solid or liquid content. In plant cells it provides turgidity and rigidity to the cell. In single-celled organisms vacuoles store food, e.g., Amoeba.

Long Answer:

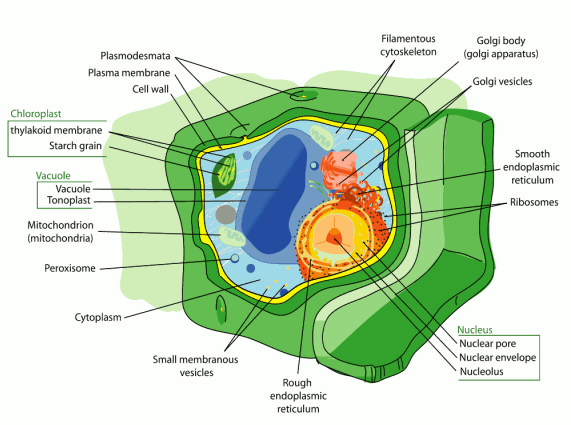
1. Answer:

Plant Cell	Animal Cell
1. Size is usually larger than animal cell.	1. Size is usually smaller than plant cell.
2. Cell wall present.	2. Cell wall absent.
3. Plastids are present.	3. Plastids are absent.
4. Vacuoles are large in number and bigger in size.	4. Vacuoles are small in size and less in number.
5. Centriole absent	5. Centriole present.

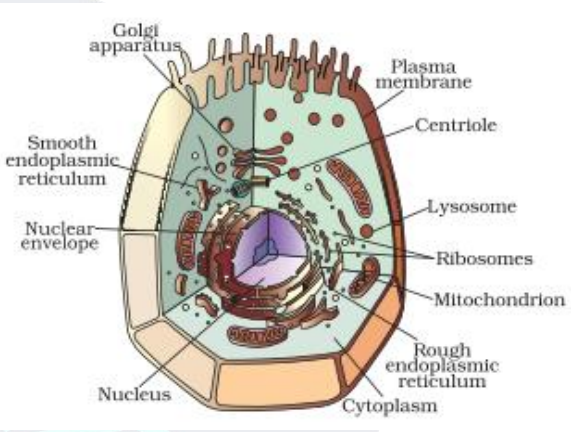
2. Answer:

Characters	Prokaryotic Cell	Eukaryotic Cell
1. Size	0.5 – 5 µm diameter.	Diameter 1 µm – 40 µm.
2. Nucleus	No true nucleus, single chromosome, nuclear membrane absent.	True nucleus, nuclear membrane is present, more than one chromosome is present.
3. Organelles	Membrane-bound organelles are absent.	Membrane-bound organelles are present.
4. Ribosomes	Ribosomes are 70s and randomly scattered.	Ribosomes are 80s, can be free or attached to ER.
5. Cell division	Cell divides by simple fission.	Cell divides by mitosis or by meosis.

3. Answer:



4. Answer:



Assertion Reason Answer:

1. (b) Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

Case Study Answer:

1. Answer:

(i) (a) Structure of animal cell

(ii) (a) Release of energy

Mitochondria are sites of cellular respiration. They use molecular oxygen from air to oxidise the carbohydrates and fats (lipids) present in the cell to carbon dioxide and water vapour. Oxidation releases energy, a portion of which is used to form ATP (adenosine triphosphate). Since the mitochondria synthesize, energy-rich compounds (ATP), they are known as 'power house' of the cell. The energy stored in ATP is used by the cell.

(iii) (d) Plastids and cell wall

(iv) (d) Nucleus

(v) (a) suicide bags

Lysosomes serve as intracellular digestive system, hence, called digestive bags. They destroy any foreign material which enter the cell such as bacteria and virus. In this way they protect the cells from bacterial infection.

Lysosomes also remove the worn out and poorly working cellular organelles by digesting them to make way for their new replacements. In this way, they remove the cell debris and are also known as demolition squads, scavengers and cellular housekeepers. Thus, lysosomes form a kind of garbage disposal system of the cell

2. Answer:

(i) (a) They store starch, oil, proteins.

(ii) (b) Chromoplasts

(iii) (c) Plastids are present only in plant cell.

(iv) (b) Chloroplasts contain green pigment.

(v) (c) Chloroplasts

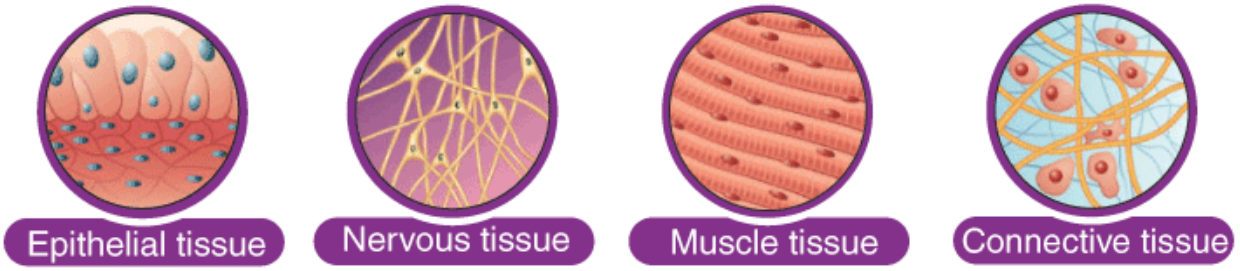
Tissues 2

Tissues are a group of cells that combine together to perform a particular function.

In simple terms, tissue can be defined as a group of cells with similar shape and function are termed as tissues. They form a cellular organizational level, intermediate between the cells and organ system. Organs are then created by combining the functional groups of tissues.

The study of tissue is known as histology and study of disease-related to tissue is known as histopathology. The standard tools for studying tissues is by embedding and sectioning using the paraffin block.

Types of Animal Tissues



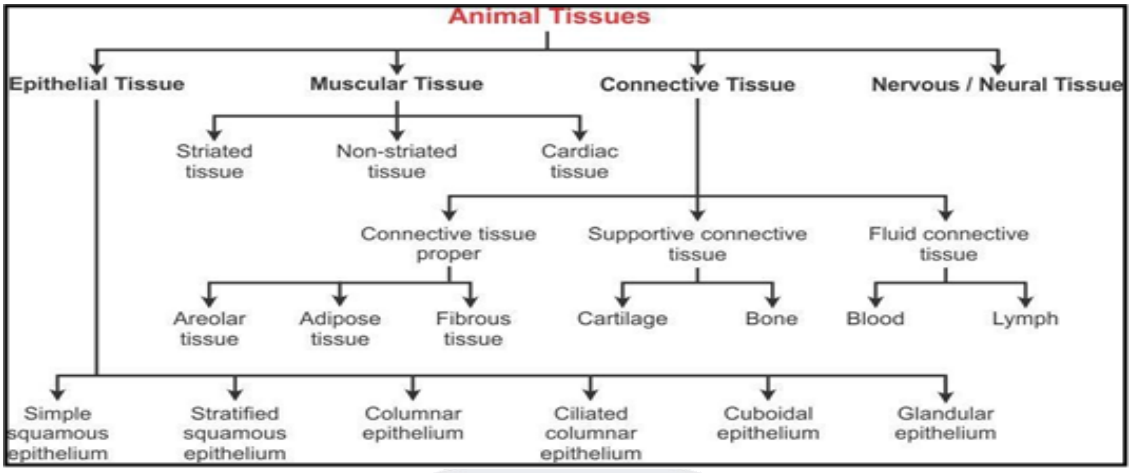
Animal tissues are grouped into four types:

- Connective Tissue
- Muscle Tissue
- Nervous Tissue
- Epithelial Tissue

The collection of tissues are joined in structural units to serve a standard function of organs. The primary purpose of these four types of tissue differs depending on the type of organism.

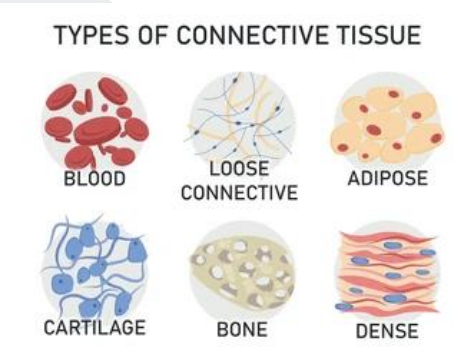
For example, the origin of the cells comprising a particular tissue type also differs.

Classification of Animal Tissues



Connective Tissues

It is made up of a matrix consisting of living cells and non living substances. They are specialized to connect various body organ. It connects bones to each other, muscles to bones. This tissue provides shape to the different organs and maintains their positions. For example, blood, bone, tendon, adipose, ligament and areolar tissues. There are three types of connective tissue:



- Fluid Connective Tissue.
- Fibrous Connective Tissue.
- Skeletal Connective Tissue.

Functions of Connective Tissue

The connective tissue functions by providing shape and maintains the position of different organs in the body. It functions as the primary supporting tissue of the body. Other important and the major functions of connective tissue in the body are:

- Insulating.
- Helps in binding the organs together and provides support.
- It protects against the invasions of pathogens by their phagocytic activity.
- Provides shape to the body, conserves body heat and also stores energy.
- It is involved in the transportation of water, nutrients, minerals, hormones, gases, wastes, and other substances within the body.

Characteristics	Location	Function
•Consists of a matrix and the cells are embedded in it	•Found in the deeper parts of the body, between the skin and muscles	•Connects various organs and keeps them in place

Types of Connective Tissues

Connective Tissue Proper/Loose Connective Tissue

- It is composed of irregular cells scattered and embedded in a soft matrix and encompasses all internal organs and body cavities.

- It acts as a binding and supporting structure within the body.

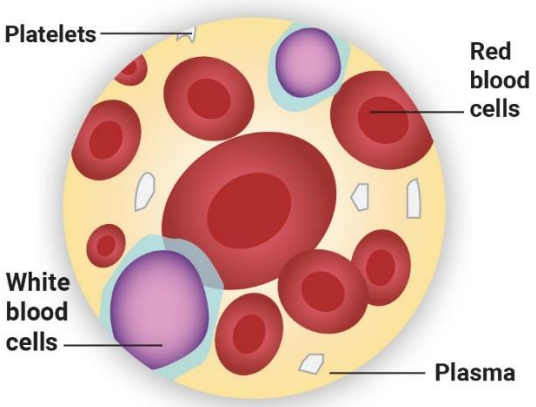
Types of Connective Tissues Proper			
Type	**Characteristics**	**Location**	**Function**
Areolar tissue	Made of gelatinous matrix containing cells and irregularly arranged fibres	Found between the skin and muscles, around the blood vessels, nerves and in the bone marrow	Supports and strengthens the internal organs
Adipose tissue	Cells are filled with fat globules	Found beneath the skin, around the kidneys and other internal organs such as intestines	Insulates the body an prevents the loss of heat
Fibrous tissue	Mainly formed of fibre-forming cells, which form the tendons and ligaments	Found in the spaces between the bones and muscles	Tendons help to attach muscles to the bones. Ligaments serve to hold the structures together and keep them strong and stable

Supportive Connective Tissue/Dense Connective Tissue

- It is composed of fibres as its main matrix element and is found in bones and cartilages.
- It connects different tissues.

Types of Supportive Connective Tissues			
Type	**Characteristics**	**Location**	**Function**
Cartilage	Non-porous, semi-transparent and elastic tissue	Present in the nose, external ear, trachea, larynx, ends of the long bones and between the vertebrae	Smoothens the bone surface at joints, allowing smooth movement of these joints
Bone	Hard, strong and non-flexible porous tissue which consists of living cells	Forms a rigid part of the skeletal system	Forms the supporting framework of the body Gives shape and rigidity to the body

Fluid Connective Tissue



- It consists of liquid as the ground substance and is present throughout the body.
- It provides nutrition, helps in transport of nutrients and gets rid of waste matter.

Types of Fluid Connective Tissues			
Type	**Characteristics**	**Location**	**Function**
Blood	Red-coloured fluid matrix which consists of plasma and cells such as RBCs, WBCs and platelets	Present throughout the body	Connects different parts of the body and establishes continuity within the body
Lymph	Fluid surrounding the body cells which contains WBCs	Present throughout the body	Transports nutrients and provides protection against diseases

Blood

It is a fluid connective tissue that links different body organs. The cells or corpuscles (wbc, rbc, paltelets) are suspended In fluid or liquid matrix called blood plasma. It helps in transport of substances such as nutrients, gases, hormones. It also regulates body temperature.

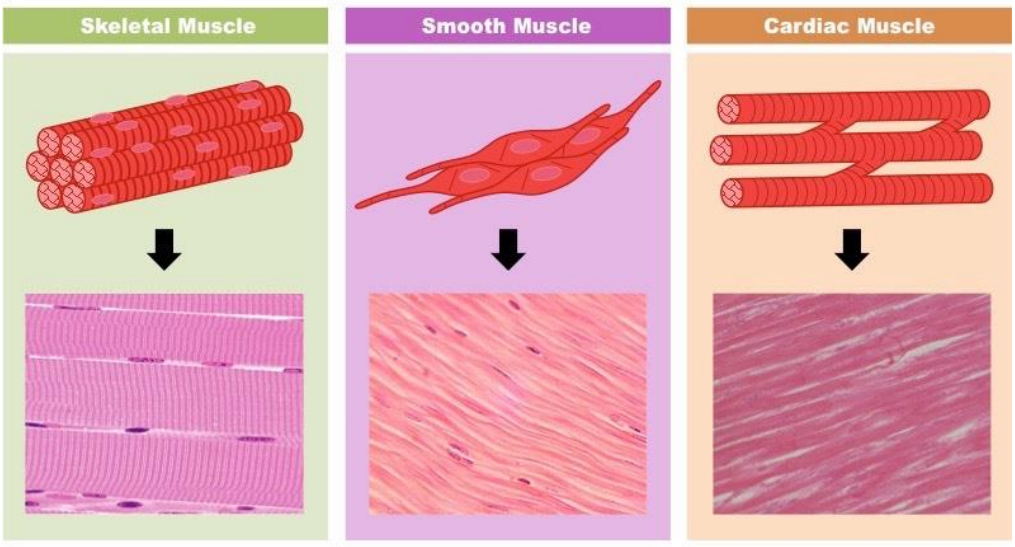
Properties shown y different blood corpuscles

RBCs – help in transport of respiratory gases.

WBCs – help in defense mechanism of body by producing antibodies.

Platelets – help in clotting of blood.

Muscle Tissue



They are involved in producing force and generating motion, either for the locomotion or for other body movements within internal organs. There are three types of muscle tissue:

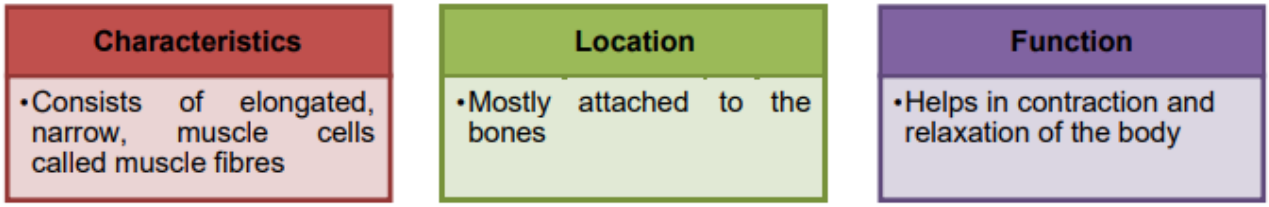
- Skeletal Muscle – they are typically attached to bones to help in movement of the body. These are present in our limb which move or stop as per our will are called striated or voluntary muscle.
- Cardiac Muscle – these are involuntary muscles and found in the heart. They have stripes of light and dark bands
- Visceral or Smooth Muscle – they are found in the inner walls of organs as the cannot work as per our will also known as involuntary muscles. They do not show any dark or light band hence also called unstriated muscle.

Functions of Muscle Tissue

Muscle tissues are associated with their movements including walking, running, lifting, chewing, picking and dropping objects, etc. The other major functions of muscle tissue in the body are:

- Helps in maintaining an erect position, or posture.
- Helps in the constriction of organs and blood vessels.
- Involved in both voluntary and involuntary movements.
- Involved in pumping blood and regulating the flow of blood in arteries.
- Controls respiration by automatically driving the movement of air both into and out of our body.

Muscle Tissue



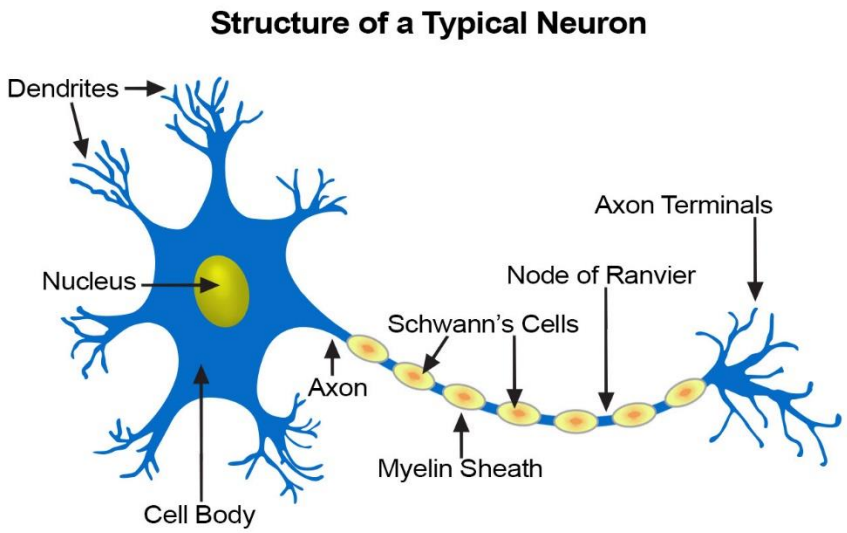
Types of Muscle Tissues

Type	Characteristics	Location	Function
Striated/skeletal/ striped/voluntary muscles	Muscle fibres are long, cylindrical, unbranched and multinucleate	Found attached to the bones	Help in voluntary muscle movement and locomotion
Non-striated/ smooth/non-striped/ involuntary muscles	Muscle fibres are smooth and without striations	Found in the uterus, digestive tract, urinary bladder, iris of the eye, bronchi of the lungs and other internal organs	Carry out movements which cannot be carried out by our conscious will
Cardiac/heart muscles	Muscle cells are short, cylindrical and have a single, centrally placed nucleus	Found only in the walls of the heart	Rhythmic contraction and relaxation of cardiac muscles help to pump and distribute the blood to various parts of the body

Differences between Smooth, Skeletal and Cardiac Muscles

SMOOTH MUSCLE	SKELETAL MUSCLE	CARDIAC MUSCLE
1. Not striated	1. Striated	1. Striated
2. Spindle-shaped	2. Cylindrical	2. Cylindrical
3. Not branched	3. Not branched	3. Branched
4. Nucleus - central	4. Nuclei - peripheral	4. Nuclei - central
5. No discs	5. No discs	5. Intercalated discs
6. Involuntary	6. Voluntary	6. Involuntary
7. Slow	7. Fast	7. Fast
8. Contraction not inherent	8. Contraction not inherent	8. Contraction inherent

Nervous Tissue



They are the main tissue components of the brain and spinal cord in the central nervous system. While, in the peripheral nervous system, the neural tissue forms the cranial nerves and spinal nerves.

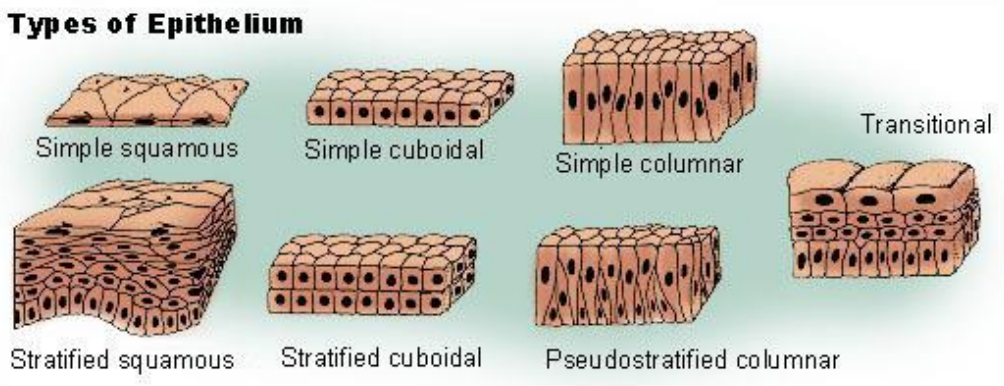
Functions of Nervous Tissue

The nervous tissue forms the communication network of the nervous system and is important for information processing. The other major functions of nervous tissue in the body are:

- Response to stimuli.
- Stimulates and transmits information within the body.
- Plays a major role in emotions, memory, and reasoning.
- Maintains stability and creates an awareness of the environment.
- Nervous tissue is involved in controlling and coordinating many metabolic activities.

Characteristics	Location	Function
•Made up of elongated cells called neurons •Each neuron consists of three parts—cell body, axon and dendrites	•Component of the nervous system and encompasses the brain, spinal cord and nerves	•Nerve cells mediate the transmission of messages from the brain to different parts of the body and vice versa

Epithelial Tissue

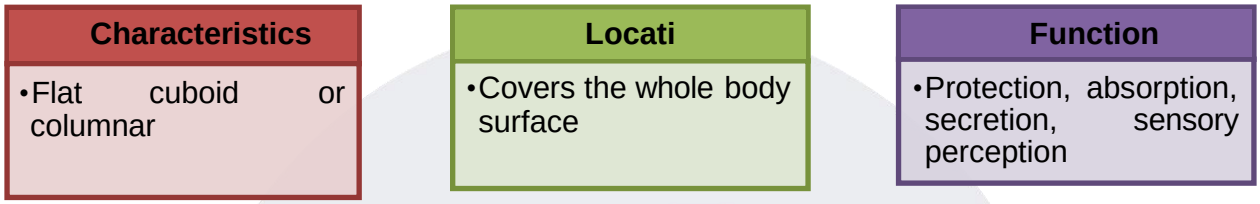


They are formed by cells which cover the external parts of the body organs and lines the organ surfaces such as the surface of the skin, the reproductive tract, the airways, and the inner lining of the digestive tract.

Functions of Epithelial Tissue

- This tissue performs a wide variety of functions including:
- Play a major role in sensory reception, excretion, filtration and other metabolic activities.
- Provide mechanical strength and resistance to the underlying cells and tissue.
- It is involved in the movement of materials through the process of filtration, diffusion and secretion.
- Protects the internal organs against the invasions of pathogens, toxins, physical trauma, radiation, etc.

Epithelial tissues are also involved in secreting hormones, enzymes, mucus and other products from ducts and transporting it to the circulatory system.



Types of Epithelial Tissues

Type	Characteristics	Location	Function
Simple squamous epithelium	Cells are large, extremely thin and flat	Lining of blood vessels, lung alveoli, esophagus, the lining of the mouth and cheek	Transport of substances through a selectively permeable membrane
Stratified squamous epithelium	Cells are arranged in a pattern of layers	Outer protective covering all over the body surface	Provides protection to underlying tissues
Columnar epithelium	Cells are tall and cylindrical-like pillars	Inner lining of the stomach and intestines	Absorption of nutrients from the digested food
Ciliated columnar epithelium	Cells possess fine hair-like cilia	Inner lining of the trachea, lungs, respiratory system and buccal chambers	In the respiratory tract, the movement of cilia pushes the mucus forward to clear it
Cuboidal epithelium	Cells are cube-shaped and are placed on a basement membrane	Lining of the kidney tubules as well as in the ducts of the salivary glands	Helps in the absorption of useful material from urine before it is passed out
Glandular epithelium	Epithelial tissue which folds inwards to form a multicellular gland	Present in the stomach, intestine and pancreas	Synthesis and secretion of substances at the epithelial surface

Levels of Organisation

Cell
- A cell is the basic structural and functional unit of a living organism. Example: Nerve cell

Tissue
- A tissue is a group of cells having a common origin, similar structure and function and held together by a cementing substance. Example: Connective tissue

Organ
- Different types of tissues working together and contributing to specific functions inside the body constitute an organ. Example: Stomach

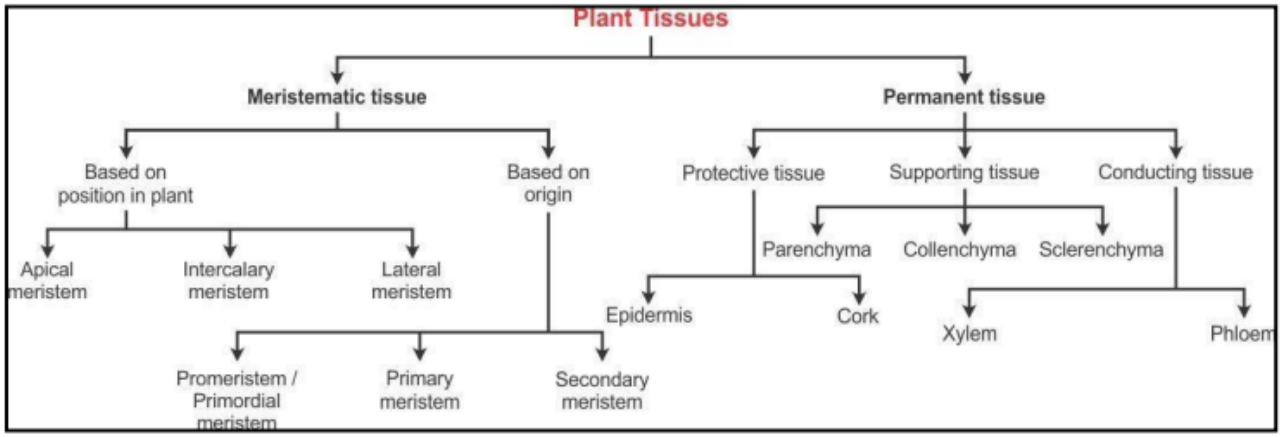
Organ system
- Different organs coordinate to perform a specific life process and form an organ system. Example: Digestive system

Organism
- Various organ systems working simultaneously together constitute an organism. Example: Plants

Differences between Plant and Animal Tissues

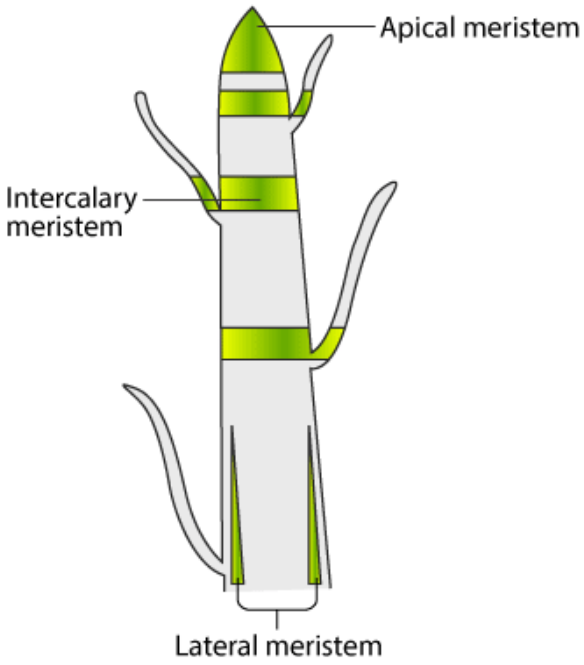
PLANT TISSUES	ANIMAL TISSUES
1. Dead supportive tissues are more abundant as compared to living tissues.	1. Living supportive tissues are more abundant as compared to dead tissues.
2. Require less maintenance energy.	2. Require more maintenance energy.
3. Differentiation of meristematic and permanent tissues.	3. No differentiation of meristematic and permanent tissues.
4. Organization is simple.	4. Organisation is relatively complex.
5. Tissue organisation is meant for stationary habit of plants.	5. Tissue organisation is meant for high mobility of animals.

Classification of Plant Tissues



Meristematic Tissue

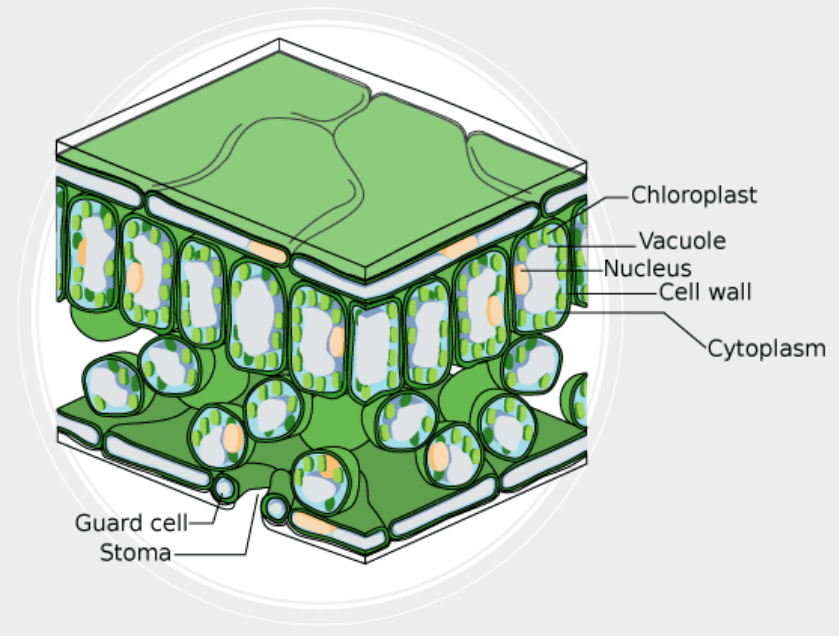
Characteristics	Location	Function
•Cells are thin-walled and composed of cellulose.	•Located at the tips of the roots and stems, and the base of the node, internode or leaf.	•The cells of meristematic tissue divide actively, which results in growth (increase in thickness and length) of plants.



Types of Meristematic Tissues

Type	Location	Function
Apical meristem	Located at the growing points of the stem, roots, branches and in growing young leaves near the tips of stems and axillary buds	Enables the root and stem to grow by increasing the length of plants
Intercalary meristem	Located at the internodes or stem regions between the places at which the leaves attach and at leaf bases	The cells are active and they continuously form several new cells
Lateral meristem/ Cambium	Present laterally (on the sides) on the roots and stem and is situated parallel to the longitudinal axis below the bark	The girth and width/diameter/thickness of the stem or root increases because of the lateral meristem

Permanent Tissues



Permanent tissues are formed by the division of the meristematic tissue cells which have lost their ability to multiply.

Types of Permanent Tissues

Protective Tissue

- It is found on the surface of the roots, stems and leaves.
- It consists of cells with thick walls.
- It provides protection against mechanical injury or invasion by parasitic fungi.

Types of Protective Tissues			
Type	**Characteristics**	**Location**	**Function**
Epidermis	Cells are elongated and flattened with no intercellular spaces between them.	Present in the outermost layer of leaves, flowers, stem and roots.	Protects the plant from desiccation and infection.
Cork	Cells are rectangular with vacuolated protoplasts.	It is the outermost layer formed after the epidermis undergoes certain changes.	Prevents desiccation, infection and mechanical injury.

Supporting Tissue

- It provides support to the plant.

Types of Supporting Tissues			
Type	**Characteristics**	**Location**	**Function**
Parenchyma	Consists of relatively non-specialised large, thin-walled living cells	Mainly present in the soft parts of the plant and outer cortical region of roots and stems	Provides temporary support and maintains the shape of the plant body

Collenchyma	Cells are living and elongated with cell walls irregularly thickened at the corners	Located in non-woody plants, leaf stalks and below the epidermis of the stems and veins of leaves	Provides mechanical support and elasticity to young dicotyledonous plants
Sclerenchyma	Consists of elongated, narrow and fibre-like cells. Cells are dead, pointed at both ends and thickened	Located in the stems around the vascular bundle, veins of leaves and hard covering of seeds and nuts	Provides strength and toughness to plant parts

Conducting Tissue (Vascular Tissue)

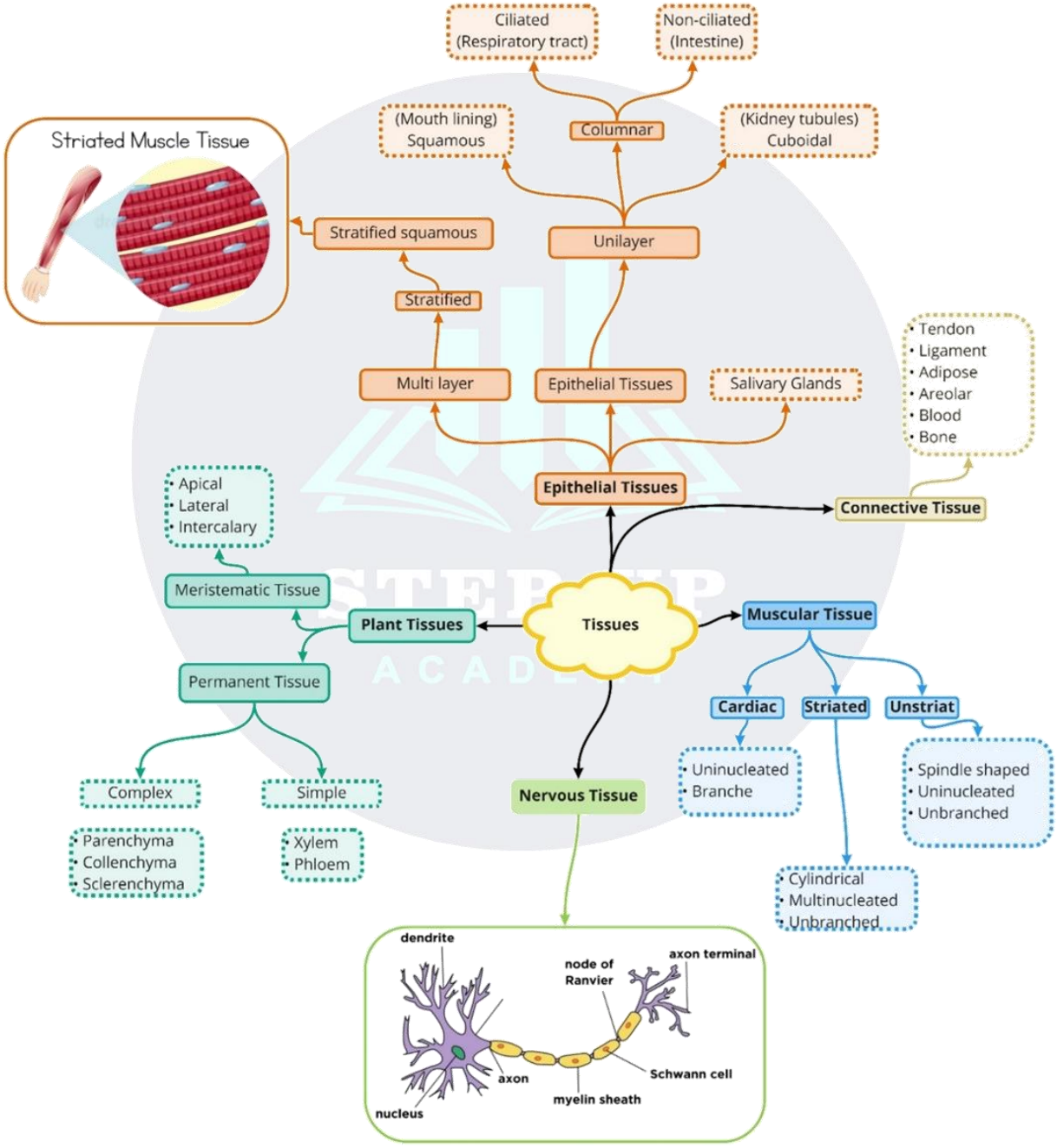
- It is present in stems, roots and leaves.
- It provides a passage for water and dissolved materials to move up and down in the plant body.

Types of Conducting Tissues			
Type	**Characteristics**	**Location**	**Function**
Xylem	Complex permanent tissue with thick-walled cells; most of the cells are dead	Present in the stem, roots and leaves	Provides upward movement of water and dissolved materials
Components of Xylem			
Tracheids	Made of elongated cells with flat and tapering ends	-	Provide a network of hollow and connected cells for the transport of water
Xylem vessels	Tubular structures which consist of dead cells	-	Allow free flow of water and minerals from the roots to the leaves
Xylem parenchyma	Consists of living parenchyma cells associated with xylem	-	Stores food in the plant body
Xylem fibres	Separated by thin cross walls	-	Mainly support the plant
Types of Conducting Tissues			
Type	**Characteristics**	**Location**	**Function**
Phloem	Complex permanent tissue	Lies just beneath the bark of the tree	Provides a passage for the downward movement of food
Components of Phloem			
Sieve tubes	Tubular cells with perforated walls and arranged end to end	-	Translocation of organic substances
Companion cells	Cells are living and keep their nuclei and other organelles throughout their life	-	Help to control the activity of sieve tube elements
Phloem fibres	Elongated, tapering and dead cells with thickened cell walls	Found particularly in the stem	Provide mechanical strength to plants
Phloem parenchyma	Cells are alive and filled with cytoplasm	-	Store and Transports food from the leaves to the other non-green parts of the plants

Differences between Meristematic and Permanent Tissues

MERISTEMATIC TISSUE	PERMANENT TISSUE
1. Simple tissue	1. Simple, complex or specialised tissue
2. Component cells are small, spherical or polygonal and undifferentiated	2. Component cells are large, differentiated with different shapes
3. Intercellular spaces are absent	3. Intercellular spaces are present
4. Cells grow and divide regularly	4. Cells do not divide
5. Metabolically active	5. Metabolic rate is slow
6. Provides growth to the plant	6. Provides protection, support, conduction, photosynthesis, storage

Class : 9th Science
Chapter- 6: Tissues



Important Questions

Multiple Choice Questions:

1. Which tissue is present at the growing tips of stem and roots ?
   (a) Permanent
   (b) Meristematic
   (c) Conductive
   (d) Complex
2. Blood is a type of:
   (a) connective tissue
   (b) muscular tissue
   (c) nervous tissue
   (d) epithelial tissue
3. Brain is composed of:
   (a) muscular tissue
   (b) connective tissue
   (c) nervous tissue
   (d) epithelial tissue
4. The heart of organisms is made up of:
   (a) muscular tissue
   (b) connective tissue
   (c) nervous tissue
   (d) epithelial tissue
5. Skin of hand is composed of:
   (a) muscular tissue
   (b) connective tissue
   (c) nervous tissue
   (d) epithelial tissue
6. Water and minerals are transported by:
   (a) phloem
   (b) cavities
   (c) xylem
   (d) all of them
7. Stomata are found:
   (a) in the epidermis of leaf
   (b) in xylem
   (c) in phloem
   (d) collenchyma
8. Which muscles act involuntarily?
   (i) Striated muscles
   (ii) Smooth muscles
   (iii) Cardiac muscles
   (iv) Skeletal muscles
   (a) (i) and (ii)
   (b) (ii) and (iii)
   (c) (iii) and (iv)
   (d) (i) and (iv)
9. Which is not a function of epidermis?
   (a) Protection from adverse condition
   (b) Gaseous exchange
   (c) Conduction of water
   (d) Transpiration
10. Cartilage is not found in:
    (a) nose
    (b) ear
    (c) kidney
    (d) larynx

Very Short Question:

1. Name the tissues responsible for the movement of the body.
2. How does neuron look like?
3. Name the types of simple tissues.
4. Name the types of complex tissues.
5. Where is apical meristem found?
6. Which tissue make up the husk of coconut?
7. What are the constituents of phloem?
8. Define aerenchyma.
9. What is the utility of tissues in multicellular organisms?
10. Name the two types of tissues.

Short Questions:

1. Give four differences between bone and cartilage.
2. Give the functions of bone.
3. Give the functions of cartilage.
4. What are the functions of areolar tissue?
5. Give difference between xylem and phloem.

6. What are fibres?
7. Name the tissues for the following:
   (a) Stores fat in animal body.
   (b) Divides and re-divides to grow in plants.
   (c) Tissue that joins hone to hone.
   (d) Covers the external surface of animal body.
8. What is stomata?

Long Questions:

1. Write a note on plant tissues.
2. Show the types of animal tissues using flow chart.
3. What is connective tissue? Explain its types.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

Assertion: Amoeba is the single cell animal in which single cell carries out all movement like intake of food, gaseous exchange and excretion.

Reason: Amoeba is not unicellular organism.

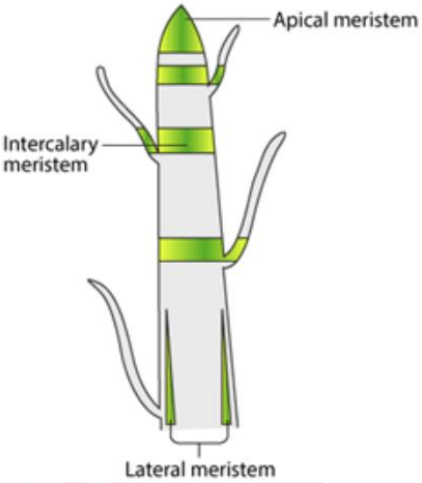
2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

Assertion: Amoeba is the single cell animal in which single cell carries

Reason: Amoeba is the single cell organism.

Case Study Questions:

1. The growth of plants occurs only in certain specific regions. This is because the dividing tissue, also known as meristematic tissue, is located only at these points. Depending on the region where they are present, meristematic tissues are classified as apical, lateral and intercalary. New cells produced by meristem are initially like those of meristem itself, but as they grow and mature, their characteristics slowly change and they become differentiated as components of other tissues.



Apical meristem is present at the growing tips of stems and roots and increases the length of the stem and the root. The girth of the stem or root increases due to lateral meristem (cambium). Intercalary meristem seen in some plants is located near the node Cells of meristematic tissue are very active, they have dense cytoplasm, thin cellulose walls and prominent nuclei. They lack vacuoles.

(i) Which meristem helps in increasing the girth of the plant?
   (a) Primary meristem
   (b) Apical meristem
   (c) Intercalary meristem
   (d) Lateral meristem

(ii) Lateral meristem is responsible for_____.
   (a) Growth of apical portion
   (b) Increase in the length
   (c) Increasing the girth of stem and root
   (d) Growth in parenchyma

(iii) The meristem present at the base of the internode is_____.

(a) Lateral meristem

(b) Intercalary Meristem

(c) Apical Meristem

(d) All of the above

(iv) What are the characteristic of Meristematic tissue?

(v) Enlist the type of meristematic tissue.

2. Meristematic tissue take up a specific role and lose the ability to divide. As a result, they form a permanent tissue. This process of taking up a permanent shape, size, and a function is called differentiation. Differentiation leads to the development of various types of permanent tissues.

Simple Permanent Tissue

Tissue made of one type of cells, which look like each other. Such tissues are called simple permanent tissue. Parenchyma is the most common simple permanent tissue. It consists of relatively unspecialised cells with thin cell walls. They are living cells. They are usually loosely arranged, thus large spaces between cells (intercellular spaces) are found in this tissue. This tissue generally stores food. In some situations, it contains chlorophyll and performs photosynthesis, and then it is called chlorenchyma. In aquatic plants, large air cavities are present in parenchyma to help them float. Such a parenchyma type is called aerenchyma. Yet another type of permanent tissue is sclerenchyma. It is the tissue which makes the plant hard and stiff. We have seen the husk of a coconut. It is made of sclerenchymatous tissue. The cells of this tissue are dead. They are long and narrow as the walls are thickened due to lignin.

Complex Tissue

Complex tissues are made of more than one type of cells. All these cells coordinate to perform a common function. Xylem and phloem are examples of such complex tissues. They are both conducting tissues and constitute a vascular bundle. Xylem fibres are mainly supportive in function. Phloem transports food from leaves to other parts of the plant. Except phloem fibres, other phloem cells are living cells.

(i) Tissue made of only one type of cell is termed as _____.

(a) Simple permanent tissue

(b) Complex permanent tissue

(c) Simple Meristematic tissue

(d) Complex Meristematic tissue

(ii) Xylem and phloem are examples of:

(a) Meristematic tissue

(b) Simple tissue

(c) Protective tissue

(d) Complex tissue

(iii) In aquatic plants, which type of parenchymatissue is found?

(a) Aerenchyma

(b) Chlorenchyma

(c) Sclerenchyma

(d) Parenchyma

(iv) What is mean by Differentiation?

(v) Enlist the type of parenchyma tissue.

Answer Key

Multiple Choice Answers:

1. (b) Meristematic
2. (a) connective tissue
3. (c) nervous tissue
4. (a) muscular tissue
5. (d) epithelial tissue
6. (c) xylem
7. (a) in the epidermis of leaf
8. (b) (ii) and (iii)
9. (c) Conduction of water
10. (c) kidney

Very Short Answers:

1. **Answer:** Muscle tissue and nervous tissue
2. **Answer:** A neuron is the unit cell of nervous tissue. It is a thread-like structure with cell body and axon.
3. **Answer:** (a) Parenchyma (b) Collenchyma (c) Sclerenchyma
4. **Answer:** Xylem and phloem.
5. **Answer:** It is present at the growing tips of stem and root, it increases the length of the stem and roots.
6. **Answer:** Sclerenchyma.
7. **Answer:** Phloem constitutes the sieve tubes, companion cell, phloem parenchyma and phloem fibres.
8. **Answer:** When the cells have air-filled large cavities of parenchyma, it is called aerenchyma. Aerenchyma helps aquatic plants in floating.
9. **Answer:** It helps in growth, organisation of different organs and performing functions.
10. **Answer:** Plant tissues and animal tissues.

Short Answer:

1. **Answer:**

Bone	Cartridge
1. Hard and non-flexible	1. Flexible not very hard
2. Porous	2. Non-porous
3. Blood vessels present	3. Blood vessels absent
4. Matrix made up of protein and mineral salts	4. Matrix made up of proteins

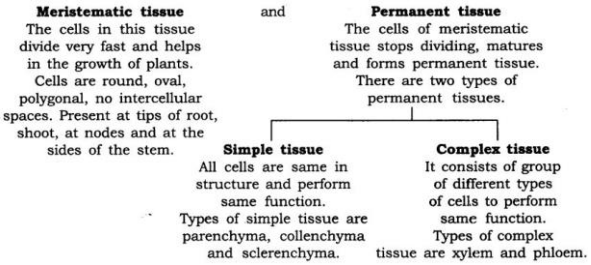
2. **Answer:** The functions of bone are:
   (i) It provides shape to the body.
   (ii) It provides skeletal support to the body.
   (iii) It anchors the muscles.
   (iv) It protects the vital body organs like brain, lungs, etc.
3. **Answer:**
   (i) It provides support and flexibility to the body parts.
   (ii) It smoothens surface at joints.
4. **Answer:** Functions are:
   (i) It helps in repair of tissues after an injury.
   (ii) It also helps in combating foreign toxins.
   (iii) It fixes skin to underlying muscles.
5. **Answer:**

Xylem	Phloem
1. It consists of mainly dead elements.	1. It consists of mainly living elements.
2. It conducts water and minerals.	2. It conducts food.
3. It provides mechanical strength to the plant.	3. It does not provide mechanical strength to the plant.

6. **Answer:** Fibres consist of very long, narrow and thick cells. Example, jute fibre.
7. **Answer:**
   (a) Adipose tissue
   (b) Meristematic tissue.
   (c) Ligament
   (d) Epithelial tissue.
8. **Answer:** Stomata are small pores present on the surface of a leaf which helps in the exchange of gases and in transpiration.

Long Answer:

1. **Answer:** Plant tissues consist of two main types of tissue.



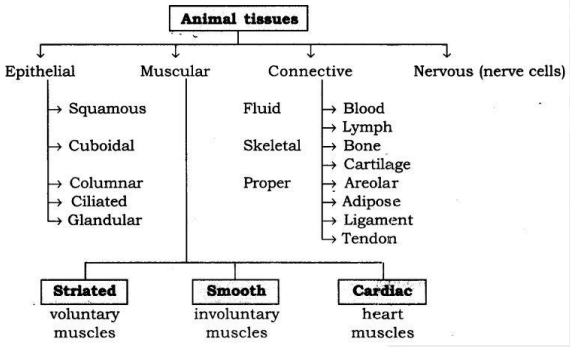
Parenchyma: Present in soft parts of the plant.

Collenchyma: Provides mechanical support to plant present in stalks. Sclerenchyma: They provide strength and flexibility to the plants.

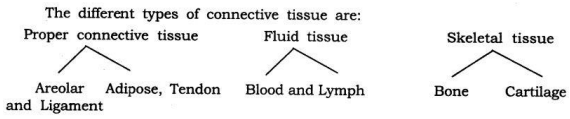
Xylem: Conduct water in plants from root to shoot. Consists of tracheids, vessels, xylem parenchyma and xylem fibres.

Phloem: Conduct food to all parts of plant. Consist of sieve tubes, companion cell, phloem parenchyma and phloem fibres.

2. **Answer:**



3. **Answer:** The connective tissue consists of different types of cells, all of them perform same function.



Areolar connective tissue: It is found between the skin and muscles, around blood vessels and nerves and in the bone marrow.

Areolar tissue fills the space inside the organs. It supports internal organs and helps in repair of tissues.

Adipose tissue: Adipose tissue stores fat, found below the skin and between internal organs. The cells of this tissue are filled with fat globules. It acts as insulator due to fat storage.

Blood: It has a fluid called plasma, in plasma are present red blood cells, white blood cells and platelets. Blood flows all over the body and helps in the transport of gases, digested food, hormones and waste material to different parts of the body.

Lymph: Lymph carries digested fat and lot of white blood cells in the plasma. Bone: It forms the framework that supports the body. It supports the different parts of our body. It is strong and non-flexible tissue.

Cartilage: It is present in nose, ear, trachea and larynx. It smoothens bone surfaces at joints.

Tendon: It connects bone and muscles. These tissues are fibrous, flexible and with lot of strength.

Ligament: It connects bone to 'bone. It is elastic, has lot of strength.

Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (b) Both Assertion and Reason are correct, and reason is not the correct explanation for assertion.

Case Study Answers:

1. (i) (d) Lateral meristem

(ii) (c) Increasing the girth of stem and root

(iii) (b) Intercalary Meristem

(iv) Characteristic of Meristematic tissue

- Meristematic tissue are very active type of tissue.
- They have dense cytoplasm.
- The wall of Meristematic cells are thin cellulosic walls and prominent nuclei.
- They lack vacuoles.

(v) There are three types of meristematic tissue

- Apical Meristem
- Intercalary Meristem
- Lateral meristem

2. (i) A

(ii) D

(iii) A

(iv) Meristematic tissue lose the ability to divide. As a result, they form a permanent tissue. This process of taking up a permanent shape, size, and a function is termed as differentiation.

(v) There are three type of parenchyma tissue

- Aerenchyma
- Chlorenchyma
- Sclerenchyma

Diversity in Living Organisms 3

- The variety in living organisms existing on the Earth is called **biodiversity**.
- **Taxonomy** is a biological science which deals with the identification, nomenclature and classification of organisms.
- The system of sorting living organisms into various groups based on their characteristic similarities and differences is called **classification**.
- The principles of classification help us in tracing the evolutionary relationships of the species around us.
- Organisms with ancient body designs are referred to as **primitive** or lower organisms, while organisms which have acquired their body designs relatively recently are called **advanced** or higher organisms.
- A **species** is a group of organisms of a particular kind whose members can interbreed among themselves to produce fertile young ones.
- **Diversity** is the presence of different organisms in the same ecosystem or geographical location. Diversity gives a chance for a more balanced ecosystem.
- **Evolution** is the slow process by which the organisms change according to their needs to survive the environment around them. Evolution leads to the formation of new organisms and more diversity in the ecosystem.
- **Charles Darwin** was an English biologist and a naturalist. He travelled on HMS Beagle to Galapagos Island in South America. Using his observation, he proposed the theory of evolution in his book On the Origin of Species.

Nomenclature

Carolus Linnaeus

- Carolus Linnaeus is a Swedish botanist and physician who is also called 'Father of taxonomy'.
- He introduced the Binomial nomenclature and laid the ground rules which paved way for modern taxonomy.

Binomial Nomenclature

- The **binomial nomenclature** system was suggested by the Swedish botanist **Carolus Linnaeus**.
- According to binomial nomenclature, every organism is given a scientific name for identity. The scientific name includes two terms. The **first term** is the name of the **genus**, and the **second term** is the name of the **species**.

Taxonomy

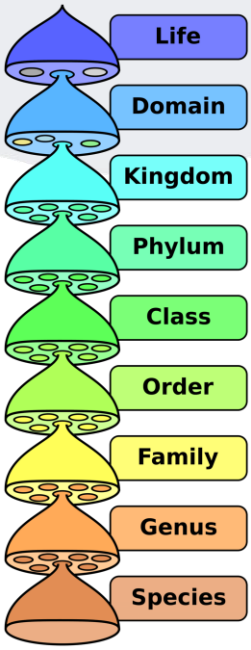
Taxonomy is the branch of science that deals with the classification of organisms.

Hierarchy of Classification

- **A kingdom** is the highest level of classification which consists of a number of phyla or divisions (in case of plants) with similar characteristics.

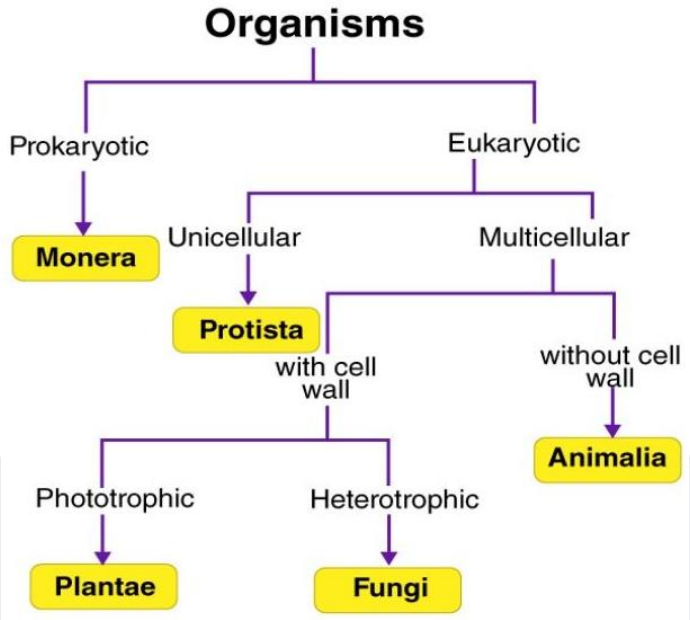
Kingdom → Phylum → Class → Order → Family → Genus → Species

- **Phylum/Division** is a level of classification which consists of a number of classes with similar characteristics.
- A **class** is the level of classification which consists of a number of orders with similar characteristics.
- An **order** is the level of classification which consists of a number of families with similar characteristics.
- A **family** is the level of classification which consists of a number of Genus with similar characteristics.
- **Genus** is the level of classification which consists of a number of species with similar characteristics.
- **Species** is the level of classification which consists of a number of organisms with similar characteristics and can interbreed to give rise to a fertile offspring.



Five Kingdom Classification

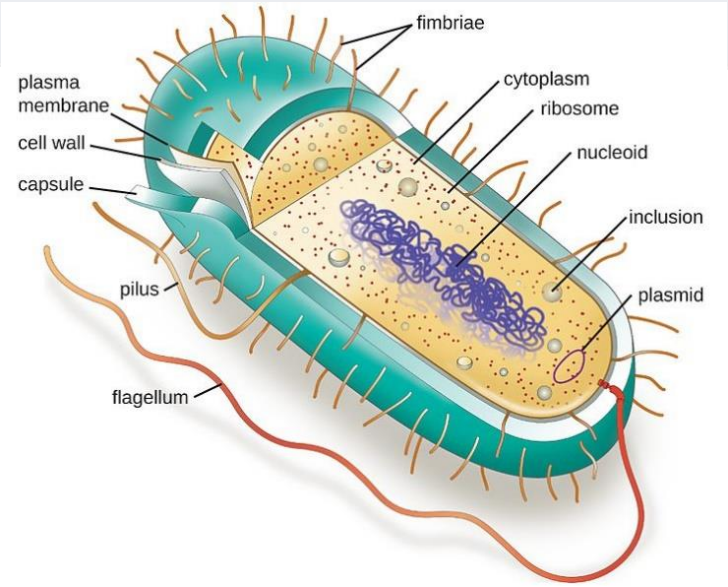
- 5 Kingdom classification is the most accepted system of classification given by R.H.Whittaker.
- This classification solved most of the issues in taxonomy related to the placement of bacteria and fungi.
- The 5 kingdoms are Monera, Protista, Fungi, Plantae and Animalia.



Kingdom Monera

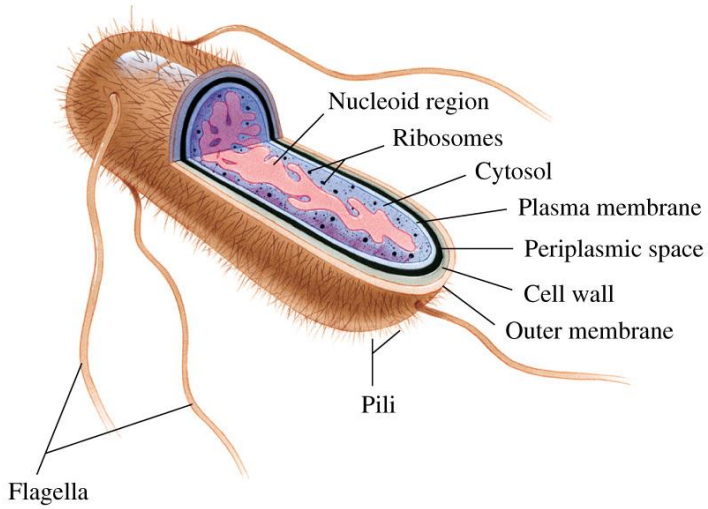
- All the prokaryotic organisms are placed in this Kingdom.
- Bacteria and their ancient cousin, archaebacteria are the organisms that makeup Kingdom Monera.
- These are prokaryotic, unicellular, autotrophic/heterotrophic organisms.
- Bacteria have a cell wall made up of polysaccharides.

Archea



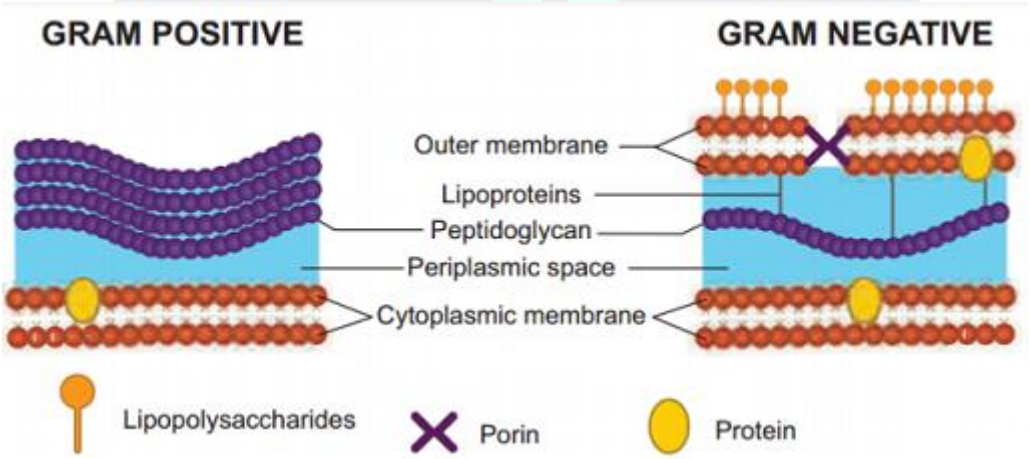
- The category in the kingdom Monera which consists of the organisms surviving in extremely hot conditions.
- They are considered to be the most ancient living organism present on the planet.

Eubacteria



- Eubacteria is phylum of Monera consists of all the bacteria that survive in a normal environment.
- All the major helpful and pathogenic bacteria we know today fall under this category.

Gram +ve/-ve bacteria



- Some bacteria have a very thick cell wall which makes them take up Gram stain and appear violet.
- There are other bacteria which have a thin cell wall and on Gram staining appear pink.
- Usually, gram +ve bacteria are pathogenic in nature.

Kingdom Protista

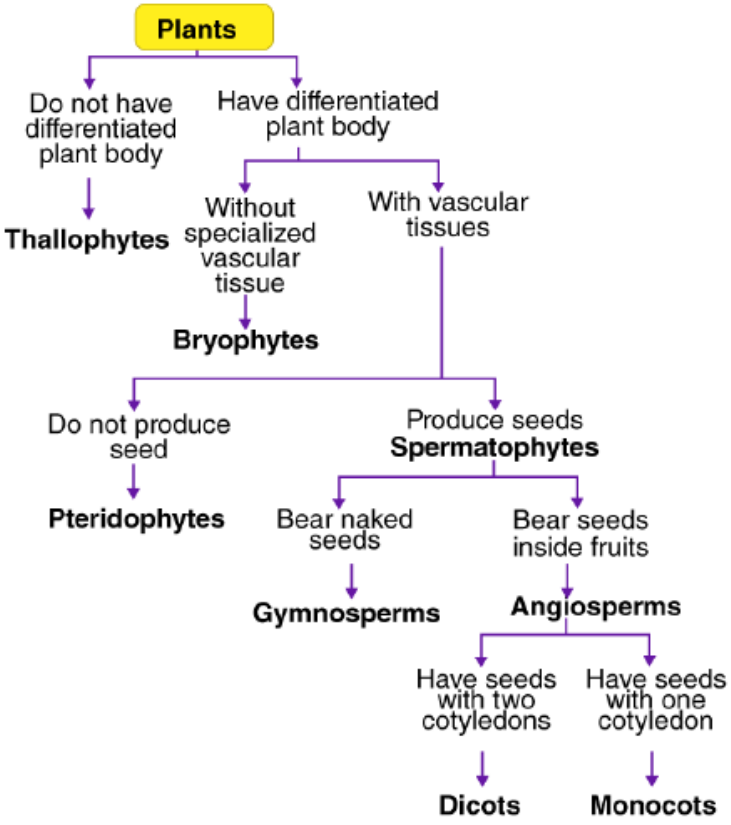
- **Protista Kingdom** Protista is made up of all the eukaryotic unicellular organism except yeast.
- **Protozoans** are the unicellular eukaryotic organisms that come under the Kingdom Protista.
- Examples include paramecium, amoeba, Plasmodium, euglena, leishmania etc.
- **Fungi like Protists** This kingdom includes unicellular fungi like yeast and moulds.
- **Plant-like Protists** Kingdom Protista includes some unicellular algae which are photosynthetic.

Kingdom Fungi

- The organisms of Kingdom Fungi are mostly saprophytic.
- It is the only Kingdom which has the multicellular and unicellular organisms.
- Majority of them have a cell wall made up of chitin.

KINGDOM	CHARACTERISTICS	EXAMPLES
Monera	• Organisms have a prokaryotic cell structure. • The cell lacks a distinct nucleus.	Bacteria, Cyanobacteria, Mycoplasma
Protista	• Contain a well-defined nucleus. • Nuclear materials are organised in the form of a linear, double-stranded and helical DNA along with proteins.	Chlamydomons Euglena, Amoeba
Fungi	• Possess a true nucleus and a definite cell wall, which is composed of chitin.	Mucor, Rhizopus, Puccinia
Plantae	• Cell is bound by a cell wall, which is made of cellulose. • Contains a true nucleus and membrane-bound cell organelles.	Algae, mosses, ferns
Animalia	• Lack cell wall and plastid.	Earthworm, Sycon, beetle

Classification of Kingdom Plantae



Cryptogamae

- Cryptogams literally mean 'plants with hidden reproductive parts'
- Cryptogams are plants that produce spores to reproduce instead of seeds. So these plants do not have flowers or fruits.
- Cryptogams are further classified as thallophytes, bryophytes and pteridophytes.

Phanerogamae

- Phanerogams are plants that produce seeds for reproduction.
- Some of them do not produce flowers, while the others produce flowers.
- Phanerogams are further classified as gymnosperms and angiosperms.

Thallophyta

- Thallophyta is the first division of plant kingdom.
- It consists of red, green and brown algae.
- They don't have a lot of differentiated structure.

Bryophyta

- Bryophyta is the 2nd division of plant kingdom.
- These are the first plants to have differentiated roots and shoots.

Pteridophyta

- Pteridophyta is the 3rd division of plant kingdom.
- These plants have proper differentiation of roots, stem and leaves.

Gymnosperms

- Gymnosperm stands for naked seed.
- They are the first phanerogams since they produce seeds, which is not enclosed in a fruit.

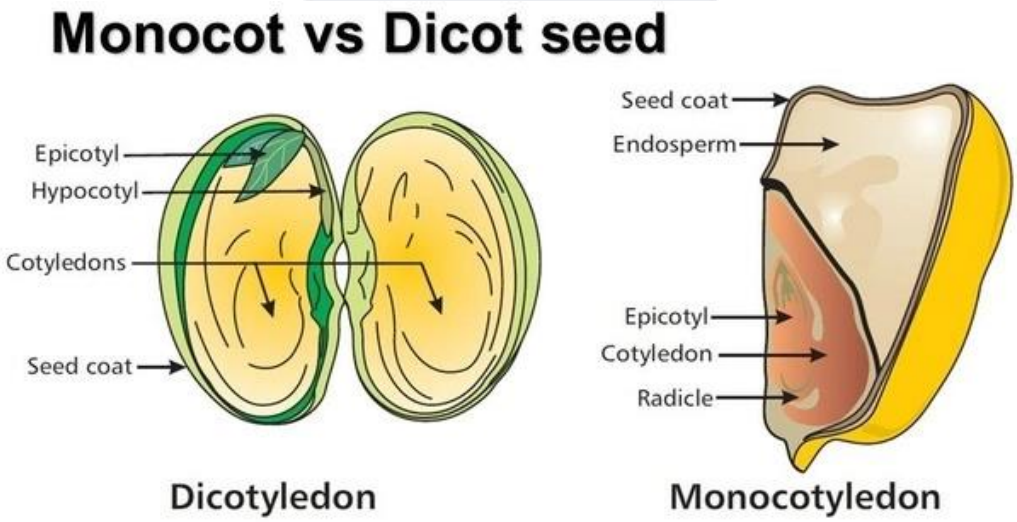
Angiosperms

- Angiosperm is the last division of plant kingdom and has what scientist assume, the most evolved organisms on the planet.
- They bear flowers and fruits, inside which the seeds are found.

Cotyledons

- Cotyledons are structures present in seeds for nutrition during germination when leaves are not yet developed.
- Angiosperms either have two cotyledons making them dicots or only one, making them monocot.

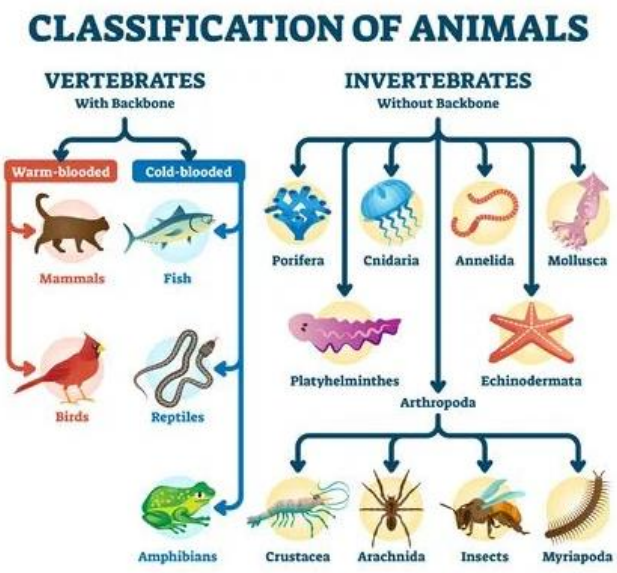
Dicots and Monocots



- Angiosperms, the highly evolved plants on the planet Earth, are further classified based on the number of cotyledons their seeds have.
- When seeds have two cotyledons, they are called dicots.
- Dicots have tap root system and reticulate venation. Examples: Mango, Pea, Beans, etc.
- If seeds have only one cotyledon, they become monocots.
- Monocots show fibrous root system and parallel venation.
- Examples: all grains like wheat, maize, rice etc.

SUBKINGDOM–DIVISION	CHARACTERISTICS	EXAMPLES
Subkingdom Cryptogamae Division Thallophyta/Algae	• Plants have an irregularly shaped, undifferentiated body called thallus. • Predominantly aquatic.	*Nostoc, Oscillatoria, Chlamydomonas*
Subkingdom Cryptogamae Division Bryophyta	• Plant body is either in the form of an undifferentiated thallus or in the form of leafy erect structures. • No specialised tissue for the conduction of water and other substances from one part of the plant body to another.	*Riccia, Funaria, Anthoceros*
Subkingdom Cryptogamae Division Pteridophyta	• Plant body is differentiated into stem, leaves and roots. • Have specialised tissue for the conduction of water and other substances from one part of the plant body to another.	*Psilotum, Nephrolepis, Equisetum*
Subkingdom Phanerogamae Division Gymnospermae	• Bear naked seeds. • Usually perennial, evergreen and woody.	*Gingko, Pinus, Gnetum*
Subkingdom Phanerogamae Division Angiospermae	• Plant body produces seeds which are enclosed within the fruits. • Based on the number of cotyledons, angiosperms are divided into two classes—monocots and dicots.	Maize, bean, wheat

Classification of Kingdom Animalia



Classification of Phylum Invertebrata

PHYLUM	CHARACTERISTICS	EXAMPLES
Porifera	• Simplest multicellular animals with perforated bodies. • The body consists of a tube.	Sycon, bath
Coelenterata	• Have a two-layered body wall, which encloses a single cavity in which digestion takes place. • There are finger-like projections called tentacles present near the mouth for catching food.	Hydra, jellyfish
Platyhelminthes	• Small, soft, flattened and unsegmented worms. • Do not have a body cavity or a coelom.	Liver fluke, tapeworm
Annelida	• The body is cylindrical and divided into ring-like segments. • Have a true body cavity called coelom, present between the body wall and the digestive tube, which is filled with coelomic fluid.	Earthworm, leech
Nemathelminthes	• The body is long, cylindrical and unsegmented without a body cavity. • The nervous system is well-developed and consists of simple nerves.	Hookworm, Ascaris
Arthropoda	• Have jointed limbs, one pair each on some or on all body segments. • Have an exoskeleton made of chitin but lack cilia.	Crayfish, crab
Mollusca	• Have a soft, unsegmented body without appendages but with a hard and calcareous shell to protect the soft body.	Snail, slug
Echinodermata	• The body may be spherical, cylindrical or star- shaped, hard, unsegmented or non-metameric. • Possess a spiny exoskeleton.	Starfish, brittle star
Urochordata	• Triploblastic animals with a coelom which show bilateral symmetry. • The body has three distinct parts—proboscis, collar and trunk.	Balanoglossus, Amphioxus

Classification of Phylum Vertebrata

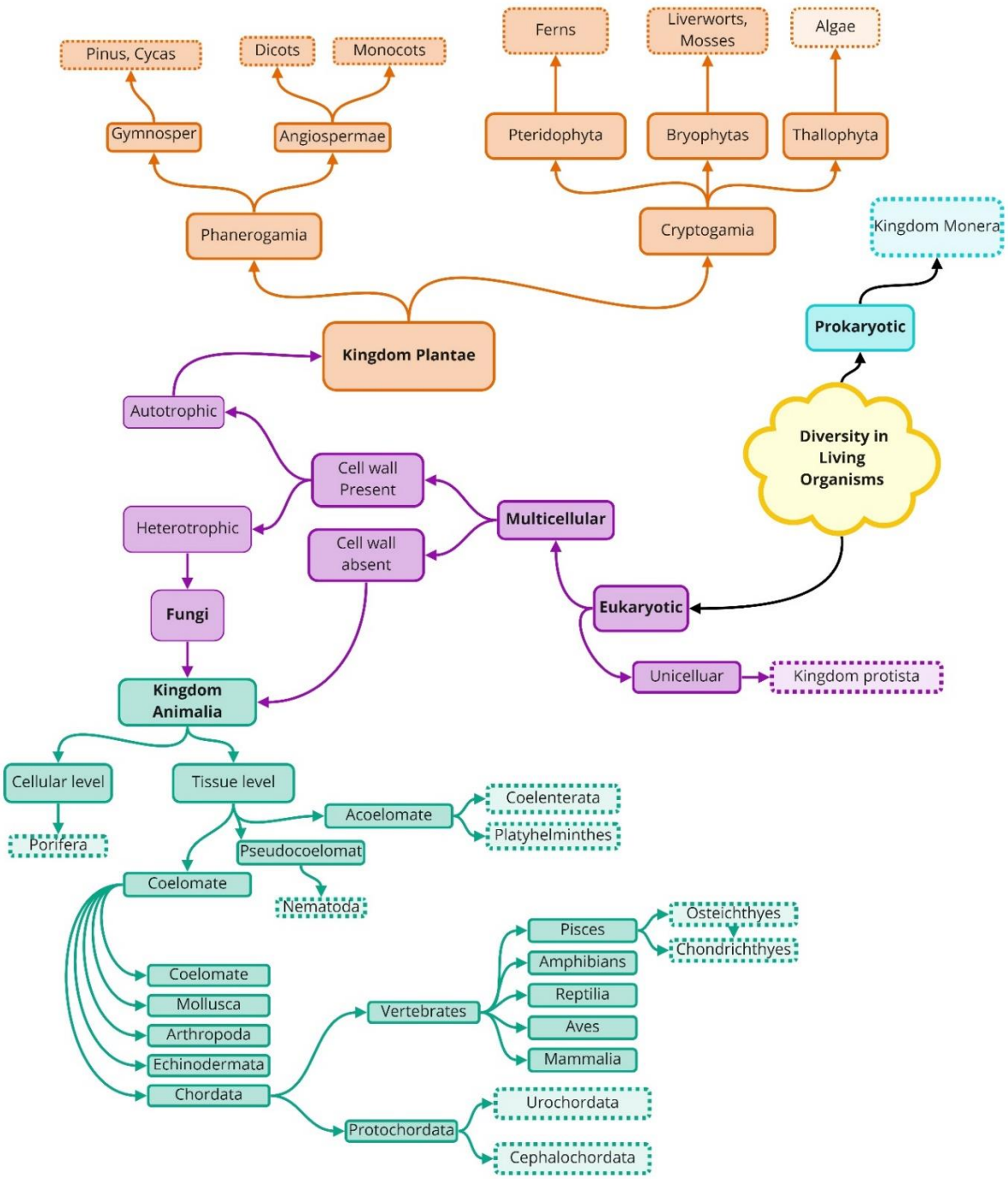
CLASS	CHARACTERISTICS	EXAMPLES
Pisces	• Organisms belonging to Class Pisces are fish. • They are cold-blooded or poikilothermic animals.	Shark, dogfish
Amphibia	• The body is divisible into a head and trunk. Neck is absent. • Have a three-chambered heart with two auricles and one ventricle. • They are cold-blooded animals.	Frog, toad
Reptilia	• The body is divisible into head, neck, abdomen and tail. • Most of them have a three-chambered heart. • Ventricle of the heart is partially divided.	Lizard, snake

Aves	• All birds belong to Class Aves. • Warm-blooded or homeothermic animals. • Heart is four-chambered.	Pigeon, sparrow
Mammalia	• Warm-blooded animals. • Have a four-chambered heart with two auricles and two ventricles.	Cat, dog

Differences between Vertebrates and Invertebrates

VERTEBRATES	INVERTEBRATES
1. Have an internal skeleton	1. No internal skeleton
2. Backbone present	2. Backbone absent
3. Tail usually present	3. Tail absent (anus at the tip of the back end of the body)
4. Heart on the ventral side of the body	4. Heart, when present, on the dorsal side of the body
5. Nerve (spinal) cord dorsal and hollow	5. Nerve cord ventral and solid
6. Have two pairs of limbs	6. Have three or more pairs of limbs if present
7. Haemoglobin in red blood cells	7. Haemoglobin, if present, dissolved
8. Examples: Fish, frog, lizard, bird	8. Examples: Leech, earthworm, Sycon

Class : 9th Science
Chapter - 7 : Diversity in Living Organisms



Important Questions

Multiple Choice Questions:

1. Mammals are:
   (a) warm-blooded
   (b) cold-blooded
   (c) both
   (d) none of them
2. Reptiles are:
   (a) warm-blooded
   (b) cold-blooded
   (c) both
   (d) none of them
3. The book 'Systema Naturae' was written by:
   (a) Carolus Linnaeus
   (b) Whittaker
   (c) Haeckel
   (d) None of them
4. How many research papers of Carolus Linnaeus were published on classification?
   (a) 12
   (b) 13
   (c) 14
   (d) 16
5. Which among the following produce seeds?
   (a) Thallophyta
   (b) Bryophyta
   (c) Pteridophyta
   (d) Gymnosperms
6. Who proposed the nomenclature system of living organisms first of all?
   (a) Robert Hooke
   (b) Carolus Linnaeus
   (c) Leeuwenhoek
   (d) Schleiden
7. Who is considered the father of taxonomy?
   (a) Carolus Linnaeus
   (b) Robert Hooke
   (c) Leeuwenhoek
   (d) Schleiden
8. Which one is a true fish?
   (a) Jellyfish
   (b) Starfish
   (c) Dogfish
   (d) Silverfish
9. Which among the following have an open circulatory system?
   (i) Arthropoda
   (ii) Mollusca
   (iii) Annelida
   (iv) Coelenterata
   (a) (i) and (ii)
   (b) (iii) and (iv)
   (c) (i) and (iii)
   (d) (ii) and (iv)
10. Gymnosperms are kept under:
    (a) Algae
    (b) Bryophyta
    (c) Tracheophyta
    (d) None of them
11. Which among the following have scales?
    (i) Amphibians
    (ii) Pisces
    (iii) Reptiles
    (iv) Mammals
    (a) (i) and (iii)
    (b) (iii) and (iv)
    (c) (ii) and (iii)
    (d) (i) and (ii)
12. The amphibian animal is:
    (a) Fish
    (b) Frog
    (c) Lizard
    (d) Bat
13. Identify a member of Porifera:
    (a) Spongilla
    (b) Euglena
    (c) Penicillium
    (d) Hydra

14. Two chambered heart occurs in:
    (a) crocodiles
    (b) fish
    (c) aves
    (d) amphibians

Very Short Question:

1. Who wrote the book "The Origin of Species"?
2. Who proposed the classification of organisms into 5 kingdom?
3. Define species.
4. Give example of the organism belonging to Monera and Protista Kingdom.
5. Name the appendages used for movement by organism belonging to Protista kingdom.
6. What is lichen?
7. What is symbiotic relationship?
8. What is saprophytic nutrition?
9. Give simple dassificatian of plant kingdom.
10. Name the plant amphibian.

Short Questions:

1. Give the characteristics of Monera.
2. Give the characteristics of Protista.
3. Give the difference between thallophyte and bryophyte.
4. What are hermaphrodites? Give two examples.
5. Give the difference between monocots and dicots.
6. Give the difference between two types of symmetry that animals show.
7. Differentiate between vertebrates and invertebrates.
8. Name the phylum of the following animals:
   (a) Tapeworm (b) Starfish
   (c) Jellyfish (d) Octopus

Long Questions:

1. What is the criterion for classification of organisms as belonging to kingdom Monera or Protista?
2. Explain the three basic features for grouping all organisms into five major kingdoms.
3. Differentiate between Bryophyta and Pteridophyta. Give example of each group.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Nucleus can be A basic characteristic of animal classification.

   Reason: Nucleated cells have capacity to participate making multicellular organism because they can take up specialised function.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Nucleus can be A basic characteristic of animal classification.

   Reason: Nucleus is the only organelle present in the cell which shows animal characters.

Case Study Questions:

1. Biologists, such as Ernst Haeckel (1894), Robert Whittaker (1969) and Carl Woese (1977) have tried to classify all living organisms into broad categories, called kingdoms.

The classification Whittaker proposed has five kingdoms: Monera, Protista, Fungi, Plantae and Animalia, and is widely used. These groups are formed on the basis of their cell structure, mode and source of nutrition and body organisation.

The modification Woese introduced by dividing the Monera into Archaebacteria (or Archaea) and Eubacteria (or Bacteria) is also in use. Further classification is done by naming the sub-groups at various levels as given in the following scheme:

Kingdom
↓
Phylum (for animals) / Division (for plants)
↓
Class
↓
Order
↓
Family
↓
Genus
↓
Species

Thus, by separating organisms on the basis of a hierarchy of characteristics into smaller and smaller groups, we arrive at the basic unit of classification, which is a 'species'. A species includes all organisms that are similar enough to breed and perpetuate.

(i) Who proposed Five Kingdoms?

(a) Ernst Haeckel (1894)

(b) Robert Whittaker (1969)

(c) Carl Woese (1977)

(d) None of above

(ii) Which of the following kingdom is a part of five kingdom system?

(a) Monera

(b) Protista

(c) Animalia

(d) All of the above

(iii) Kingdom Monera divided into

(a) Archaebacteria

(b) Eubacteria

(c) Both a & b

(d) None of above

(iv) A groups of five kingdom are formed on the basis of

(a) Cell structure,

(b) Mode and source of nutrition

(c) Body organisation.

(d) All of the above

(v) What is species?

2. The first level of classification among plants depends on whether the plant body has well differentiated, distinct parts. The next level of classification is based on whether the differentiated plant body has special tissues for the transport of water and other substances. Further classification looks at the ability to bear seeds and whether the seeds are enclosed within fruits.

THALLOPHYTA

Plants that do not have well-differentiated body design fall in this group. The plants in this group are commonly called algae. These plantsare predominantly aquatic. Examples are Spirogyra, Ulothrix, Cladophora, Ulva and Chara.

BRYOPHYTA

These are called the amphibians of the plant kingdom. The plant body is commonly differentiated to form stem and leaf-like structures. There is no specialised tissue for the conduction of water and other substances from one part of the plant body to another. Examples are moss (Funaria) and Marchantia.

PTERIDOPHYTA

In this group, the plant body is differentiated into roots, stem and leaves and has specialised tissue for the conduction of water and other substances from one part of the plant body to another. Some examples are Marsilea, ferns. The reproductive organs of plants in all these three groups are very inconspicuous, and they are therefore called 'cryptogams', or 'those with hidden reproductive organs'. On the other hand, plants with well differentiated reproductive parts that ultimately make seeds are calledphanerogams. This group is further classified, based on whether the seeds are naked or enclosed in fruits, giving us two groups – gymnosperms and angiosperms.

Gymnosperms are the plants which bear naked seeds and are usually perennial, evergreen and woody. Examples are pines and deodar. Angiosperms are the plants which seeds are enclosed inside an ovary.

(i) Plants that do not have well-differentiated body is known as _____.

(a) Bryophytes

(b) Pteridophytes

(c) Thallophytes

(d) Angiosperms

(ii) The plants which bear naked seeds:

(a) Angiosperms

(b) Gymnosperms

(c) Thallophytes

(d) Pteridophytes

(iii) Phanerogams are further classified into:

(a) Angiosperms

(b) Gymnosperms

(c) Thallophytes

(d) Both a & b

(iv) Which of the following is the distinguishing feature of Bryophytes:

(a) Plant body is differentiated to form stem and leaf-like structures

(b) No specialised tissue for the conduction of water and food

(c) Both a & b

(d) None of above

(v) Explain the three important aspect on which classification of Plantae?

Answer Key

Multiple Choice Answers:

1. (a) warm-blooded
2. (b) cold-blooded
3. (a) Carolus Linnaeus
4. (c) 14
5. (d) Gymnosperms
6. (b) Carolus Linnaeus
7. (a) Carolus Linnaeus
8. (c) Dogfish
9. (a) (i) and (ii)
10. (c) Tracheophyta
11. (c) (ii) and (iii)
12. (b) Frog
13. (a) Spongilla
14. (b) fish

Very Short Answers:

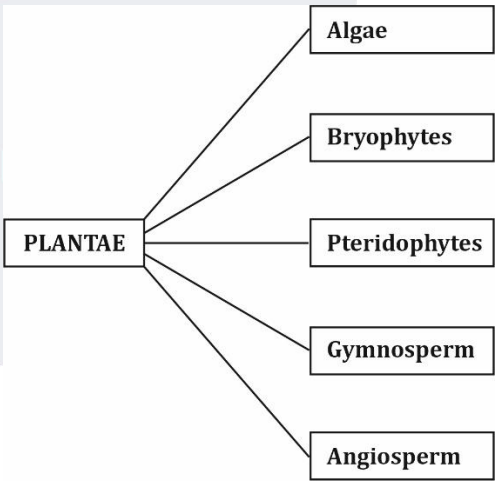
1. **Answer:** Charles Darwin in 1859.
2. **Answer:** Robert Whittaker (1959).
3. **Answer:** All organisms that are similar to breed and perpetuate.
4. **Answer:** Monera, Anabaena, blue-green algae Protista—Eugleno, Paramecium, Amoeba
5. **Answer:**

   Paramecium – Cilia

   Euglena – Flagella

   Amoeba – Pseudopodia

6. **Answer:** The symbiotic association of fungi and blue-green algae, is called lichen.
7. **Answer:** It is a relationship between two organisms in which both of them are benefitted, e.g., fungi gets food from blue-green algae and in return blue-green gets shelter [lichens].
8. **Answer:** The organisms using dead and decaying organic matter as food are said to show saprophytic nutrition.
9. **Answer:**



10. **Answer:** Bryophyta e.g., Funaria (Moss).

Short Answer:

1. **Answer:**

   (a) Organisms are unicellular, do not have a defined nucleus.

   (b) Organisms may have cell wall or may not have cell wall.

   (c) Mode of nutrition is either autotrophic or heterotrophic.

2. **Answer:**

(a) Organisms are unicellular and eukaryotic.

(b) Use appendages for locomotion like cilia, flagella, etc.

(c) Nutrition is either autotrophic or heterotrophic.

(d) E.g., algae, protozoa.

3. **Answer:**

Thallophyte	Bryophyte
Body is thallus like not differentiated into -root, stem. Example: Spirogyra.	Plant Body is differentiated into stem and leaf like structures. Example: Moss.

4. **Answer:** When an organism has both the sexes, i.e., it can produce both sperms and eggs are called hermaphrodites. Example: Sponges, earthworms.

5. **Answer:**

Monocots	Dicots
1. Seeds with one cotyledon. 2. Leaves have parallel venation. 3. Root system—fibrous.	Seeds with two cotyledons. Leaves have reticulate venation. Root system—tap root.

6. **Answer:** Symmetry—Bilateral and Radial

Bilateral Symmetry	Radial Symmetry
Any organism that has same design on left and right halves of the body. Example: Earthworm, spider, cockroach.	Any organisms with a body design such that it can be divided into two equal halves from any radius. Example: Starfish sea urchin.

7. **Answer:**

Vertebrates	Invertebrates
1. Notochord is present. 2. True internal skeleton present.	Notochord is absent. No true internal skeleton present.

8. **Answer:**

(a) Tapeworm – Flatyhelminthes

(b) Starfish – Echinodermatai

(c) Jellyfish – Coelenterata

(d) Octopus – Mollusca

Long Answer:

1. **Answer:** Criterion for classification of organisms belonging to kingdom Monera:

(i) These organisms do not have a defined nucleus or organelles, nor do any of them show multicellular body designs.

(ii) Some of them have cell walls while some do not have.

The mode of nutrition of organisms in this group can be either by synthesizing their own food (autotrophic) or getting it from the environment (heterotrophic).

(iv) This group includes bacteria, blue-green algae or cyanobacteria and mycoplasma.

Criterion for classification of organisms belonging to kingdom Protista:

(i) This group includes many kinds of unicellular eukaryotic organisms.

(ii) Some of these organisms use appendages, such as hair-like cilia or whip-like flagella for moving around.

(iii) Their mode of nutrition can be autotrophic or heterotrophic.

(iv) This group includes unicellular algae, diatoms and protozoans.

2. **Answer:**

The three basic features for grouping the organisms into five kingdoms are:

(i) Cell structure: On the basis of this the two groups are prokaryotes and the eukaryotes which are distinguished on the basis of absence or presence of well defined nuclear membrane.

(ii) Thallus organization: The organisms are grouped as unicellular or multicellular organisms on the basis of their being composed of a single cell or of many cells respectively.

(iii) Mode of nutrition: The organisms are grouped as autotrophs or heterotrophs on the basis of their ability to synthesise their own food or being dependent on other organisms for their food.

3. Answer:

Bryophyta:

- They are called the 'amphibians of the plant kingdom'.
- They lack vascular tissues.
- Body is not well-differentiated into true root, stem or leaves.
- The dominant phase or the main plant body is gametophyte (haploid).
- Sporophyte depends upon gametophyte for its support and nutrition.
- Spores are formed in capsule of sporophyte.
- Examples: Liverworts, Mosses

Pteridophyta:

- They are the first land plants.
- They have vascular tissues xylem and phloem.
- Body is well-differentiated into true roots, stem and leaves.
- The dominant phase or the main plant body is sporophyte (diploid).
- Sporophyte and gametophyte are independent structures in them.
- Spores are produced inside the sporangia borne on leaves or cones.
- Examples: Ferns, Horsetail, Marsilea

Assertion Reason Answer:

1. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
2. (c) Assertion is true but Reason is false.

Case Study Answers:

1. (i) (b) Robert Whittaker (1969)

(ii) (d) All of the above

(iii) (c) Both a & b

(iv) (d) All of the above

(v) By separating organisms on the basis of a hierarchy of characteristics into smaller and smaller groups, we arrive at the basic unit of classification, which is a 'species'. A species includes all organisms that are similar enough to breed and perpetuate.

2. (i) (c) Thallophytes

(ii) (b) Gymnosperms

(iii) (d) Both a & b

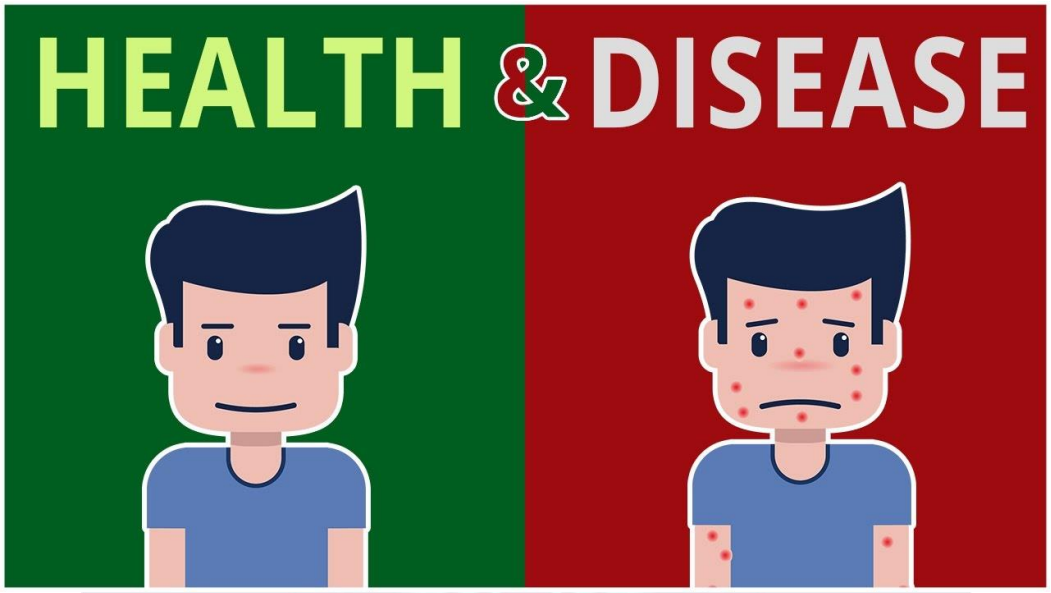
(iv) (c) Both a & b

(v) The first level of classification among plants depends on:

- Whether the plant body has well differentiated, distinct parts
- Whether the differentiated plant body has special tissues for the transport of water
- The ability to bear seeds and whether the seeds are enclosed within fruits

Why Do We Fall ill? 4

Health and Disease



Health

It is defined as the state of complete physical, mental and social well-being.

The health of an individual is affected by changing internal and external factors including personal, economic, environmental and social factors.

Disease

It is the departure from normal health through a structural or functional disorder of the body.

"A disease is a condition that deteriorates the normal functioning of the cells, tissues, and organs."

Diseases are often thought of as medical conditions that are characterized by their signs and symptoms.

The disease can also be defined as:

"Any dangerous divergence from a functional or normal state of an entity."

When a person is inflicted with a disease, he exhibits a few symptoms and signs that range from normal to severe depending upon the medical condition. Hence, in order to identify different diseases, the normalcy of an entity needs to be studied and understood as a clear demarcation between disease and disease-free is not always apparent.

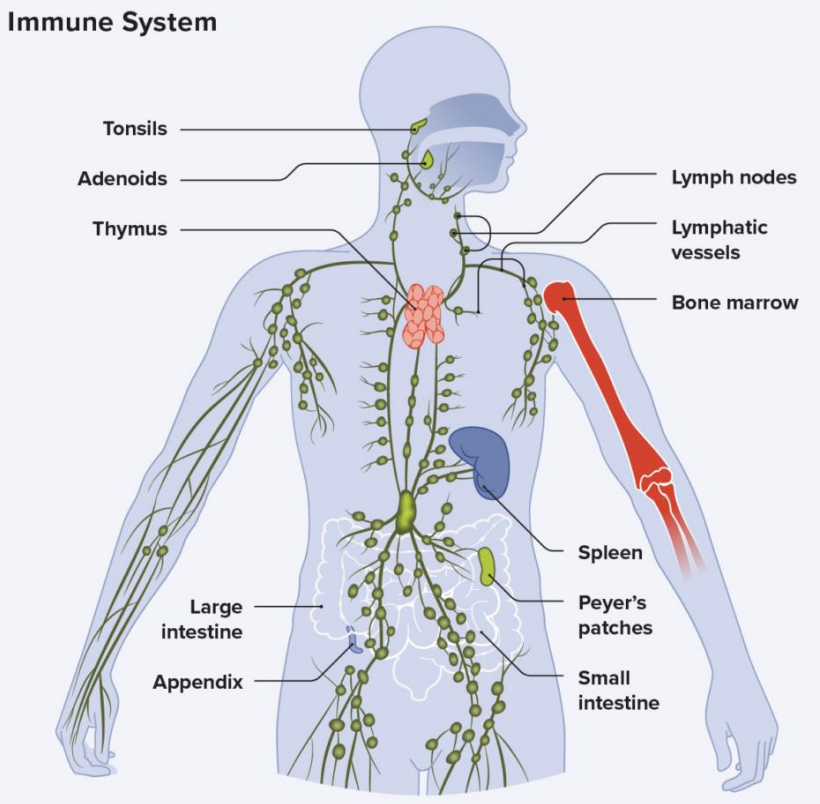
The Immune System

An immune system is the part of the body that provides protection against infection from pathogens, invading foreign substances and other toxins.

Yes, this is due to the immune system.

Children, both infants and toddlers tend to fall ill more often and are more prone to infections as they do not have

a fully developed immune system, compared to adults. Likewise, as people grow old, their immune system weakens and makes things worse.

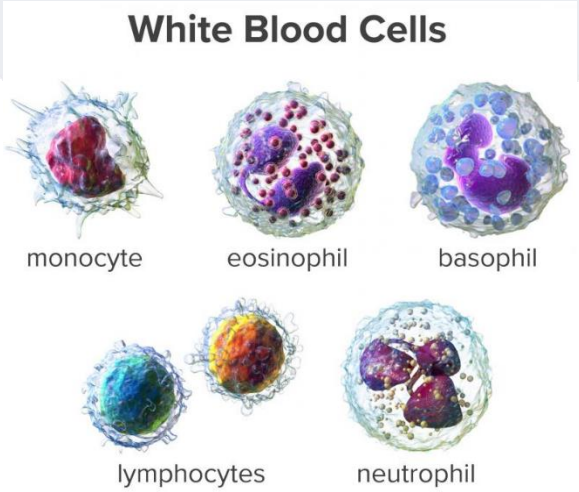


Everyone's immune system is different and it varies with age, lifestyle and there are many factors which affect the immune system.

Here, in this article let us learn in detail about the human immune system, different parts, types and other facts related to it.

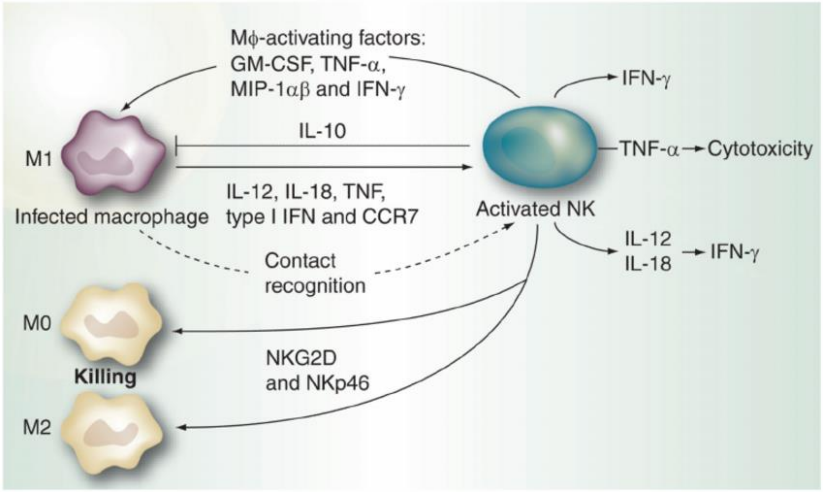
Skin and Mucous Membranes Skin and Mucous membranes act as the layer of defence. While skin protects the body externally, mucous membrane protects the insides of the body.

WBC



WBC- White blood cells are called Leucocytes or Leukocytes. They are the important components of our immune system and are present in the blood and lymph. They function by attacking and kill the pathogens and protect our body free from pathogens and infections. There are of different types of and are classified based on the location as well. The different types of White blood cells found in the blood are neutrophils, lymphocytes, monocytes, basophils, ad eosinophils. These blood cells have specialized functions.

Macrophages and NK Cells



Macrophages are large and specialized cells of the immune system. These cells are produced in response to infections or due to the development of damaged or dead cells. They attack cancer cells through destruction and ingestion. Natural Killer Cells bind to the enemy cell and they dissolve the membrane so the cell can't function.

Dendritic Cells

Dendritic cells create the memory and carry information about the pathogens to the liver, spleen, lymph nodes.

Inflammatory Response

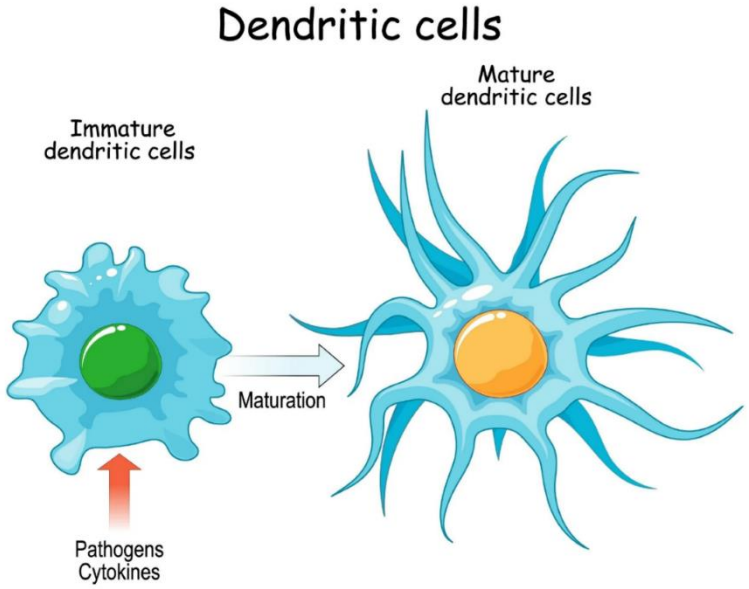
An inflammatory response is seen in the body when it gets injured or infected by a pathogen. Inflammations help in the localization of the issue and prevent it from spreading.

Disease and Its Causes

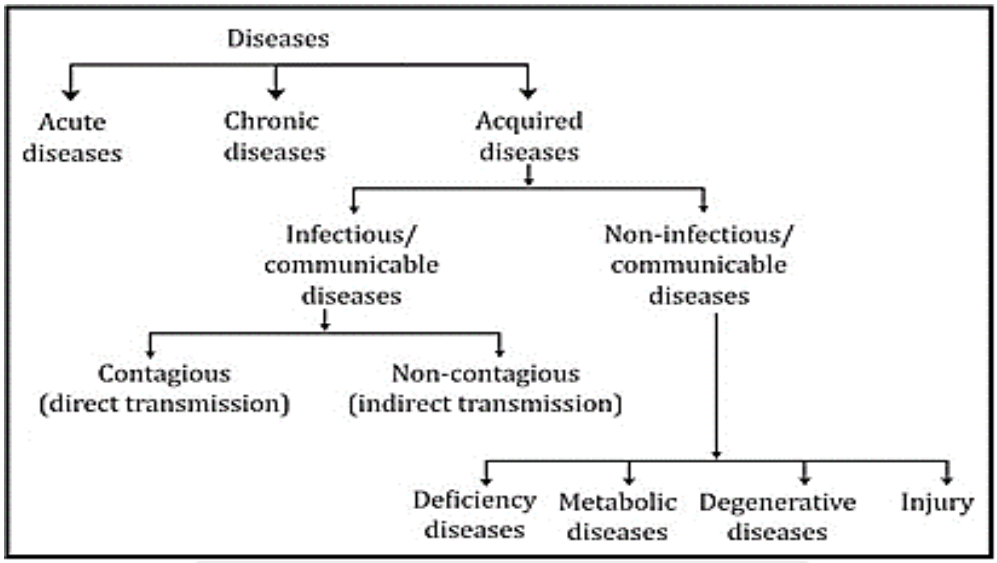
The diseases are usually caused by many factors rather than a single cause. When we have a disease, we eventually show some signs, such as headaches, cough, cold, weakness. These signs are referred to as "symptoms." In almost all diseases, symptoms are shown immediately after having been struck by the disease. However, it varies depending upon the seriousness of the disease.

Symptoms and signs of Diseases

When the body gets diseased, it shows certain symptoms and signs of illness. These symptoms and signs help in identification and diagnosis of the disease. A symptom is felt by the affected person while signs can be detected by another person. A symptom is thus, subjective and a sign is an objective.



Types of diseases



Diseases which develop after birth are called **acquired** diseases.

Acute diseases are those which last for a very short time. These diseases can be fatal and are usually caused by an external agent. Diseases in which the symptoms are quickly visible in the body and last for a shorter duration are called **acute** diseases. Examples: Common cold, malaria

Chronic diseases are those which last for a long time. They take a lot of time to heal and can be caused by any external or internal factor. Diseases which are long-term, with their symptoms lasting for months or years, are called chronic diseases. Examples: Elephantiasis, tuberculosis

Different types of Causes of Disease

Diseases can be caused due to pathogens such as virus or bacteria. Some diseases can also be due to internal factors such as genetic mutation.

Intrinsic/Internal Factors	• These are disease-causing factors which exist within the human body. • Genetic disorders. Example: Haemophilia
Extrinsic/External Factors	• These are disease-causing factors which enter the human body from outside and cause a disease. • Disease-causing microorganisms. Example: Malaria
Levels of Immediate Causes	• First-level cause: Primary cause/causative agent: Bacteria, virus • Second-level cause: Secondary cause: Lack of good nourishment • Third-level cause: Tertiary cause: Poverty

Infectious Diseases

Diseases that are caused by pathogens and can spread to other individuals in the populations are called infectious diseases.

Non-infectious diseases

Diseases that cannot spread from one individual to another are called non-infectious diseases. Usually, these diseases are not caused by a pathogen.

INFECTIOUS DISEASES	NON-INFECTIOUS DISEASES
1. Caused by attack of pathogens	1. Caused by factors other than pathogens
2. Caused by extrinsic factors	2. Caused by intrinsic factors
3. Transmitted from one person to another	3. Do not get transmitted from one person to another
4. Transmission of diseases occurs through direct contact or some medium	4. Transmission in hereditary diseases is from parent to offspring
5. Examples: Cholera, malaria	5. Examples: Diabetes, goitre

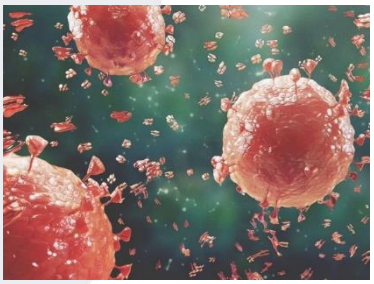
Infectious Diseases

Infectious Agents

Viruses	•AIDS, chickenpox, influenza, poliomyelitis
Bacteria	•Typhoid, cholera, tuberculosis, tetanus
Fungi	•Skin infections, dandruff, ringworm
Protozoa	•Malaria, amoebic dysentery, Kala-azar
Metazoa	•Elephantiasis, ascariasis
Mites	•Scabies

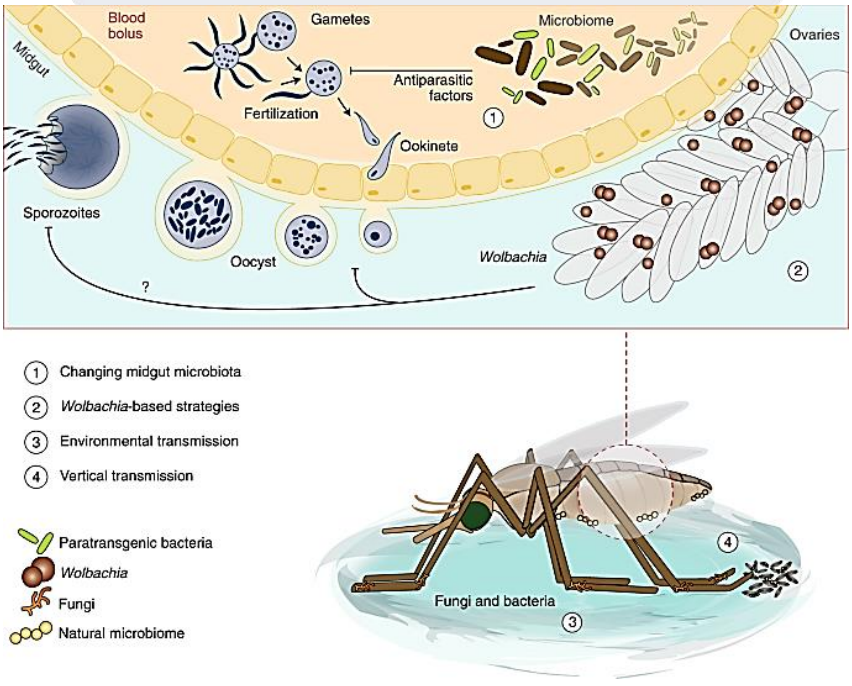
Pathogens

Pathogens are external agents that cause diseases in other organisms. This pathogen includes harmful microbes or microorganism such as bacteria, virus, fungi or protozoa.



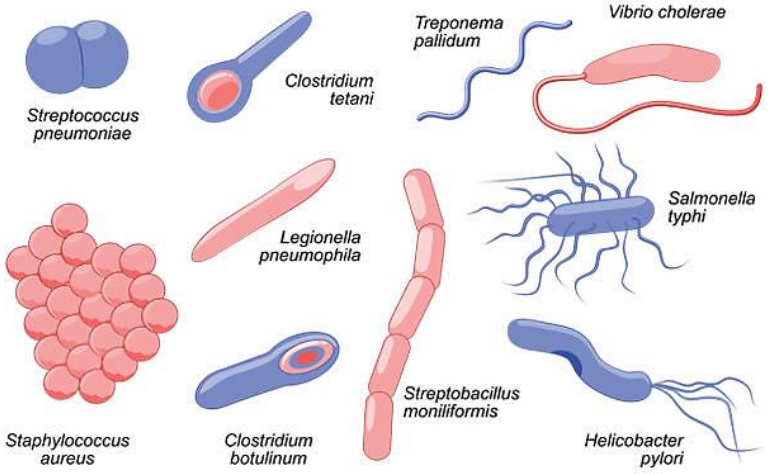
Vector

Vectors are those organisms that carry a pathogen from the host to a recipient. Mosquito, rats and mice are some of the common vectors that carry infectious diseases.



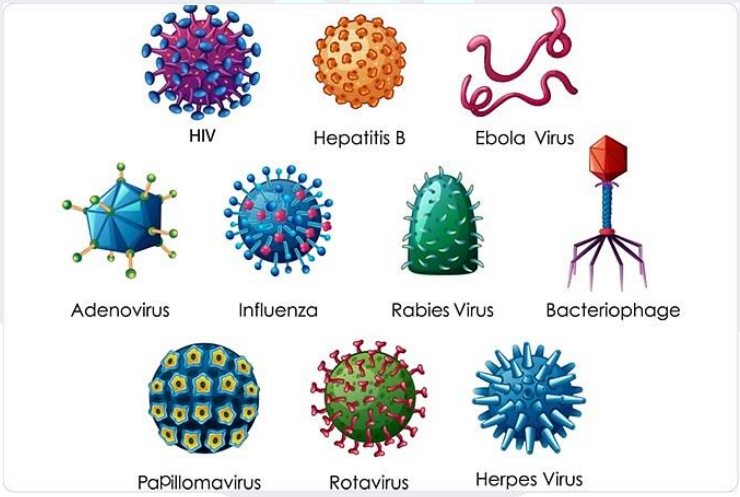
Bacteria

Bacteria are microorganisms that are seen in almost all environmental condition. Not all bacteria are harmful to pathogens. Some bacteria are also beneficial to human beings. Bacteria are beneficial for, digestion, extracting antibiotics from them, nitrogen fixation, etc.



Virus

A virus is a microorganism that is always pathogenic in nature. They do not have molecular machinery to replicate without a host. Therefore, they enter the host cell and replicate and in the process destroy the host cell. A few of the common diseases spread by the viruses are cold, influenza, dengue fever AIDS, etc.



Fungi

Fungi are a group of organisms which are eukaryotic in nature and saprophytic in nutrition. They could be either unicellular or multicellular organism. Many common skin infections such as ringworm, nail infection, etc. are examples of Fungal diseases

Nail Infection

Ringworm

Parasites

A parasite is an organism that lives in another organism, called the host, and often harms it. It is dependent on its host for survival – it has to be in the host to live, grow and multiply.

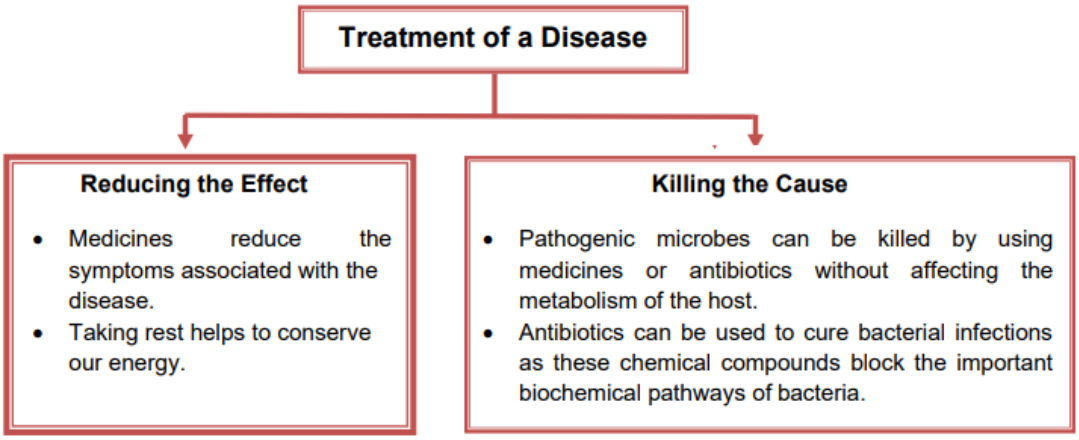
Means of Spread of Infectious Diseases

Air-borne diseases	Spread through air when droplets of pathogens are expelled into the air because of coughing, sneezing or talking. **Examples:** Influenza, meningitis
Water-borne diseases	Caused by consumption of contaminated water. **Examples:** Typhoid fever, cholera, hepatitis A
Food-borne diseases	Caused by consumption of food contaminated with chemical toxins or pathogens. **Examples:** Taeniasis, trichinosis
Vector-borne diseases	Caused by pathogens transmitted by vectors such as insects and ticks. **Examples:** Malaria, elephantiasis
Sexually transmitted diseases	Caused by pathogens transmitted by sexual contact. **Examples:** AIDS, syphilis
Fomite-borne diseases	Caused by pathogens present on inanimate objects such as clothing and bedding used by infected people. **Examples:** Scabies, ringworm

Organ-specific and Tissue-specific Manifestations of Diseases

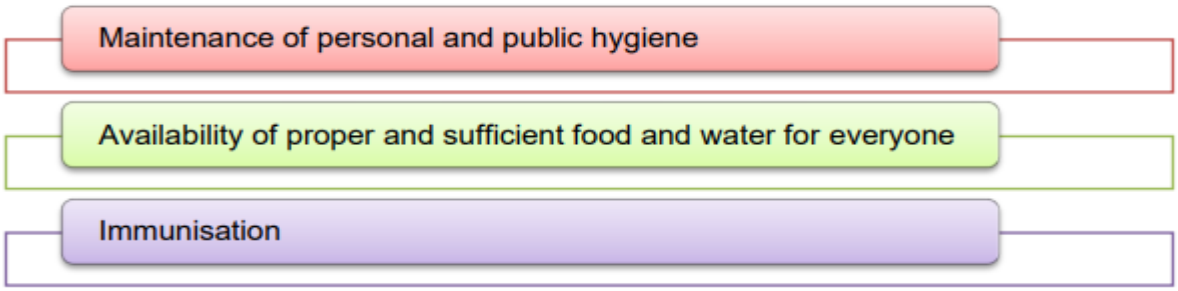
- The **signs** and **symptoms** of a disease depend on the tissue or organ which the microbe targets.
- The severity of **disease manifestation** depends on the number of microbes within the body.
- During infection, the immune system gets activated. It sends many soldier cells to the affected tissue to kill the microbes. This causes inflammation.
- **Inflammation** is due to the escape of some chemicals which cause allergic reactions in our body. They attract blood supply because of which the amount of blood and the temperature of the surrounding area increase. The consequent swelling of the area is called **oedema**.
- **Plasma** and **white blood cells** (WBCs) of the immune system of the body are discharged at the affected site. Plasma contains products such as **antibodies** and **macrophages** which kill or inhibit the growth of pathogens.
- Doctors carry out **confirmatory tests** such as laboratory tests of blood, urine and stool or even perform an X-ray to confirm the presence of a disease.

Principles of Treatment of Diseases



Principles of Prevention of Diseases

- Prevention of diseases follows three basic principles:



General Ways of Prevention of Infectious Diseases

- We can prevent exposure to **air-borne microbes** by providing living conditions which are not overcrowded.
- We can prevent exposure to **water-borne microbes** by providing safe, filtered and boiled drinking water.
- We can provide clean environments to prevent exposure to **vector-borne microbes**. This would not allow their multiplication.

Specific Ways of Prevention of Infectious Diseases

- **Immunisation** is the process by which an individual's immune system is equipped to fight off infectious agents.
- **Vaccination** provides active immunity.
- Vaccines against some common diseases such as BCG vaccine, DPT vaccine, polio vaccine, vaccines for tetanus, diphtheria, whooping cough, measles and many others have been administered in India.

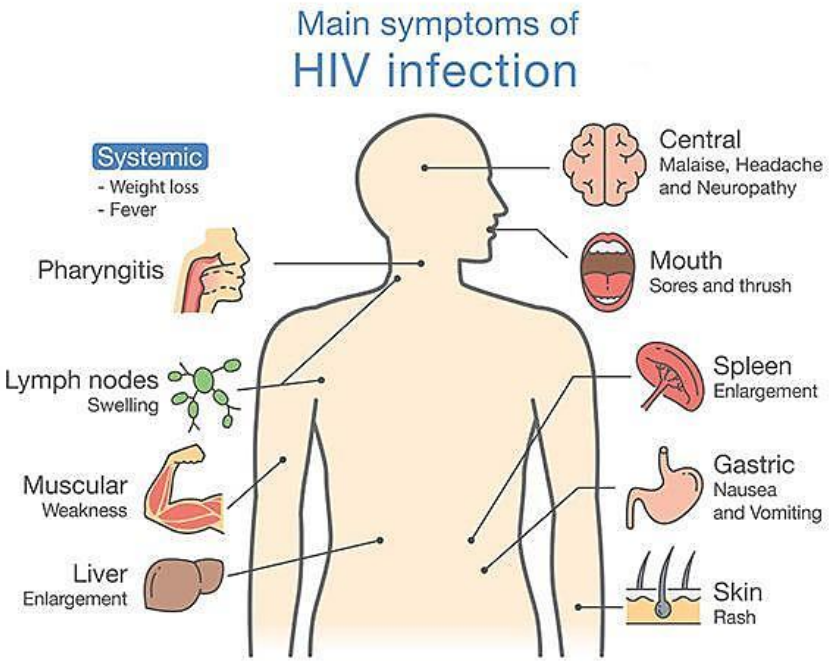
Vaccination

When the immune system first sees an infectious microbe, it responds against it and then remembers it specifically. So the next time that particular microbe, or its close relative enter the body, the immune system responds with even greater vigorous. This eliminates the infection even more quickly than the first time around. This is the basis of principle of immunization.

We fool the immune system of human body into developing a memory for particular infection by putting something that mimics the microbes we want to vaccinate against, into the body. This does not actually cause the disease but this would prevent any subsequent

Jaundice or hepatitis is a disease of liver. It is caused by viral infection. There is a vaccine for hepatitis A available in market. Rabies-It is spread by the bite of infected dog and other animal. It is a viral disease caused by a rabies virus which is present in saliva of infected animals. 5 Anti-rabies vaccines are available.

AIDS-Acquired imuno deficiency syndrome virus.



It is cause by retrovirus called as HIV.

It attacks white blood cells of human beings and weakens the human body immune system. It reduces the natural immunity of human body. The patients suffering from AIDS die from other infections.

OPV=Oral Polio Vaccine

PPTP=Pulse polis immunization programmer

BCG vaccine (Bacillus Calmette Guerin):It is for the prevention of tuberculosis.

Principles of Treatment

There are 2 ways to treat infectious diseases

1. Reduce the effect of the disease
2. Kill the cause of disease

To reduce the effect of disease: we provide treatment that will reduce the symptoms. The symptoms are because of inflammation.

We can take medicines that bring down fever, reduce pain or loose motion, take bed rest. Such a kind of symptom-directed treatment is inadequate. Since it will not make the pathogen to go away. For that we have to kill the microbe itself One way To kill microbes is to use medicines. Microbes can be classified into different categories.

Infections

AIDS

AIDS stands for Acquired Immunodeficiency Syndrome. It is caused by the Human Immunodeficiency Virus. AIDS systematically destroys the immune system of the patient, leaving them vulnerable to the easiest of the diseases.

Prevention of Disease

Antibiotics

Antibiotics are antimicrobial drugs produced from other organisms, such as fungus and some bacteria, which are used for treating against the harmful infections caused by pathogens or harmful microorganisms. These antibiotics functions by:

- Alteration of Cell Membranes.
- Inhibition Antimetabolite Activity.
- Inhibition of Nucleic Acid Synthesis.
- Inhibiting of Cell Wall Synthesis (a most common mechanism).
- Inhibition of Protein Synthesis (Translation) (second largest class).

Preventive Measures

The preventive measures can be taken to avoid infection of various diseases. The most common measure is the maintenance of hygienic condition.

While treating an infection or a disease, three limitations are generally faced. These three limitations are as follows:

- Someone had a disease which completely damaged his body functions to an extent that it can't be recovered.
- A person suffering from some ailment might be bedridden for some time because it takes time to cure any disease.
- A person suffering from some disease might spread the infection to other people as well.

Therefore, it is necessary to prevent certain diseases beforehand.

How Can Disease Be Prevented?

There are two ways of preventing a particular disease.

General Ways

- Hygienic conditions should be maintained in the surroundings we live in. There should be limited exposure to airborne microbes by providing not so crowded living conditions.
- Safe drinking water should be provided to prevent water-borne diseases.
- Provide a clean environment which prevents the breeding of mosquitoes. This prevents the spread of vector-borne diseases.

Specific Ways

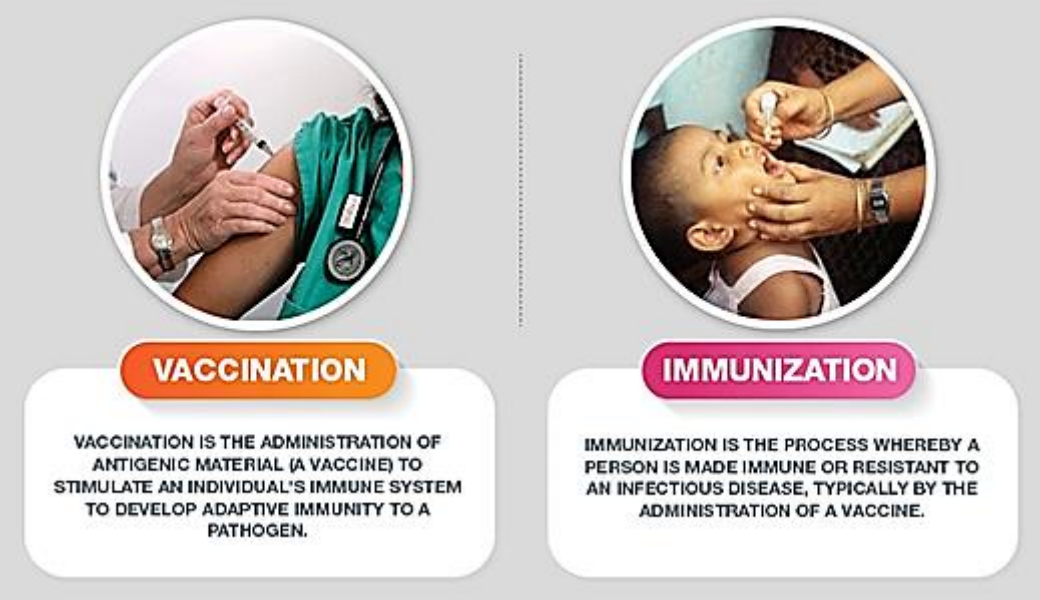
The immune system normally fights off microbes. The cells of the immune system are specialized in killing infectious microbes. That is why we don't always fall sick on coming in contact with an infectious person. As soon as an antigen enters the body, these cells come into play.

Immunization

Immunization is the process whereby a person is made immune or resistant to an infectious disease. Vaccines are the common means to immunize people.

Difference Between VaccinationaAnd Immunization

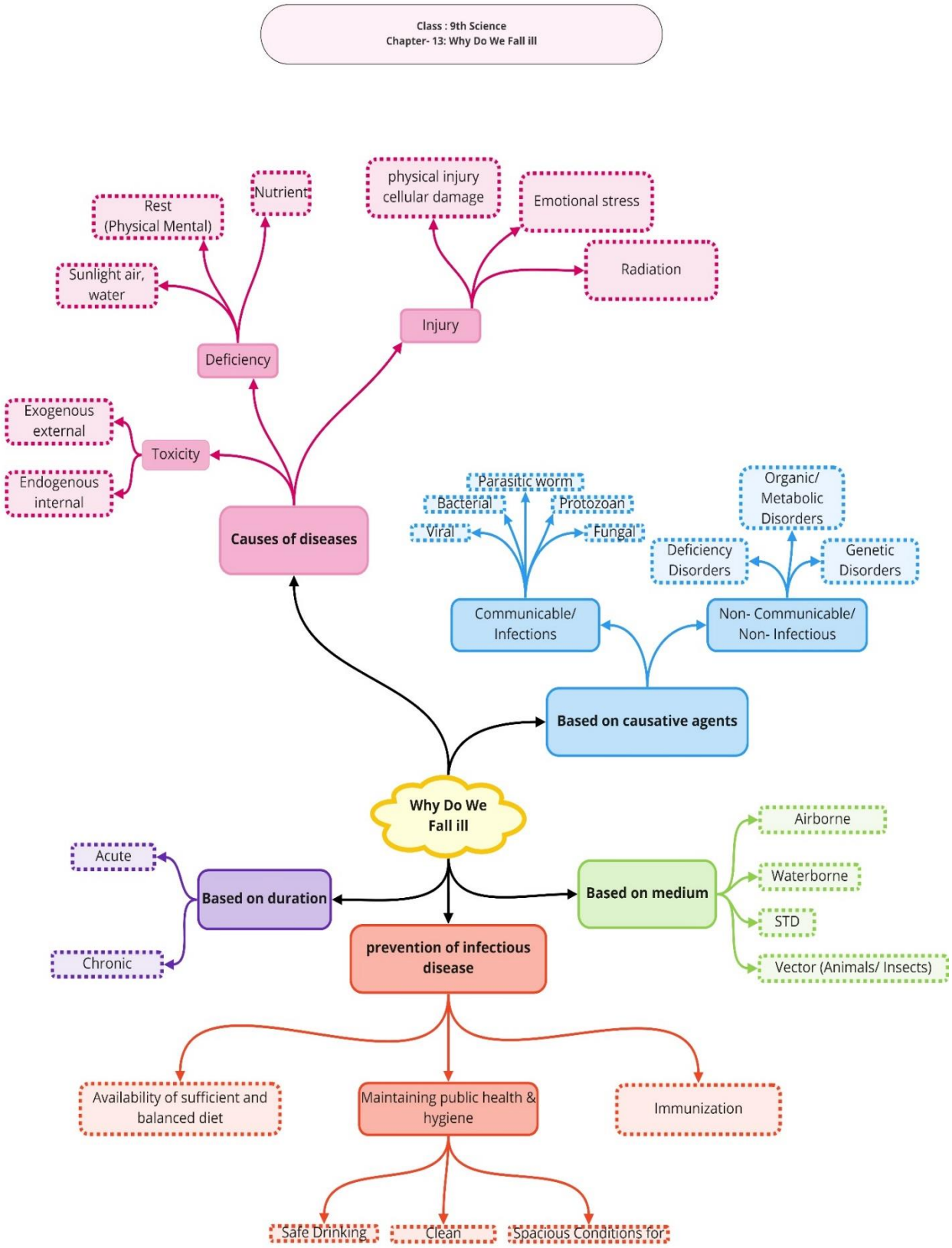
The major difference between Vaccination and Immunization is that a vaccine is administered to people to create immunity from that disease. For example, before the polio vaccine is administered, the infant does not have immunity to the disease and has a high risk of contracting that disease. Therefore, a vaccination builds up resistance (immunity) to a disease.



In essence, vaccination and immunization go hand in hand. Immunity to a disease can occur naturally or be induced by artificial means. For instance, once you contract Chicken Pox, it is very rare for the same person to contract the disease again because they build up immunity to the disease. Creating immunity artificially involves exposure to very weak or deactivated disease causing microbes. The major difference between Vaccination And Immunization are summarized as follows:

Difference Between Vaccination And Immunization	
Vaccination	**Immunization**
The process involves introducing a weakened / deactivated disease causing microbes into a person	The process starts after the person is exposed to the vaccine and the body starts building resistance to that disease
It is usually injected or administered orally	It is not administered in any way. Tthe body develops resistance from vaccines.

Imovax Rabies is the trade name for rabies vaccine	The body builds up immunity through this vaccine for the disease rabies.
Vaccination does not guarantee complete resistance to a disease	Complete immunity occurs when the person fully recovers from the disease.
Usually, if mutation happens to microbes, it might render the vaccine ineffective (this is the reason why common cold has no vaccine)	Similarly, variations of a disease impact the body's ability to generate an immune response.


Class : 9th Science
Chapter- 13: Why Do We Fall ill
Why Do We Fall ill
Causes of diseases
Deficiency
Rest (Physical Mental)
Nutrient
Sunlight air, water
Injury
physical injury cellular damage
Emotional stress
Radiation
Toxicity
Exogenous external
Endogenous internal
Based on causative agents
Communicable/ Infections
Parasitic worm
Bacterial
Protozoan
Viral
Fungal
Non- Communicable/ Non- Infectious
Organic/ Metabolic Disorders
Deficiency Disorders
Genetic Disorders
Based on duration
Acute
Chronic
Based on medium
Airborne
Waterborne
STD
Vector (Animals/ Insects)
prevention of infectious disease
Availability of sufficient and balanced diet
Maintaining public health & hygiene
Immunization
Safe Drinking
Clean
Spacious Conditions for

Important Question

Multiple Choice Questions:

1. Which one of the following is not a viral disease?
   (a) Dengue
   (b) AIDS
   (c) Typhoid
   (d) Influenza
2. Which one of the following is not a bacterial disease?
   (a) Cholera
   (b) Tuberculosis
   (c) Anthrax
   (d) Influenza
3. Which one of the following causes Kala-azar?
   (a) Ascaris
   (b) Trypanosoma
   (c) Leishmania
   (d) Bacteria
4. AIDS cannot be transmitted by:
   (a) sexual contact
   (b) hugs
   (c) breastfeeding
   (d) blood transfusion
5. Which one of the following diseases is not caused by bacteria?
   (a) Typhoid
   (b) Anthrax
   (c) Tuberculosis
   (d) Malaria
6. Viruses, which causes hepatitis are transmitted through:
   (a) air
   (b) water
   (c) food
   (d) personal contact
7. The name of bacterial disease is
   (a) Ringworm
   (b) Measles
   (c) Typhoid
   (d) Malaria
8. T.B. (Tuberculosis) is caused by:
   (a) Vibrio Cholerae
   (b) Mycobacterium tuberculosis
   (c) HIV virus
   (d) Salmonella typhi (bacteria)

Very Short Question:

1. What are infectious or communicable diseases?
2. What are congenital diseases?
3. Give one local and one general effect of the inflammation process.
4. Name the organism causing the following diseases:
   (a) Kala-azar
   (b) Sleeping sickness
5. It was diagnosed that a patient has lost the power of fighting any infection.
   (i) Name the disease the patient is suffering from.
   (ii) Name the pathogen responsible for the disease.
6. What is immunity?
7. The diseases which can be prevented by using vaccines.
8. What are principles of treatment of a disease?
9. How do children in many parts of India get immune to hepatitis-A by the time they are five year old?
10. Name the causative organisms of tuberculosis and cholera.

Short Questions:

1. What are the differences between acute and chronic diseases?
2. What is a pandemic disease? Give one example.
3. Mention the symptoms because of which you will visit a doctor and why?
4. Why is DPT called triple antigen?
5. What are the symptoms shown by a person if the
   (i) lungs get infected?
   (ii) stomach is infected?

6. "In our country majority of children are already immune to hepatitis A without giving its vaccine to them." Justify this statement giving reasons.
7. List any four factors that must be taken care of by an individual for keeping good health.
8. Why are antibiotics effective against bacteria?

Long Questions:

1. Write a note on plant tissues.
2. Show the types of animal tissues using flow chart.
3. What is connective tissue? Explain its types.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Cell plays vital role in the body.

   Reason: Cell is the basic unit of body structure.
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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: cell plays vital role in the body.

   Reason: cell is the basic unit of wall making.

Case Study Questions:

1. There are many tissues in the body. These tissues make up physiological systems or organ systems that carry out body functions. Each of the organ systems has specific organs as its parts, and it has particular functions. So, the digestive system has the stomach and intestines, and it helps to digest food taken in from outside the body. The musculoskeletal system, which is made up of bones and muscles, holds the body parts together and helps the body move. When there is a disease, either the functioning of one or more systems of the body will change for the worse. These changes give rise to symptoms and signs of disease. Symptoms of disease are the things we feel as being 'wrong'. Such as headache, cough, loose motions, a wound with pus these are all symptoms. These indicate that there may be a disease, but they don't indicate what the disease is. For example, a headache may just stress or very rarely it may mean meningitis, or any one of a dozen different diseases.

The manifestations of disease will be different depending on a number of factors. Some diseases last for only very short periods of time, and these are called acute diseases. We all know from experience that the common cold lasts only a few days. Other ailments can last for a long time, even as much as a lifetime, and are called chronic diseases. An example is the infection causing elephantiasis, which is very common in some parts of India.

(i) Which of the following is the function of musculoskeletal system?

(a) Digest food taken in from outside the body

(b) Holds the body parts together

(c) Helps the body move

(d) Both b & c

(ii) Which of the following is the function of Digestive system?

(a) Digestion of food

(b) Holds the body parts together

(c) Helps the body move

(d) Both b & c

(iii) Diseases that last for only very short periods of time are termed as:

(a) Chronic Diseases

(b) Symptoms

(c) Acute Diseases

(iv) Define Acute Diseases.

(v) Define Chronic Diseases.

2. Acute and chronic diseases have different effects on our health. Any disease that causes poor functioning of some part of the body will affect our health. This is because all functions of the body are necessary for being healthy. But an acute disease, which is over very soon, will not have time to cause major effects on general health, while a chronic disease will do so.

For example, cough and cold, which all of us have from time to time. Most of us get better and become well within a week or so. And there are no lasting effects on our health.

When we get infected with a chronic disease such as tuberculosis of the lungs, then being ill over the years does make us lose weight and feel tired all the time. We are likely to have prolonged general poor health if we have a chronic disease. Chronic diseases have very drastic long-term effects on people's health as compared to acute diseases.

(i) Which of the following is the example of chronic disease?

(a) Cold

(b) Cough

(c) Tuberculosis

(d) All of the above

(ii) Identify correct statement given below,

Statement 1 – Chronic diseases have very drastic long-term effects on health.

Statement 2 – Acute diseases does not cause major effects on general health.

Statement 3 – Chronic diseases last for only very short periods of time.

Statement 4 – Acute diseases last for very long periods of time.

(a) Both 1 & 2

(b) Only 1

(c) Both 3 & 4

(d) All of the above

(iii) Which of the following is the example of acute disease?

(a) Cold & Cough

(b) Tuberculosis

(c) Both a & b

(d) None of the above

(iv) What is the distinguishing feature of Acute Diseases?

(v) What is the distinguishing feature of Chronic Diseases?

Answer Key

Multiple Choice Answers:

1. (c) Typhoid
2. (d) Influenza
3. (c) Leishmania
4. (b) hugs
5. (d) Malaria
6. (b) water
7. (c) Typhoid
8. (b) Mycobacterium tuberculosis

Very Short Answers:

1. **Answer:** The diseases which are caused by infectious agents are called as infectious diseases as they can spread from one person to another through some medium or by direct contact.

   Example: Pneumonia, common cold, tuberculosis, etc.

2. **Answer:** The diseases which are present in a person since birth are called congenital diseases.

   Example: colour blindness.

3. **Answer:** Swelling or pain is a local effect. Fever or headache is a general effect.

4. **Answer:**

   (a) Kala-azar is caused by Leishmania

   (b) Sleeping sickness is caused by Trypanosoma.

5. **Answer:**

   (i) AIDS.

   (iii) HIV is the causative organism of AIDS. [HIV-Human immunodeficiency virus]

6. **Answer:** The ability of the body of a person to fight against the disease causing organisms is called immunity. Name any disease that can be prevented by using vaccines.

7. **Answer:** The diseases which can be prevented by using vaccines are polio, small pox, diphtheria, tetanus, measles, etc.
8. **Answer:**
   - The principles of treatment are:
   - reducing the effects of the disease.
   - to kill the cause of the disease.
9. **Answer:** The children become immune to hepatitis A virus as they are exposed to hepatitis A virus present in the water they drink.
10. **Answer:**
    - Tuberculosis: Caused by bacterium called as Mycobacterium tuberculosis.
    - Cholera is caused by a bacterium called as Vibrio cholera

Short Answer:

1. **Answer:**

   Acute disease: The disease which lasts for only very short periods of time is called acute disease.

   They get over soon and do not get much time to affect the health more adversely. Example: Common cold

   Chronic disease: The disease which can last for a long time, even as much as a lifetime is called chronic disease.

   They have a long-term effect on the health of a person. Example: Elephantiasis
2. **Answer:** The disease which affects the health of human population all over the world is called a pandemic disease. For example, AIDS.
3. **Answer:** High fever, headache, tiredness, loose motion, cough and cold, loss of appetite and body weight are some of the symptoms for which we will visit a doctor because the doctor would be able to ascertain the disease caused on the basis of the symptoms produced and give medication accordingly.
4. **Answer:** DPT is called as triple antigen as it affects three antigens to produce the antibodies against them. The diseases are: Diphtheria, Pertussis and Tetanus.
5. **Answer:**

   (i) Cough, breathlessness, tiredness are the symptoms produced if the lungs of a person get affected by a disease.

   (ii) Loose motion, vomiting and stomach-ache are the symptoms produced when the stomach of a person gets affected by a disease.
6. **Answer:** Majority of the children are already exposed to the hepatitis A virus by the time they are five years old because the water which the children generally drink contains the hepatitis A virus. The immune system thus helps to develop immunity against the virus.
7. **Answer:** The four factors which must be taken care by an individual for keeping good health are:

   Proper nourishing balanced diet

   Clean and hygienic environment

   Good social environment

   Proper sanitation and cleanliness
8. **Answer:** Antibiotics block the biochemical pathways of the bacteria which inhibit their growth and kill them. For example: Penicillin blocks the pathway involved in the synthesis of cell wall which protects the bacteria. This inhibits their growth and kills them.

Long Answer:

1. **Answer:**

   (a) 'Health' is defined as a state of physical, emotional, mental and social well being of a person.

   (b) The four factors whose non availability or absence can cause disease are:

   (i) Proper nourishing food: If the person does not get proper nourishing food and a balanced diet, then disease may affect the person.

   (ii) Proper hygienic conditions and cleanliness: If the surroundings are not hygienic and the public cleanliness is ignored in a society, then the individuals living there become more prone to diseases.

   (iii) Good social conditions: The society in which the person lives should cater towards a healthy mind set of the members of the society. A bad social environment makes the individuals of the society develop an unhealthy attitude.

   (iv) Good economic conditions: Poverty is a major cause of diseases and poor economic conditions increase the chances of spread of diseases in the society due to inadequate food and unhygienic conditions.

2. **Answer:**

(a) AIDS can spread by four ways: Sexual contact, Transfusion of AIDS infected blood, use of infected syringe and from an infected mother to her baby during pregnancy or through breast feeding.

(b) Antibiotics block the biochemical pathways of the microorganism in order to inhibit their growth and kill them. But, the viruses do not employ such biochemical pathways of their own. They utilize the host machinery to multiply themselves. So, antibiotics cannot be used for the treatment of the viral diseases like AIDS.

3. **Answer:**

(a) Mode of transmission of Jaundice: Contaminated water Organ affected by Jaundice: Liver

(b) Access to pure drinking water can prevent jaundice.

(c) Most of the children of India are already exposed to the hepatitis A virus through the drinking water and their immune system helps to develop immunity against the disease by the time they are five years old. So, it is not necessary to give them the hepatitis A vaccine.

Assertion Reason Answer:

1. (b) Both Assertion and Reason are correct, and reason is not the correct explanation for assertion.

2. (c) Assertion is true but Reason is false.

Case Study Answers:

1. (i) (d) Both b & c

(ii) (a) Digestion of food

(iii) (c) Acute Diseases

(iv) Diseases that last for only very short periods of time are called as Acute Diseases

(v) Diseases that last for long period of time, even as much as a lifetime are called as Chronic Diseases.

2. (i) (c) Tuberculosis

(ii) (a) Both 1 & 2

(iii) (a) Cold & Cough

(iv) Distinguishing feature of Acute Diseases :

- Acute diseases last for very short period of time.
- Acute diseases does not cause major effects on general health.
- Example – Cold and cough.

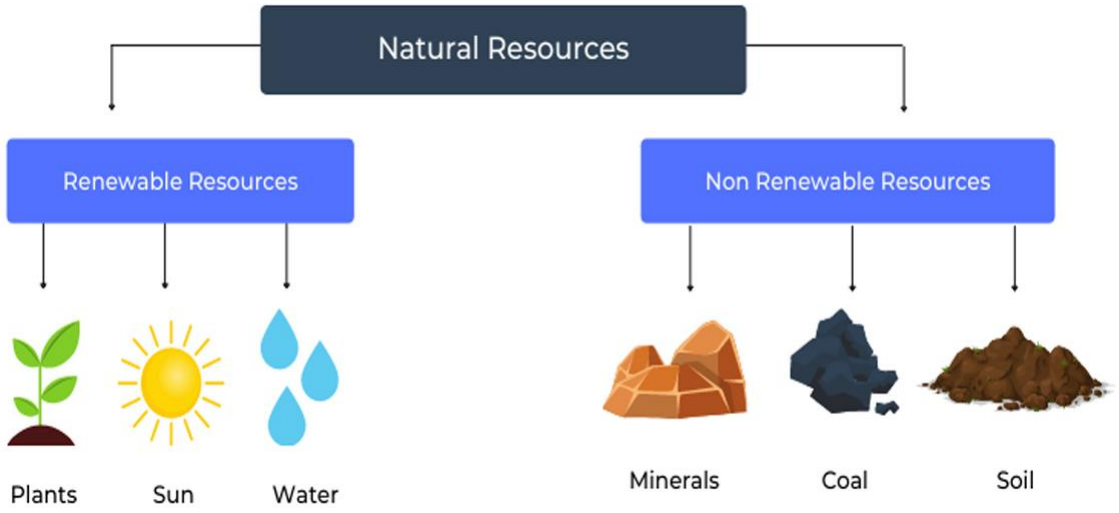
(v) Distinguishing feature of Chronic Diseases :

- Chronic diseases last for very long periods of time.
- Chronic diseases does cause major effects on health.

Example – Tuberculosis.

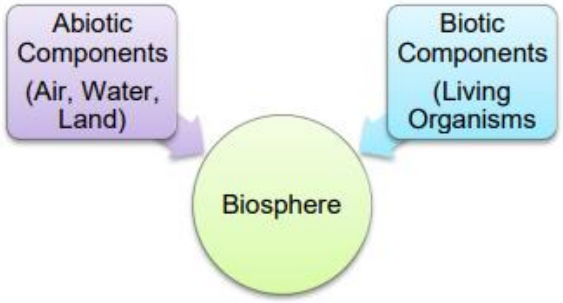
Natural Resources 5

- Natural resources are substances found in nature which can be used by human beings to fulfil their necessities.



- The biosphere is the region of the Earth where the lithosphere, hydrosphere and atmosphere interact, making life on Earth possible.

Physical Divisions of the Biosphere	Description
Lithosphere	• Outer crust of the Earth. • Also known as land. • Its upper weathered part forms soil.
Hydrosphere	• Water component of the Earth—water present on the Earth's surface and underground. • 75% of the Earth's surface is occupied by water.
Atmosphere	• Blanket of air which covers the Earth is called the atmosphere.



Air

Air is a mixture of gases such as nitrogen, oxygen, carbon dioxide, other gases and water vapour.

Eukaryotes and prokaryotes use oxygen to break down glucose and release carbon dioxide.

Human activities such as combustion of coal and burning of fuel use oxygen and release carbon dioxide.

The amount of carbon dioxide in the atmosphere is very low and it is maintained in two ways:

Green plants convert carbon dioxide into glucose in the presence of sunlight.

Marine animals use carbonates dissolved in seawater to make their shells.

Significance of the Atmosphere

(A) Role of the Atmosphere in Climate Control

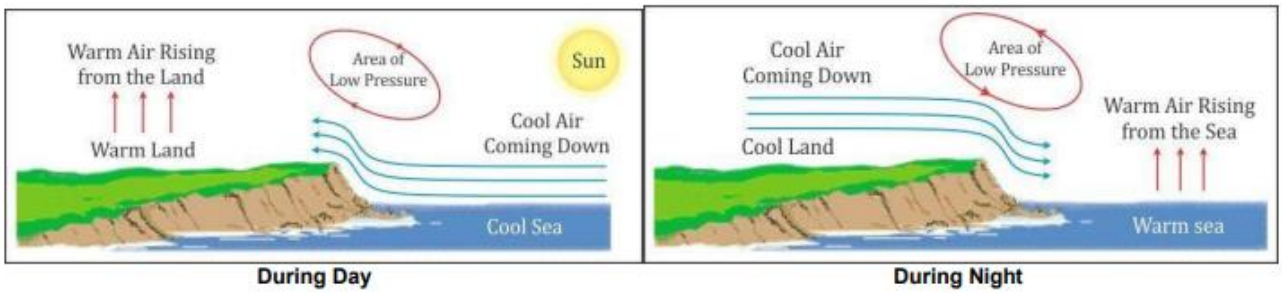
- Air is a bad conductor of heat.
- It keeps the average temperature of the Earth steady during the day and throughout the whole year.
- The atmosphere prevents sudden increase in temperature during daylight hours.
- During the night, the atmosphere slows down the escape of heat into space.
- The Moon does not have an atmosphere. The temperature on the Moon ranges between –190°C and 110°C. In the daytime, the temperature rises to 110°C, and at night, it cools down to –190°C.

(B) Winds: Movement of Air

- The movement of air from one region to another creates wind.

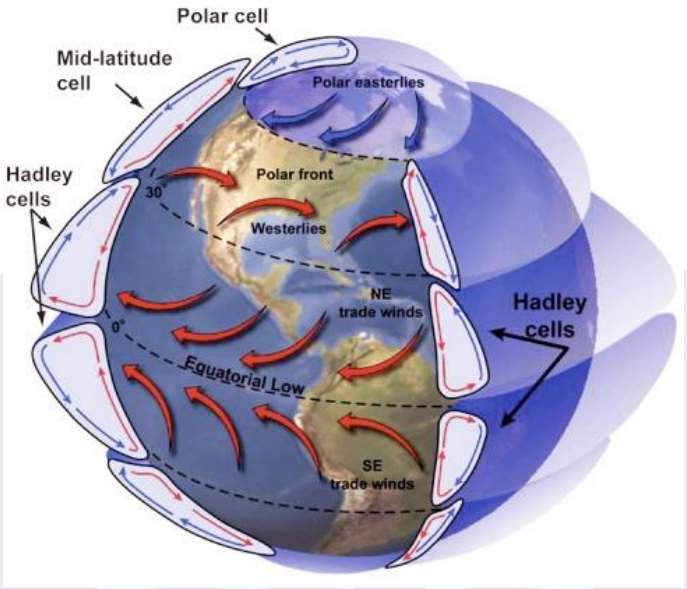
Air Movement in Coastal Areas

In daytime, there is a regular flow of cool air from the sea towards the land, while during the night, air starts flowing from the land towards the sea.



During Day | During Night

Wind Belts



- Temperature differences across the Earth develop major **wind belts**.
- These wind belts define the climate zones of the world.

Factors Influencing Movements of Air

1. Uneven heating of land at different regions of the Earth
2. Differences in heating and cooling of land and water bodies
3. Vaporisation and condensation of water vapour
4. Rotation of the Earth
5. Presence of mountain ranges in the path of wind
6. Differences in topography over which wind passes

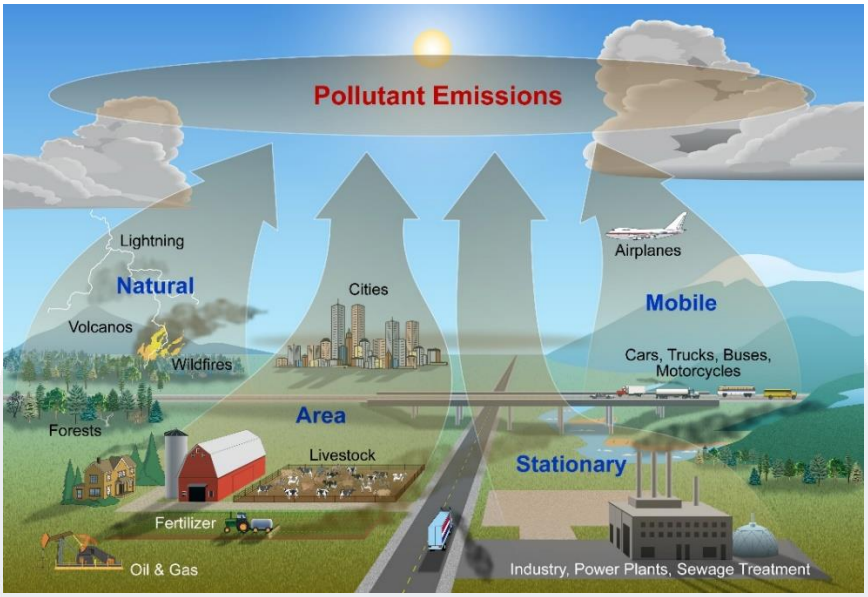
(C) Rain

- A large amount of water evaporates into the air when the water bodies get heated because of solar radiations.
- The air carrying water vapour gets heated and rises, expands and cools forming clouds.
- As more condensation occurs, the droplets grow and become heavy, and they fall in the form of rain.
- When the temperature of air is very low, precipitation occurs in the form of snow, hailor sleet.

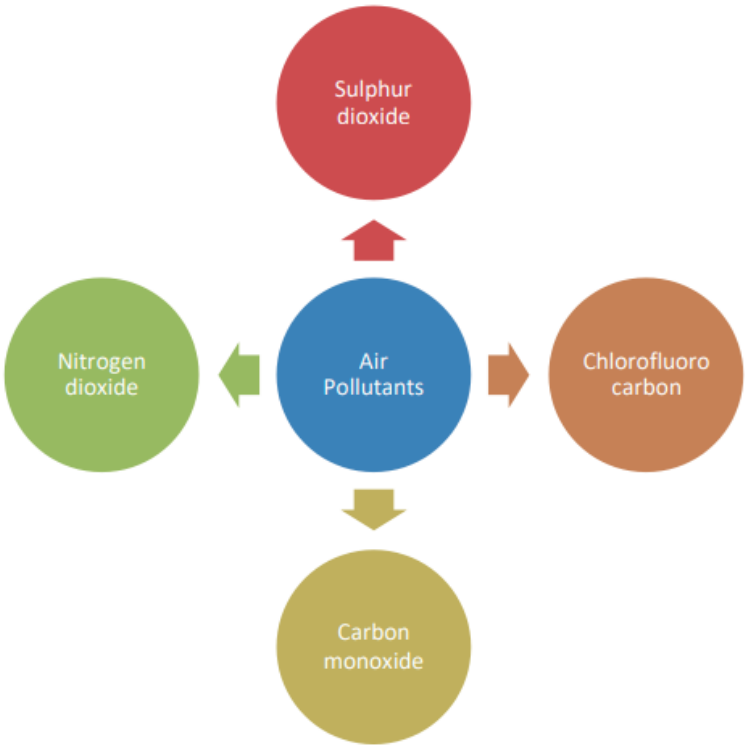
Rainfall Pattern

- Prevailing wind patterns decide rainfall patterns.
- In large parts of India, the rainfall is brought by the south-west or north-east monsoons.

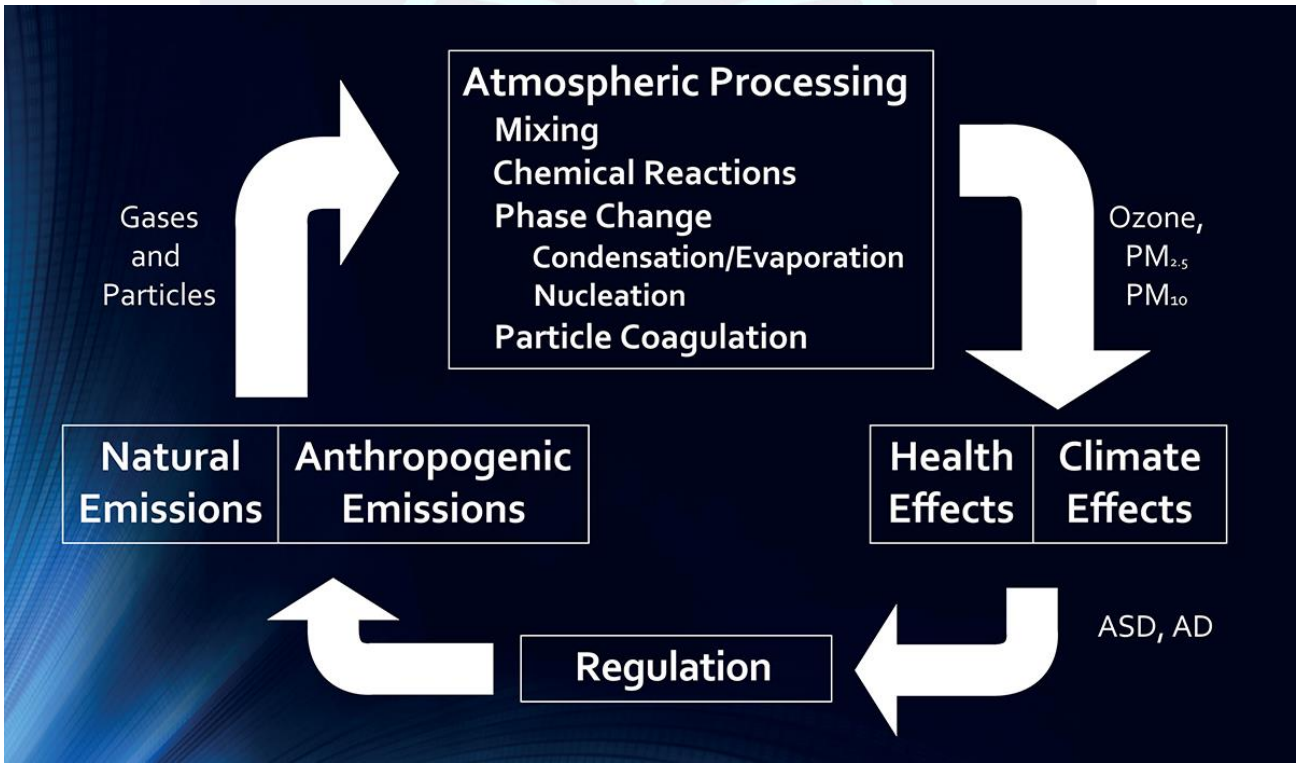
(D) Air Pollution Sources



Some Major Pollutants



Effects of Air Pollution



Oxides of sulphur and nitrogen react with rain water and result in acid rain.

Suspended particles of pollutants react with heat and sunlight causing low visibility, i.e. smog.

Increased concentration of greenhouse gases such as CO_2 in the atmosphere prevents escape of heat from the Earth into space leading to global warming.

Release of CFC through air conditioners and refrigerators causes ozone depletion which may cause skin cancer and skin diseases.

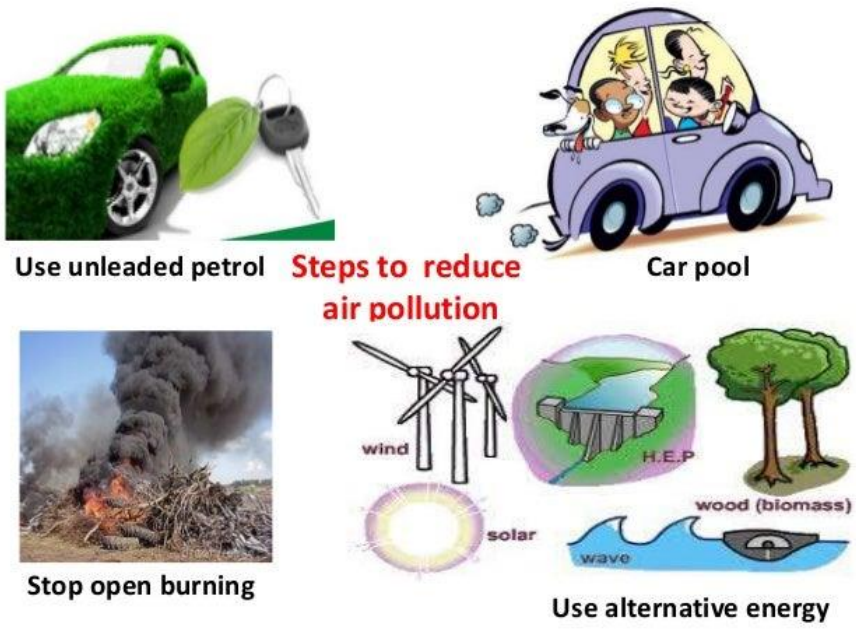
DID YOU KNOW ?

16 September is celebrated as 'International Ozone Day'.

FACT !

In 1952, approximately 12,000 people died in the London smog episode.

Prevention of Air Pollution

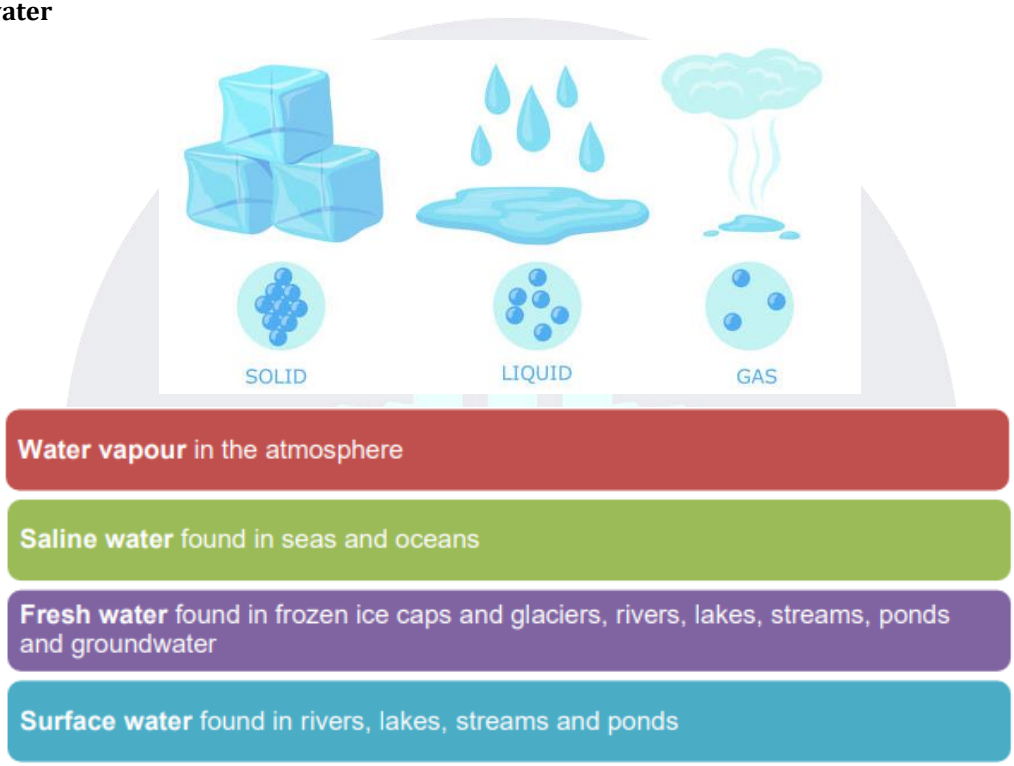


• Minimise the use of fuels such as petrol and diesel. Use a cleaner source such as compressed natural gas (CNG).
• Regular emission testing for vehicles (e.g. PUC test for automobiles).
• Industries must have tall chimneys with electrostatic precipitators and filters.
• Garbage and plastics should not be burnt.
• Nuclear wastes should be disposed of safely.
• Fines and penalties should be enforced for those who break laws amended to control air pollution.

Water

Water is inexhaustible and the most important resource on the Earth.

Forms of water



- When rain falls, water percolates into the ground through soil particles which is called **groundwater**.

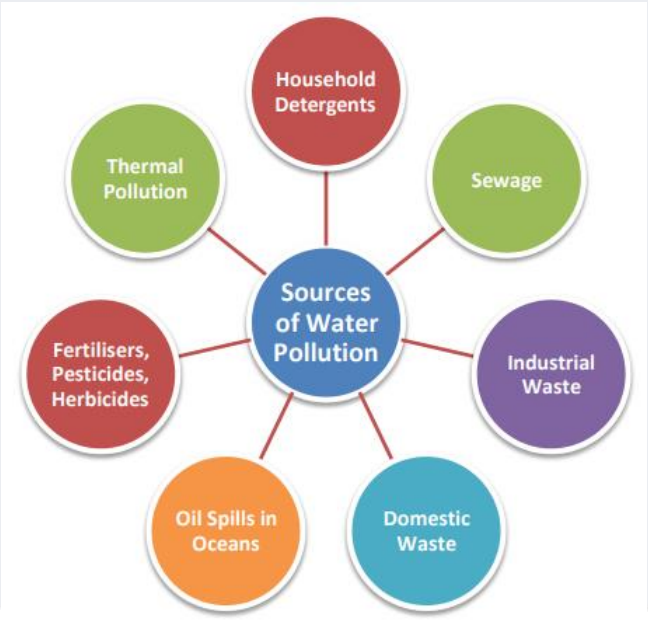
Significance of Water

- Water is essential for the maintenance of life.
- It plays an important role in the formation of soil.
- It is a living medium for many organisms.
- Humans use water for drinking, washing utensils and clothes, sewage disposal, agriculture etc.
- All cellular processes and metabolic reactions require water.
- Water is the medium through which substances are transported within the body.

Water Pollution

Water pollution is the contamination of water sources such as rivers, lakes, oceans and groundwater.

Sources of Water Pollution



Effects of Water Pollution

- Polluted water becomes unsuitable for drinking and for other uses.
- Toxic substances enter the food chains and get concentrated at each successive trophic level in the food chain. This is called biomagnification.
- Sewage carries disease-producing microorganisms which may cause water borne diseases such as cholera, dysentery, jaundice, typhoid, diarrhoea etc.
- Microorganisms present in polluted water depletes its oxygen content resulting in the death of aquatic organisms.
- Mixing of fertilisers in water sources cause algal growth called eutrophication which results in less oxygen supply to aquatic organisms resulting in their death.
- Oil spills result in choking of the respiratory system of organisms causing their death.

Prevention of Water Pollution

Sewage, industrial waste and domestic waste should be treated to make them harmless before they are released into water bodies.
Use of chemical pesticides must be minimised.
Use of biofertilisers should be encouraged.
Washing of utensils and clothes and bathing of cattle in water bodies must be avoided.
Garbage and other domestic waste should not be thrown in water bodies.
Leakage of drainage pipes must be prevented.
Awareness must be created among students and adults about the severity of water pollution.
Laws should be formulated to control water pollution. Penalties should be enforced for those who break the law.

Soil

Soil is the part of the Earth's crust which consists of disintegrated rocks and decaying organic matter. When soil loses its plant cover, it is exposed to wind and rain. It gets blown away or washed away rapidly. This condition is known as soil erosion.

Formation of Soil

1. The Sun	• Rocks expand because of heat energy from the Sun. • At night, rocks cool down and contract. • Expansion and contraction of rocks are not simultaneous which results in the formation of cracks in the rocks. • When the cracks grow further, rocks break into small pieces.
2. Water	• Water gets filled in the cracks present in rocks. • At low temperature, this water freezes and expands. • Expansion of water widens the cracks in rocks. • Flowing water wears away the ground surface over which it is flowing. • Fast-flowing water always carries small pieces of rocks. • These small rocks, or pebbles, rub against rock surfaces gradually causing soil to form from the rocks.
3. Wind	• Strong winds strike the surface of rocks and erode or break them.

4. Biological Weatherig	• Lichens grow on rock surfaces and extract minerals. • This creates crevices on rocks in which a thin layer of soil gets filled. • Mosses grow on this soil. • They deepen the crevices, and cracks are formed.
	• Roots of plants grow deep in the ground in search of nutrients and water. • As the roots grow, they form cracks in the rocks and eventually break them.

Soil Profile

A soil profile represents the vertical section of the Earth's crust.

It is made of horizontal layers of soil which vary in thickness, colour, texture, porosity and composition.

- The topmost layer of the soil which contains humus and living organisms is called the **topsoil**.
- Humus is a major factor which decides the structure of the soil.
- Humus makes the soil more porous and aerated, and increases its water-holding capacity.

Soil Pollution

The contamination of soil which reduces its quality and fertility is called soil pollution.

Sources of Soil Pollution

Effects of Soil Pollution

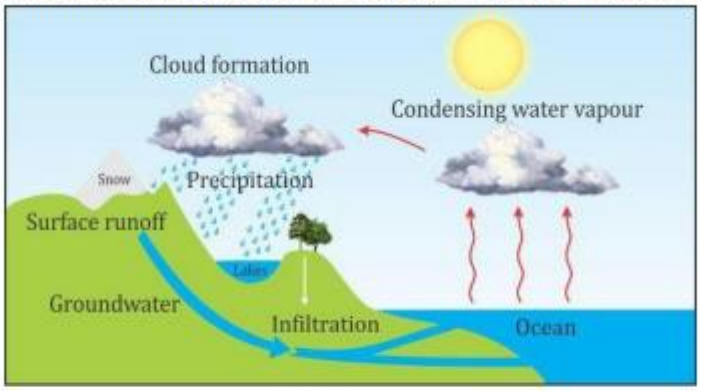
Pesticides such DDT enter food chains and affect organisms at each trophic level.

Chemicals present in liquid waste acumulates in the soil and reduces the soil fertility.

Agricultural waste becomes a breeding ground for organisms which may harm the crops.

Prevention of Soil Pollution

Avoid overuse of pesticides and fertilisers. Use of biofertilisers must be encouraged.

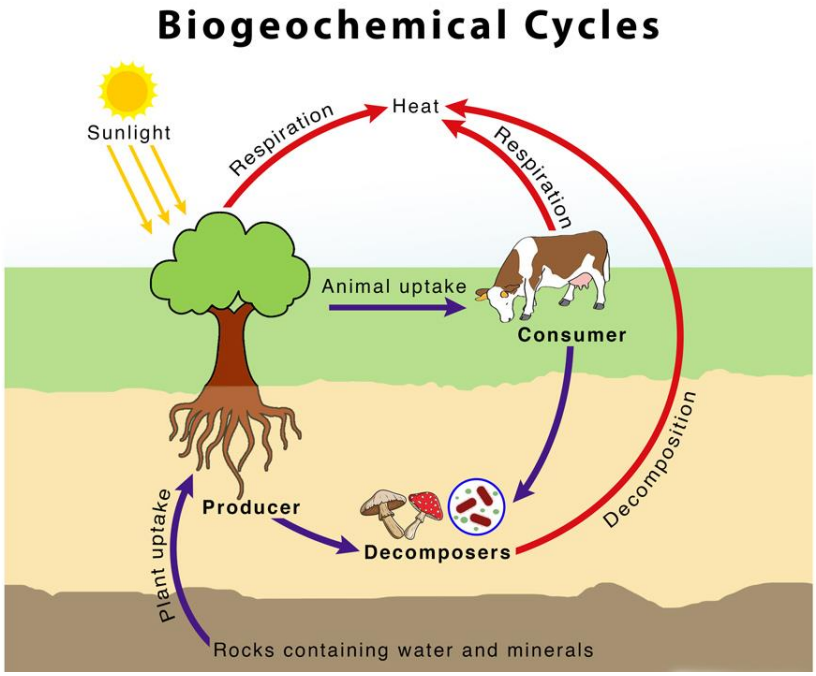


Water cycle

Plastic bags, glass and metal cans must be recycled.

Plant and animal waste can be converted into manure.

Biogeochemical Cycle

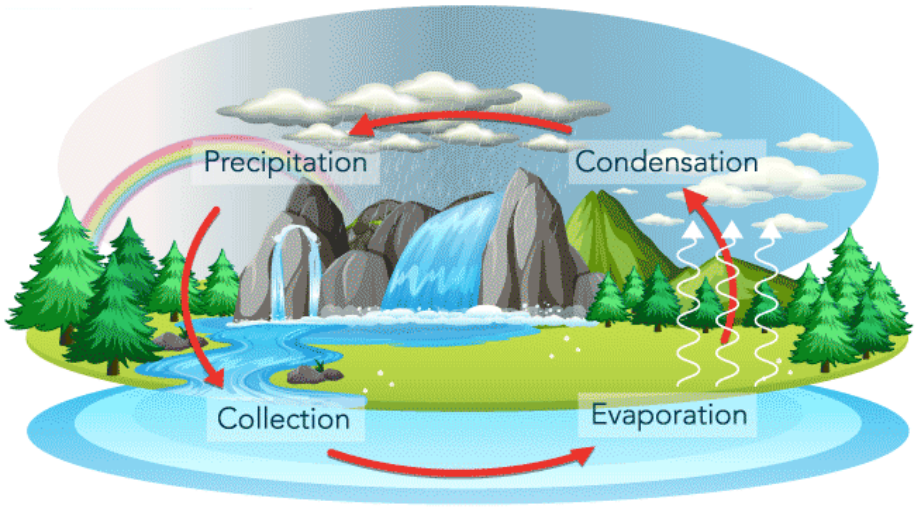


Biotic and abiotic components interact with each other to form a stable system.

Living organisms require various nutrients for their growth and metabolism which are derived from the lithosphere. These nutrients are called biogeochemicals.

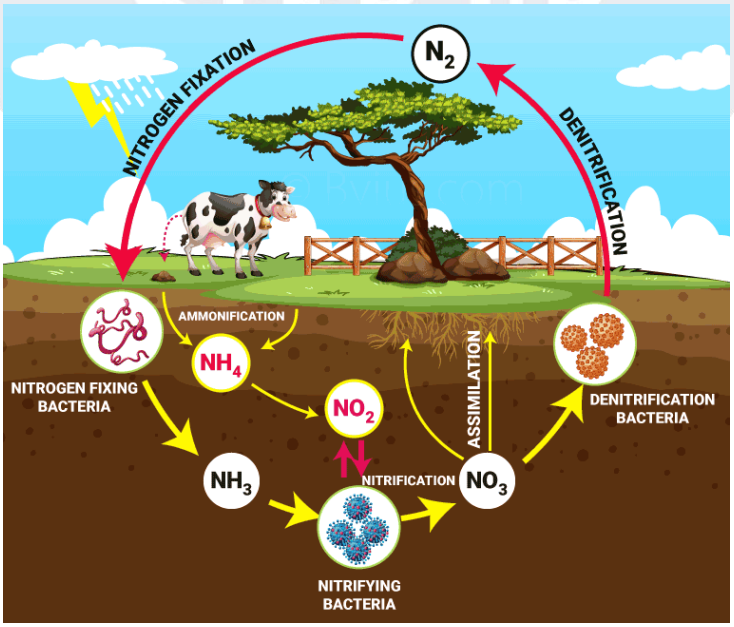
The biogeochemicals are constantly recycled between biotic and abiotic components. This circulation of biogeochemicals in the biosphere is called a biogeochemical cycle.

(A) Water Cycle



- There is constant exchange of water between the air, land and sea.
- The exchange of water also occurs between living organisms and their environment.
- During the water cycle, water gets evaporated from water bodies and falls on the Earth in the form of rain.
- Some water becomes part of the groundwater reservoir, some amount of water becomes part of the springs, some is used by living beings and some meets the sea through rivers.

(B) Nitrogen Cycle

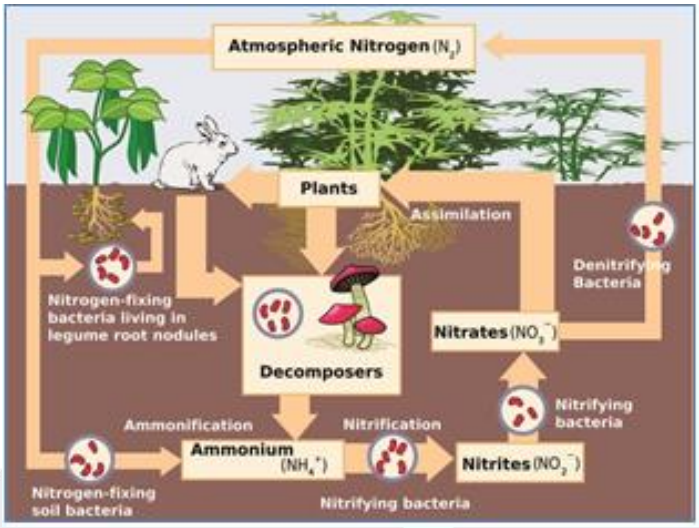


- Nitrogen is an important nutrient present in proteins, amino acids and nucleic acids.
- Although nitrogen is required by living organisms, it cannot be used when available in its free state.
- Nitrogen is converted into a usable form by the process of **nitrogen fixation**.

Nitrogen Fixation

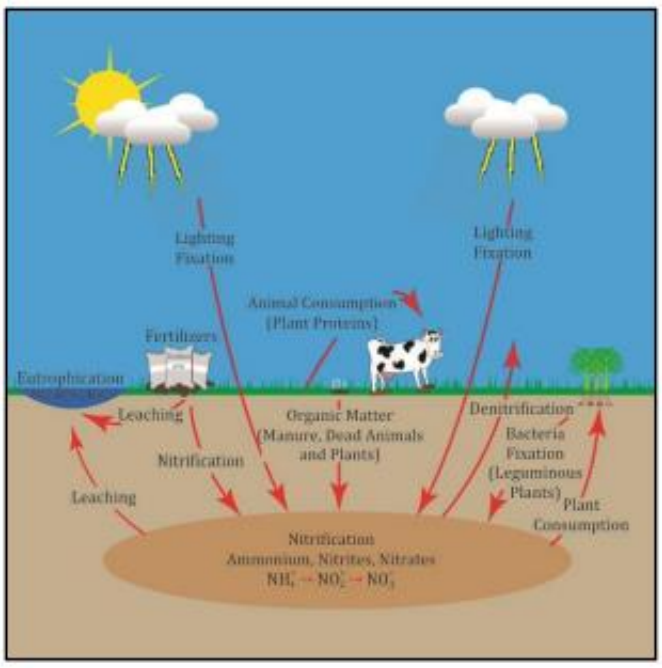
Biological Process

- Nitrogen-fixing bacteria convert atmospheric nitrogen into nitrites and nitrates which are used by plants.
- Secondary and tertiary consumers get nitrogen from plants.



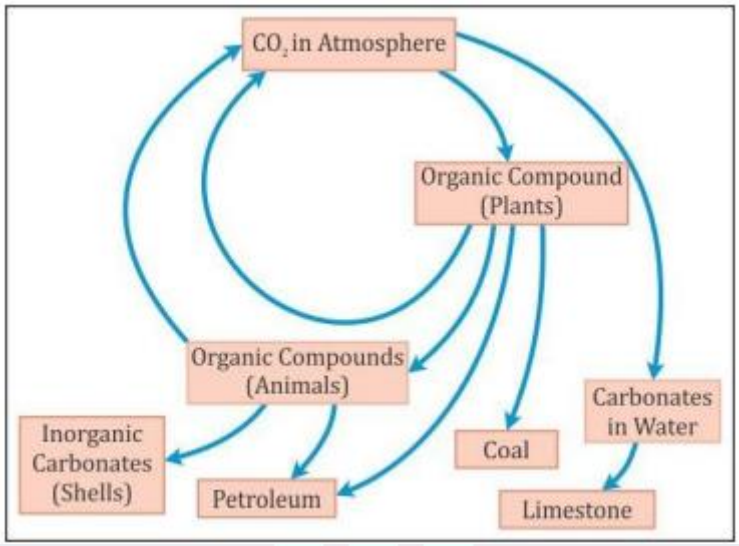
Physical Process

- During lightning, atmospheric nitrogen react with oxygen and forms dilute nitric acid.
- This nitric acid comes down to the Earth during rainfall.
- Plants use nitric acid to form nitrates, which are further used to synthesise proteins.
- When plants and animals die or when animals excrete urea and uric acid, certain bacteria carry out ammonification.
- Plants can assimilate these ammonium ions, or bacteria further convert them into nitrate ions by nitrification.
- Some bacteria, such as pseudomonas, convert nitrates into nitrogen, ammonia or oxides of nitrogen. This process is called denitrification.
- Free nitrogen is released in the atmosphere, while oxides are used up by plants.



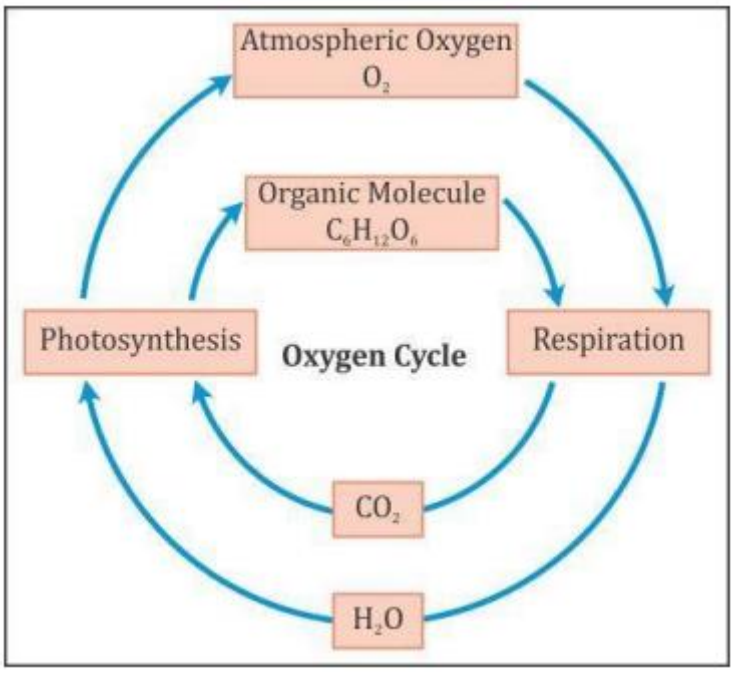
Carbon Cycle

- Carbon is an important constituent found in all living organisms in the form of carbohydrates, proteins, fats and nucleic acids.
- Carbon dioxide is used by plants for photosynthesis.
- It is released by living organisms during respiration.
- It is also released during the burning of fossil fuels and volcanic eruptions.



Oxygen Cycle

- Oxygen constitutes about 21% of the total atmosphere.
- Living organisms require oxygen for respiration.
- During photosynthesis, oxygen is released in the atmosphere.
- Oxygen is also released during the process of decomposition of dead matter by bacteria.
- It is also present in the form of ozone in the atmosphere.
- Ozone absorbs the harmful ultraviolet radiations from the Sun and protects life on Earth.



Class : 9th Science
Chapter- 14: Natural Resources

Combustion
When organic substance burns in air O_2 produce Co_2
$C+O_2 = Co_2$

Respiration
All livings take in O_2 and produce Co_2

Air: The breathe of life

Natural Resources

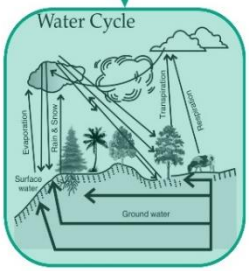
Air pollution
Eiffects: Affect respiratory system and causes diseases and skin allergies

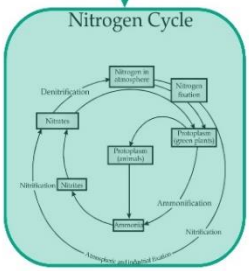
Water pollution
Eiffects: Addition of undesirable substances and removal of desirable substances, disturbance in ecological balance

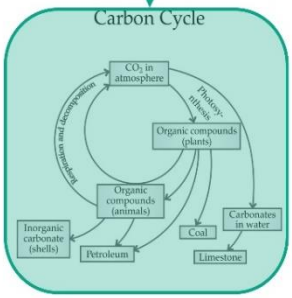
Soil pollution
Eiffects: Food Crops affected adversely by and healthy nutrients are not available in the crop yield

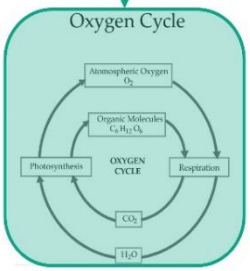
Ozone Layer O_3
- Triatomic module of oxygen O_3
- Depleted by CFCs, that Cause uv radiations from the sun to reach earth
- Effects: cause cataract, cancer damage of immune system, smog formation etc.

Biogeochemical Cycles









Important Question

Multiple Choice Questions:

1. What is the constitution of nitrogen in our atmosphere?
   (a) 28
   (b) 78
   (c) 55
   (d) 92
2. Which of the following bacteria is responsible for nitrogen fixation?
   (a) Pseudomonas
   (b) Nitrosomonas
   (c) Rhizobium
   (d) None of these
3. One of the following factors does not lead to soil formation in nature.
   (a) The sun
   (b) Water
   (c) Wind
   (d) Polythene bags
4. Which step is not involved in the carbon cycle?
   (a) Photosynthesis
   (b) Transpiration
   (c) Respiration
   (d) Burning of fossil fuels
5. The main function of the Rhizobium bacteria is:
   (a) To convert free nitrogen into nitrates
   (b) To convert the nitrates into nitrogen
   (c) Decomposition of ammonium salts
   (d) Denitrification
6. Soil pollution mostly occurs by:
   (a) Water
   (b) Fertilizers and insecticides
   (c) Mining
   (d) Crops
7. What is the percentage constitution of carbon dioxide in the atmosphere of Venus and Mars?
   (a) 95 – 97%
   (b) 20 – 22%
   (c) 35 – 40%
   (d) 70 – 72%
8. Oxygen is found in the elemental form in the atmosphere to the extent of:
   (a) 78%
   (b) 38%
   (c) 21%
   (d) 95%

Very Short Question:

1. What are the resources available on Earth for life to exist?
2. Name the compound of carbon responsible for the ozone hole in the atmosphere.
3. State the temperature range on the surface of the moon.
4. State any one difference between oxygen and ozone.
5. Name the stage in the life cycle of aquatic animals which is affected by a change in temperature.
6. Along with the natural resources available on the Earth, what else is required to meet the basic requirements of all life forms on the Earth?
7. How is biosphere a dynamic and stable system?
8. How do forests play a major role in maintaining the water cycle?
9. Why is step farming done in hills?
10. Why are root nodules useful for plants?

Short Questions:

1. What are the sources of oxygen in the atmosphere?
2. What causes winds?
   List any two methods of preventing soil erosion.
3. List the importance of oxygen gas and ozone gas in the atmosphere.
4. Mention one method by which living organisms influence the formation of soil.
5. Explain the occurrence of land breeze in coastal areas.
6. What are the two ways in which carbon dioxide is fixed in the environment?
7. Why do terrestrial forms require freshwater?
   Give two examples where freshwater can be found in the frozen form on the Earth.

8. What is the role of the atmosphere in climate control?

Long Questions:

1.

- Make a neat and labelled sketch of the nitrogen cycle in nature.
- Describe in brief the role of nitrogen-fixing bacteria and lightning in fixing nitrogen.

2. Explain the role of the atmosphere as a blanket. List the factors deciding the rainfall patterns.

3.

- Many municipal corporations are trying water harvesting to improve the availability of water. Give reason.
- Rainwater sometimes contains traces of acid. Why? Explain in brief.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Earth's large area covered with the different forms of water.

   Reason: More amount of water present on earth surface as well it also found in the form of ice.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Earth's large area covered with the different forms of water.

   Reason: All plants need water hence water quantity is high on earth.

Case Study Questions:

1. Nitrogen gas makes up 78% of our atmosphere and nitrogen is also a part of many molecules essential to life like proteins, nucleic acids (DNA and RNA) and some vitamins. Nitrogen is found in other biologically important compounds such as alkaloids and urea too. Nitrogen is thus an essential nutrient for all life-forms and life would be simple if all these life-forms could use the atmospheric nitrogen directly. Most commonly, the nitrogen-fixing bacteria are found in the roots of legumes (generally the plants which give us pulses) in special structures called root nodules. Other than these bacteria, the only other manner in which the nitrogen molecule is converted to nitrates and nitrites is by a physical process. During lightning, the high temperatures and pressures created in the air convert nitrogen into oxides of nitrogen. These oxides dissolve in water to give nitric and nitrous acids and fall on land along with rain. These are then utilised by various life forms.

Plants generally take up nitrates and nitrites and convert them into amino acids which are used to make proteins. These proteins and other complex compounds are subsequently consumed by animals. Once the animal or the plant dies, other bacteria in the soil convert the various compounds of nitrogen back into nitrates and nitrites. Thus, there is a nitrogen-cycle in nature in which nitrogen passes from its elemental form in the atmosphere into simple molecules in the soil and water, which get converted to more complex molecules in living beings and back again to the simple nitrogen molecule in the atmosphere.

(i) How much Nitrogen is present in our atmosphere?

(a) 76 %

(b) 77 %

(c) 78 %

(d) 79 %

(ii) Identify the correct statement:

Statement 1 – Nitrogen is an essential nutrient for all life-forms and life.

Statement 2 – all life-forms use the atmospheric nitrogen directly.

Statement 3 – Nitrogen is a part of DNA & RNA

Statement 4 – Our atmosphere have 79 % nitrogen.

(a) Both 1 & 2

(b) Both 1 & 3

(c) Both 3 & 4

(d) All of the above

(iii) Plants use nitrates and nitrites and convert them into:

(a) Vitamins

(b) Enzymes

(c) Amino acids

(d) Nitrogen

(iv) What is the main function of root nodules in legume plants?

(v) Explain the physical process by which nitrogen molecule is converted to nitrates and nitrites?

2. Oxygen is a very abundant element on our Earth. It is found in the elemental form in the atmosphere to the extent of 21%. It also occurs extensively in the combined form in the Earth's crust as well as also in the air in the form of carbon dioxide. In the crust, it is found as the oxides of most metals and silicon, and also as carbonate, sulphate, nitrate and other minerals. It is also an essential component of most biological molecules like carbohydrates, proteins, nucleic acids and fats (or lipids).

When we talk of the oxygen-cycle, we are mainly referring to the cycle that maintains the levels of oxygen in the atmosphere. Oxygen from the atmosphere is used up in three processes, namely combustion, respiration and in the formation of oxides of nitrogen. Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis. And this forms the broad outline of the oxygen-cycle in nature.

Though we usually think of oxygen as being necessary to life in the process of respiration, it might be of interest to you to learn that some forms of life, especially bacteria, are poisoned by elemental oxygen. In fact, even the process of nitrogen-fixing by bacteria does not take place in the presence of oxygen.

(i) How much oxygen is present in our atmosphere?

(a) 20 %

(b) 21 %

(c) 22 %

(d) 23 %

(ii) Identify the correct statement

Statement 1 – Oxygen is also an essential component of most biological molecules.

Statement 2 – Oxygen is returned to the atmosphere through process called photosynthesis

Statement 3 – Oxygen -cycle maintains the levels of oxygen in the atmosphere.

Statement 4 – Our atmosphere have 21 % oxygen.

(a) Only 1

(b) Both 2 & 3

(c) Both 1 & 4

(d) All of the above

(iii) Oxygen from the atmosphere is used up in three main processes,

(a) Combustion

(b) Respiration

(c) Formation of oxides of nitrogen

(d) All of the above

(iv) By which process Oxygen is returned to the atmosphere

(a) Respiration

(b) Photosynthesis

(c) Photolysis

(d) None of the above

(v) Write the molecular formula of oxygen?

Answer Key

Multiple Choice Answers:

1. (b) 78
2. (c) Rhizobium
3. (d) Polythene bags
4. (b) Transpiration
5. (a) To convert free nitrogen into nitrates
6. (b) Fertilizers and insecticides
7. (a) 95 – 97%
8. (c) 21%

Very Short Answers:

1. **Answer:** Air, water and land are the resources available on the Earth which help life to exist.
2. **Answer:** Chlorofluorocarbons (CFC's) are responsible for the ozone hole in the atmosphere.
3. **Answer:** The temperature ranges from -190°C to 110°C on the moon
4. **Answer:** Oxygen is a diatomic molecule with formula 02 whereas ozone is a triatomic molecule-with formula 03.
5. **Answer:** The stage of animals which is affected by the change in the temperature is – the eggs at the hatching stage, the larvae and the young ones of the animals.
6. **Answer:** Solar energy is required to meet the basic requirements of all life forms on Earth.
7. **Answer:** There is a constant interaction between the biotic and the abiotic components of the global ecosystem (biosphere) which makes it a stable system. The basic composition and the structure of the system do not change while carrying out the various processes. So, it is a stable system.
8. **Answer:** The amount of water vapour in the atmosphere is dependent on the transpiration of water from the leaves of the plants present in a forest. Also, the storage of water in watershed is influenced by the forests. So, forests play a major role in maintaining the water cycle.
9. **Answer:** Step farming is done in hills to prevent soil erosion by slowing down the speed of the water running down the slopes.
10. **Answer:** The root nodules of leguminous plants contain nitrogen-fixing bacteria like the Rhizobium which help to increase the fertility of the soil by fixing atmospheric nitrogen.

Short Answer:

1. **Answer:**

   The sources of oxygen in the atmosphere are:

   - Oxygen released during photosynthesis by plants
   - The dissociation of oxides from their compounds
   - The disintegration of ozone in presence of UV rays
   - As the water in combined form

2. **Answer:**

   Due to the unequal heating of land and water, the land get heated up faster during the day, the air on land rises up and creates a region of low pressure. As a result, the air over the sea moves towards the region of low pressure formed on the land. This causes winds to flow.

   (a) Overgrazing by cattle should be avoided.

   (b) Large scale afforestation should be done as roots of plants prevent the soil from getting carried away.

   (c) Increasing the vegetation cover on the ground reduces the impact of flowing water on soil and prevents it from getting washed away.

   (d) Contour farming can be done by ploughing the land in furrows across the natural slope of the land to trap water flowing down.

   (e) Step farming is practised in hilly regions which reduce the flow of water and give it more time to percolate into the soil.

3. **Answer:** Role of Oxygen gas: It helps in the process of combustion, respiration and formation of many organic compounds.

   Role of Ozone: It absorbs the harmful UV rays of the Sun which can cause skin diseases and cancer on reaching the Earth's surface.

4. **Answer:** The living organisms like lichens and mosses are the initial colonisers of rocks which secrete certain chemical substances that dissolve the minerals of rock and cause the gradual weathering of rocks. The rocks get broken down into small, fine particles of soil. So, living organisms play an important role in the formation of soil.

5. **Answer:** During the day, in coastal regions, the air above land gets heated faster and warm air being lighter rises up thereby creating a region of low pressure. The air over the sea then moves towards the area of low pressure. The movement of air from one region to the other creates winds. At night, water cools down slower than the land, so the air above water would be warmer than the air above land. This causes air over the land to move towards the region of low pressure over water.

6. **Answer:** Carbon dioxide is fixed in the atmosphere when:

   Green plants utilise the carbon dioxide and convert it into glucose during photosynthesis.

   Carbon dioxide dissolved in seawater in the form of carbonates gets used up by the marine animals for the formation of their shells.

7. **Answer:** The terrestrial organisms require freshwater as they face osmotic problems if kept in marine water because they have low osmotic concentration. In order to maintain the balance of the salts present in their body, freshwater organisms require a medium having less salt concentration i.e., freshwater.

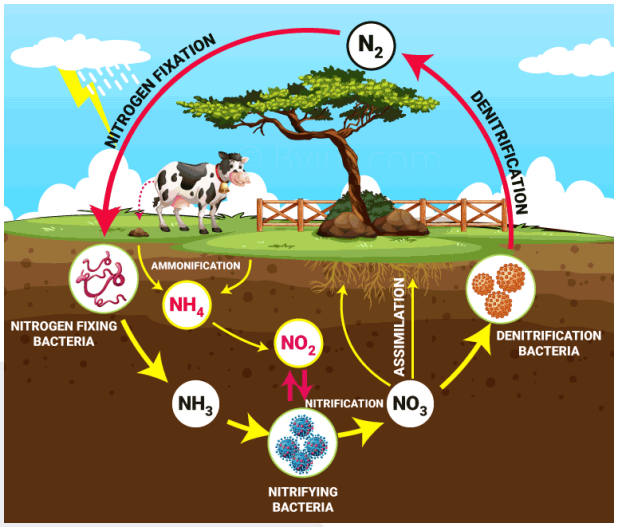
   Freshwater can be found in a frozen form at polar ice-caps and the glaciers.

8. **Answer:** The atmosphere acts as a buffer which checks excessive rise in temperature during the day and prevents excessive cooling of the Earth during the night. The atmosphere helps to keep the average temperature of the Earth steady.

Long Answer:

1. **Answer:**

   - The nitrogen cycle is:



   - The atmospheric nitrogen can be fixed in the following ways:

   By nitrogen-fixing bacteria: The nitrogen-fixing bacteria live either in a symbiotic association like the Rhizobium in the root nodules of the legumes or live freely like Azotobacter. The bacteria fix the atmospheric nitrogen into nitrates which are absorbed by the plants in soluble form and assimilated in their body.

   By lightning: Lightning has enormous energy which breaks nitrogen molecules and enables their atoms to combine with oxygen present in the air to form nitrogen oxides. These oxides dissolve in rain, form nitrates and are carried to the Earth with the rains.

2. **Answer:** The atmosphere is a blanket of air around the Earth which acts as a buffer to prevent the excessive or sudden rise of temperature during the day and also prevents excessive cooling of the Earth during the night. It slows down the escape of heat into the outer space during the night.

   Thus, the atmosphere helps to keep the average temperature of the Earth fairly steady during the day and also during the whole year. The prevailing wind patterns decide the rainfall patterns. The South-West monsoon and the North-East monsoon cause rains in large parts of India.

3. **Answer:**

- The Municipal Corporations are trying water harvesting in order to recharge the underground water reservoirs and the underground water level. This ensures the availability of water during the scarcity of rainfall or water. Rainwater harvesting involves the collection of water from surfaces on which rain falls and stores this water for later use. Generally, the water is collected from the roofs of buildings and stored in rainwater tanks.
- Combustion of fossil fuels releases oxides of nitrogen (NO_2) and sulphur (SO_2) which dissolve in rainwater to form their respective acids. These acids then fall along with rains and such rain is called acid rain. Due to the presence of such acids, the rainwater sometimes contains traces of acids.

Assertion Reason Answer:

1. (b) Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
2. (c) Assertion is true but Reason is false.

Case Study Answers:

1. (i) (c) 78 %

(ii) (b) Both 1 & 3

(iii) (c) Amino acids

(iv) Nitrogen fixation is the main function of root nodules which is one of the most important features of legumes.

(v) During lightning, the high temperatures and pressures created in the air convert nitrogen into oxides of nitrogen. These oxides dissolve in water to give nitric and nitrous acids and fall on land along with rain.

2. (i) (b) 21 %

(ii) (d) All of the above

(iii) (d) All of the above

(iv) (b) Photosynthesis

(v) Molecular formula of oxygen is: O_2

Improvement in Food Resources 6

- Plants and animals are major food sources.
- We obtain food from agriculture and animal husbandry.
- Keeping in mind the population of India, it is necessary to increase India's production efficiency of crops and livestock.
- **Sustainable management** can be defined as the adoption of various farming and production management techniques to maximise yield in agriculture and animal husbandry.
- **Agriculture** is the art and science of cultivating soil, producing crops, rearing animals for food and useful products.

Improvement in Crop Yields

Plants which are grown by man on a large scale to obtain food, clothing and other useful products are called **crops**.

Crops	Nutrients we get from crops
Cereals (wheat, maize, millet, sorghum)	Carbohydrates
Pulses (gram, pea, black gram, green gram, pigeon pea, lentil)	Proteins
Oil seeds (ground nut, soya bean, mustard, sesame castor, sunflower, linseed)	Fats
Vegetables and fruits	Vitamins and minerals

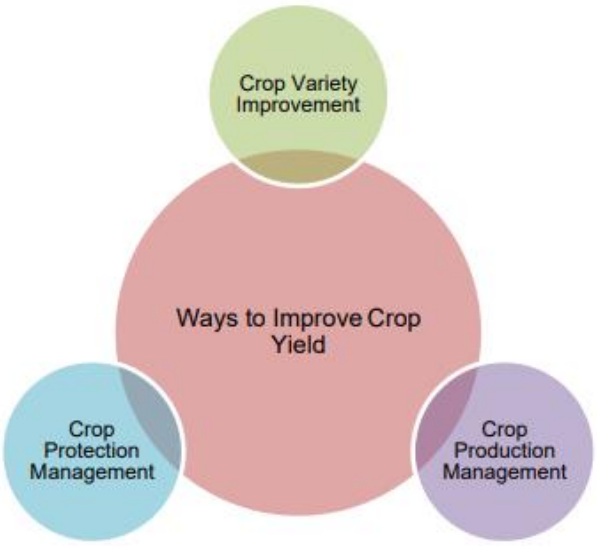
Based on the season of cultivation, crops are divided into two categories:

Kharif Crops

- They are grown in monsoon (June) and cultivated in autumn (October).
- Grown in hot and wet conditions.
- Examples: Rice, maize, tobacco, potato, onion, soyabean, millets (jowar and bajra), sugarcane, cotton, groundnut, pulses, pigeon pea

Rabi Crops

- They are grown in November and are harvested in April.
- Grown in cold and nearly dry conditions.
- Examples: Wheat, mustard, pea, barley, gram, linseed



Crop Variety Improvement

- It is the technique or the skill of selection of the best varieties of crops for various desirable characters and incorporating those characters into the crops of the next generation.

Hybridisation

It is the technique of crossing between two genetically dissimilar plants to produce a plant of a new variety. The variety produced by using this technique is called a **hybrid**.

Two ways of cross-breeding during hybridisation are:

Inter-varietal cross-breeding	•A cross between two different varities of crops
Inter-specific cross-breeding	•A cross between two different species of the same genus

The new varieties of crops obtained by hybridisation are called high-yielding varieties or **HYV seeds**. Production of HYV seeds has led to an increase in agricultural production, considerably reduced food shortage and generated more income in the agricultural sector. This is known as the Green Revolution.

Examples of hybrid varieties are:

Wheat	Hira-moti, Kalyan sona, Sonora-64
Rice	Padma, Jaya, IR-8, Pusa-205, Basmati

Genetically Modified Crops

- A gene responsible for desirable characters is transferred from one crop variety to another crop variety. The crop into which the gene is introduced to obtain the desired result is called a genetically modified crop (GMO) or transgenic plant.
- Example: BT cotton

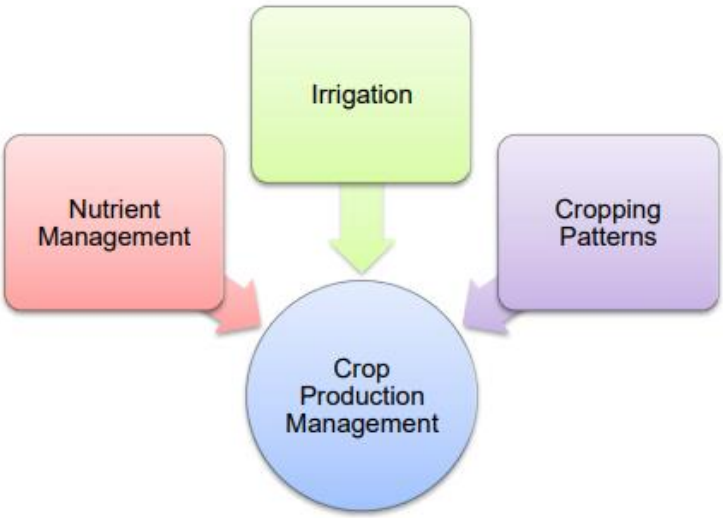
- American Scientist Norman Borlaug is known as the Father of the Green Revolution.
- M. S. Swaminathan, an Indian agricultural scientist, is known as the Father of the Green Revolution in India.

Need for Higher Crop Yield

- **Higher Yield -** Improves the commercial production of crops
- **Improved Quality -** Improvement in the quality of crops
- **Biotic and Abiotic Resistance -** Crop varieties resistant to diseases, pests, nematodes, floods, droughts
- **Change in Maturity Duration -** The shorter the duration of crop from sowing to harvesting, the more economical will be the variety of the crop
- **Wider Adaptability -** It ensures more sustenance under various environmental conditions
- **Desirable Agronomic Characteristics -** Developing crops with desired agronomic characters gives higher productivity

Crop Production Management

- Crop production management refers to controlling different aspects of crop production to obtain the maximum and best yield.



Nutrient Management

- Plants require 16 different nutrients which are obtained by air, water and soil.

Macronutrients	•Nutrients required by plants in large quantities. •The **six macronutrients** are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur.
Micronutrients	•Nutrients required by plants in small quantities. •The **seven micronutrients** are iron, manganese, boron, zinc, copper, molybdenum and chlorine.

- Deficiency of these nutrients retards the growth of plants.

Manures and Fertilisers

- It is a natural substance obtained by the decomposition of dead and decaying vegetable matter, waste from farms, household waste and excreta of animals.

Compost (Vermicompost)	Green Manure
• It is formed by the decomposition of vegetable and animal wastes, domestic waste and eradicated weeds.	• Farmers grow leguminous plants (e.g. groundnuts, soya beans, pulses) in between two crops.
• The waste matter is decomposed in pits. This process is called composting.	• Leguminous plants help to replenish the nitrogen content in the soil.
• Sometimes, organic substances are decomposed by earthworms and are converted into humus. This is called vermicompost.	• Sometimes, before sowing seeds, plants such as sun hemp or guar are grown and mulched by ploughing them into the soil.

Advantages of Manures:

- Increase the water-holding capacity of the soil
- Make the soil porous which facilitates the exchange of gases
- Improve the texture of the soil
- Replenish the general deficiency of nutrients

Fertilisers:

- Fertilisers are human-made substances.
- They contain inorganic salts or organic compounds.
- Fertilisers are nutrient-specific so that they can fulfil the specific requirement of nutrients.
- Fertilisers are costly and prepared in factories.
- Overuse of artificial fertilisers may reduce the fertility of soil. The soil may become infertile over a period of time.

Organic Farming

- Organic farming is the kind of farming in which crops are grown without using chemical fertilisers and pesticides.
- There is a maximum input of organic manure or recycled farm wastes.
- Bio-agents such as blue-green algae are used in the preparation of biofertilisers.
- Neem leaves and turmeric are used as pesticides in grain storage.
- Food grown by organic farming is called **organic food**.
- In recent years, organic farming has increased. This is because of the increased awareness in people about the safety related to the environment and food.

Irrigation

- In most parts of India, the success of crop yield depends on monsoons and sufficient rainfall during the growing season. Hence, a poor monsoon causes crop failure.
- **Irrigation** is the artificial method of supplying water to crops in a field.
- Different kinds of irrigation systems such as wells, canals, river lift system and tanks are adopted depending on the kinds of water resources available.
- Rainwater harvesting and watershed management are also used. Check dams are built to increase groundwater levels.

Advantages of Irrigation

Provides moisture to germinating seeds

Facilitates the absorption of nutrients by minerals

Disadvantages of Irrigation

Excess of water in the soil leads to water logging

Sometimes, it inhibits the process of germination

Roots do not grow properly in a standing water field

Excess irrigation destroys standing crops

It increases the amount of salt on the surface soil as water gets evaporated

Cropping Patterns

Mixed Cropping	Inter-cropping	Crop Rotation
•Growing two or more crops simultaneously on the same piece of land •Minimises the risk of crop failure •Wheat + Gram •Wheat + Mustard •Groundnut + Sunflower	•Growing two or more crops simultaneously in the same field in a definite pattern •Increases the productivity per unit area •Soyabean + Maize •Finger millet (Bajra) + Cowpea (lobia)	•Growing of different crops on the same land in pre-planned succession •Allows soil to recover its lost nutrients •Maize-Mustard-Sugarcane-Fenugreek •Maize-Potato-Sugarcane-Pea

Crop Protection Management

Weeding

- Wild and undesirable plants which grow in crop fields and compete with the crops for space, soil, nutrients, water and sunlight are called **weeds**.
- Some examples of weeds are Xanthium (gokhroo), Parthenium (gajar ghas) and Cyperinus rotundus (motha).
- Weeding is the process of removal of weeds.

Weeds are removed by various methods:

• Weeds can be pulled out by hand.
• A trowel or small arrow can be used to remove weeds.
• Chemicals generally called weedicides can be used to kill weeds. Examples: 2,4-D, MCPA
• Releasing certain insects which destroy weeds. Example: Cochineal insect

Disadvantages of Weeds

- Compete with crops for all the possible resources
- Can be responsible for spreading diseases
- Provide hideouts for rats and snakes

Pest Control

- Almost all crops are affected by insects, mites, small animals, birds and rats. Such harmful organisms are called **pests**.
- Pests reduce crop production by cutting roots, sucking cell sap or damaging stems and fruits.
- Some pests are aphids, grasshoppers and borers.
- **Common diseases related to pests:** Late blight of potato, root rot, rust and smut of wheat, gall or tumour
- Pests can be controlled by spraying pesticides and insecticides such as Bordeaux mixture and BHC.
- Animals which control pests are reared and released in the farm.
- Example: Adults and larvae of ladybird beetles feed on aphids and their eggs.

Disadvantages of Pesticides

- Destroy friendly insects along with pests
- Causes environmental pollution
- Affects nutritional quality of crops
- Animals eating such crops also get affected

Storage of Grain

Harvested crops are stored until they are sold in the market.

Sometimes, rodents, fungi, mites, bacteria and even moisture and temperature changes damage stored grains. To avoid this, special precautions are taken while storing grains.

Granaries

- Harvested grains contain a lot of moisture in them. Hence, grains are first dried.
- Dried grains are stored in granaries.
- Grains are also stored in gunny bags.
- The Government stores grains in large containers or storage towers called silos.
- Buffer stocks are stored in godowns to meet emergency needs such as natural calamities.
- Precautions to be taken while storing grains:
  - Need to be stored in a room free from moisture.
  - Tin boxes are preferred as they are mice-proof.
  - In godowns, chemicals used to prevent rats and insects must be used carefully in such a way that grains are not contaminated.
  - Storage places should be well-ventilated.

Animal Husbandry

Cattle Farming

- The breeding of wild animals for specific purposes is called domestication, and such animals are called domestic animals.
- Animal husbandry is the branch of biology which deals with feeding, shelter, caring and breeding of domesticated animals.

DID YOU KNOW ?

Dog was the first domesticated animal. It was domesticated to help in hunting and guarding.

- Animals domesticated for companionship at home are called pets.
- Animals domesticated to obtain food and other valuable products are called livestock.

There are three types of animals:

Draught Breeds	• They are primarily used for drawing bullock carts, ploughing land and transport of materials. • The milk yield is very low. • The meat is tough.
Dairy Breeds	• They are high-milk yielders. • Their males are poor draughts.
Dual Purpose Breeds	• They are good milk yielders. • The males are good for draught purposes. • Examples: Haryana, Dangi, Tharparkar

Cattle and Buffaloes

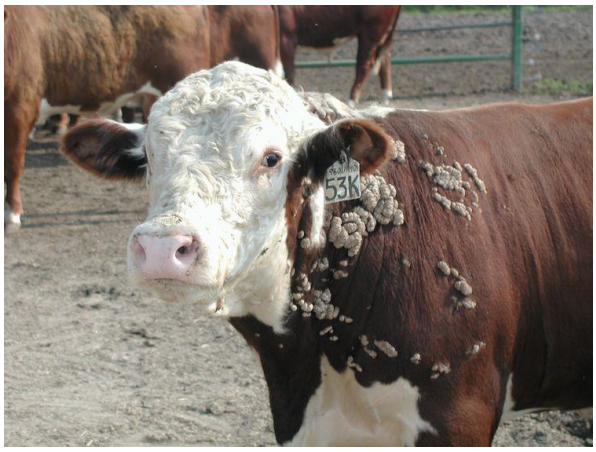
- There are 30 different breeds of cows in India.
- Examples of exotic or foreign breeds: Jersey, Holstein-Friesian, Brown Swiss
- Examples of indigenous breeds: Red Sindhi, Sahiwal, Gir

Shelter and Feeding

Shelter
• It must be well-lit and well-ventilated.
• Cattle sheds must be properly covered to protect cattle from rain, heat and cold.
• The floor should be sloping so that cleaning and keeping the place dry is easy.
• The shelter must be spacious so that each animal is comfortable and overcrowding is avoided.
• There should be an arrangement for fresh, clean drinking water.
• A proper arrangement for the disposal of the animal's urine and excreta must be made.
• Shelters should be located away from residential areas and waste disposal sites.

Feeding	
The animal food which contains essential components needed for the growth, development and general maintenance of the body is called feed.	
a) Roughage	• Roughage is a coarse, fibrous substance with low nutrient contents. • Animals get their roughage from substances in their feed such as hay, green fodder, silage, berseem, lucerne and cowpea.
b) Concentrates	• They are rich in carbohydrates, proteins, fats, minerals and vitamins.
	▪ Grains and seeds of bajra, maize, rice, jowar and barley which are rich in carbohydrates. ▪ Oil cakes formed from cotton, mustard and groundnut. ▪ Rice bran, gram chaff, wheat bran and molasses.

Diseases in Cattle



Type of Disease	Name of Disease	Symptoms
Viral Disease	Foot and mouth disease	Blisters on feet and mouth Excessive salivation Reduced appetite Soreness of mouth Fever
	Cow pox	High fever Appearance of small nodules over the body
Bacterial Disease	Anthrax	High fever Swelling on the body, especially neck
	Rinderpest (cattle plague)	High fever Excessive salivation Redness of eyes Loss of appetite
	Salmonellosis	Diarrhoea with blood clot
Mad cow disease is a degenerative disease which affects the central nervous system.		

Symptoms of sick cattle

- Stop feeding
- Become inactive and dull
- Have drooping ears and lips
- Pass loose dung and coloured urine
- Produce less milk

Poultry

- **Poultry** is the raising of chickens, ducks, turkeys and geese for meat and eggs.
- The egg-laying chickens are called **eggers** or **layers**.
- Rhode Island leghorns and white leghorns are good layers.
- The chickens reared for obtaining meat are called **broilers**.
- The following breeds are found in Indian poultry:
  - ✓ Indigenous breed: Aseel
  - ✓ Exotic breeds: White Leghorn, Rhode Island Red

New varieties of fowls are developed for the following desirable traits:

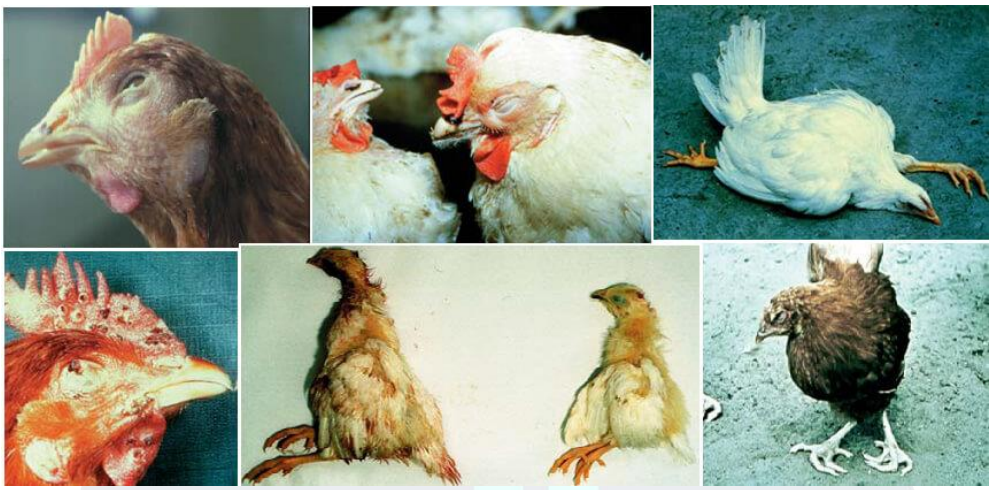
- Number and quality of chicks
- Developing dwarf broiler parent for commercial chick production
- Tolerance to high temperature
- Small-sized egg-laying bird to use diets formed by using agriculture by-products
- Low-maintenance requirements

Poultry Care

• Chickens are raised in wire cages.
• Birds should not be kept open or overcrowded.
• Feeding trays and egg trays are kept in front of the cage.
• The place should be well-ventilated.
• Clean drinking water must be provided.
• Dropping fall on the ground, so it must be cleaned at intervals.
• Bird dropping from poultry farms is an excellent source of nitrogen for plants.
• Egg production is related to day-length; artificial lighting is done to increase the day length in winter.
• The feed of poultry birds contains maize, soy, rice bran, cereals and groundnut cakes.

• For broilers, a thick layer of sawdust is provided in the sheds to absorb droppings.
• Feed and water are kept at regular intervals for easy access to all birds.
• After raising one batch, sawdust is cleared, the area is sterilised and again fresh sawdust is spread to raise another batch.

Poultry Diseases



Viral diseases	Fowl pox, Ranikhet
Bacterial diseases	Fowl cholera, salmonellosis, diarrhoea of chick, coryza
Fungal diseases	Aspergillosis

Timely vaccinations prevent chickens from these diseases.

Pisciculture (Fish Production)

Marine Fishery

- India has a coastline of 7500 km and deep seas.
- Fish are caught by using fishing nets and other gear.
- Echosounders and satellites are used to locate a large population of fish under the sea.
- Some of the popular marine fish varieties are Pomfret, Bombay duck, mackerel, snapper and mullet.

- Fish reared in pisciculture are Catla, Mrigal, Tilapia and Singhi.
- Marine fish reared in pisciculture are Pomfret, Bombay duck, snapper and mackerel.

Inland Fisheries

- Fish reservoirs such as canals, ponds, rivers, estuaries and lagoons are used for fisheries.
- The fish yield is not so high.
- Fishing is also done in paddy fields.
- In this system, local and imported species of fish, usually 5–6, are used in a single pond.
- This is done to avoid any competition for food and space.
- Some of the fish cultured by using inland fishery techniques are Rohu, Catla, Mrigal and Tilapia.

Purpose of Fish Production

- Fish is an important source of human food. It is highly proteinaceous.
- Shark liver oil and cod liver oil are rich in vitamins A and D.

Beekeeping

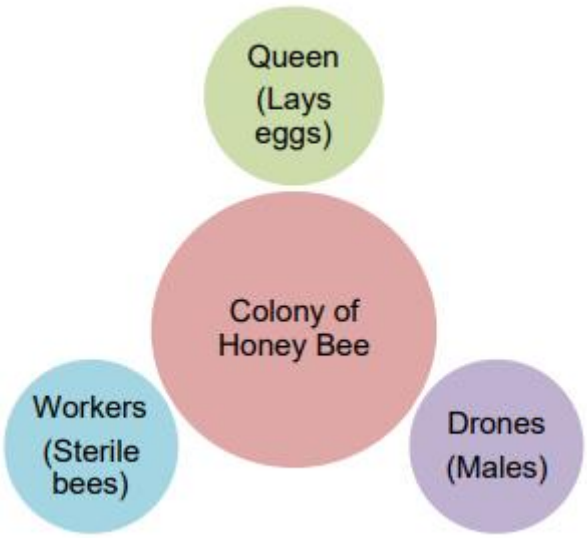
Beekeeping or apiculture is the artificial rearing of honey bees or the maintenance of colonies of honey bees by humans to obtain honey and other commercially important products.

The place where bees are kept is called a **bee yard** or **apiary**.

Italian bees

- High honey collection capacity
- Stay in given bee hive for long periods

In nature, honey bees live in colonies in a beehive made of wax which they produce. The three types of individuals found in a honey bee colony are drone, queen and worker.



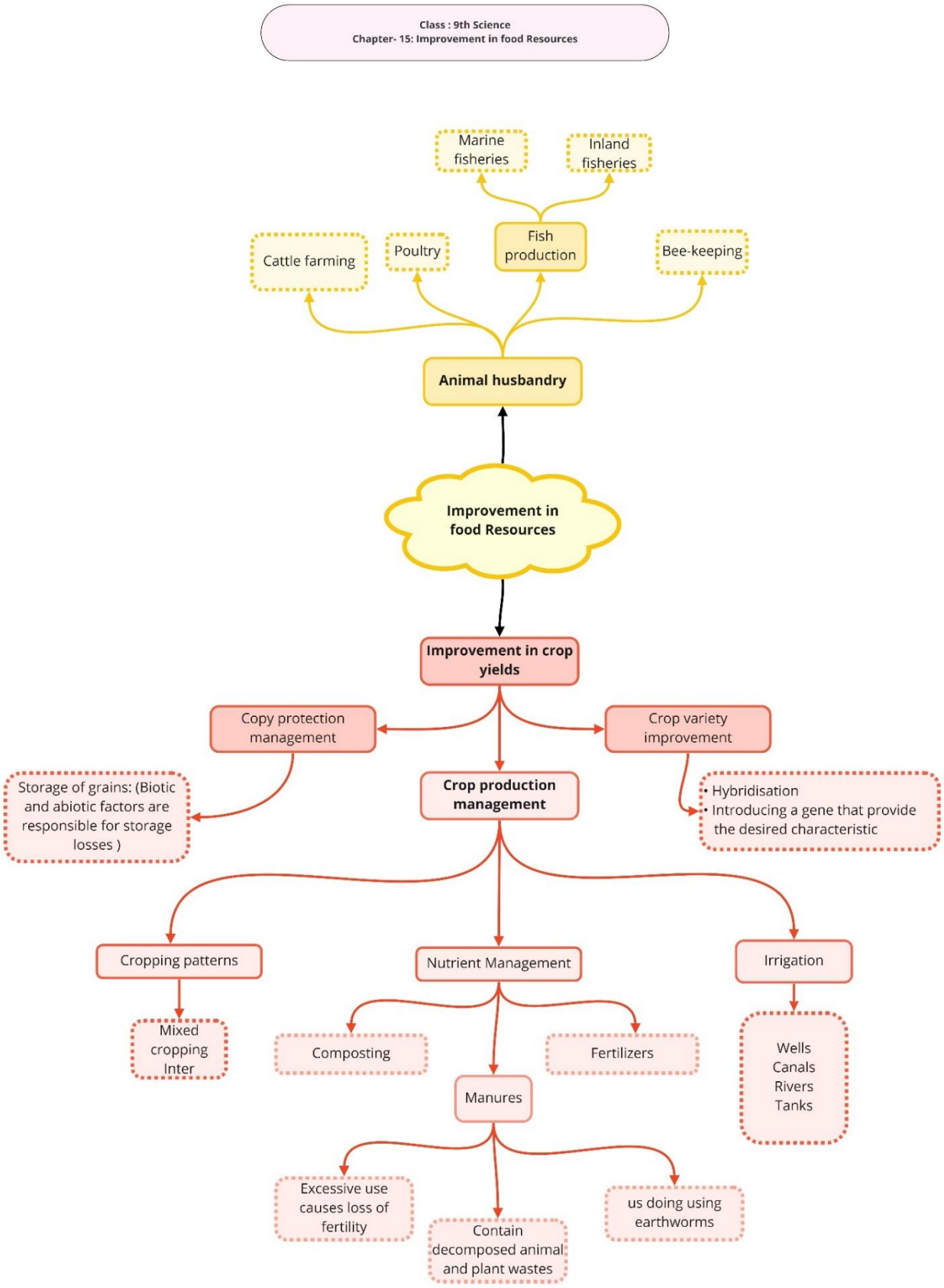
In beekeeping, one or more boxes are mounted on a stump which is about 5 feet high.

Each setup has a narrow opening which allows only worker bees to enter or exit the setup.

There are frames inside the box on which workers construct hives.

When the cells in a hive are filled with honey, the frames are removed and honey is extracted by centrifugation.

The frame with intact hive is then put back to collect more honey.


Class : 9th Science
Chapter- 15: Improvement in food Resources
Marine fisheries
Inland fisheries
Fish production
Cattle farming
Poultry
Bee-keeping
Animal husbandry
Improvement in food Resources
Improvement in crop yields
Copy protection management
Crop variety improvement
Storage of grains: (Biotic and abiotic factors are responsible for storage losses)
Crop production management
• Hybridisation
• Introducing a gene that provide the desired characteristic
Cropping patterns
Nutrient Management
Irrigation
Mixed cropping Inter
Composting
Fertilizers
Manures
Wells
Canals
Rivers
Tanks
Excessive use causes loss of fertility
Contain decomposed animal and plant wastes
us doing using earthworms

Important Questions

Multiple Choice Questions:

1. How much increase in cultivable land occurred in India from 1952 to 2010?
   (a) 20%
   (b) 25%
   (c) 35%
   (d) 40%
2. How many nutrients are essential for plants?
   (a) 16
   (b) 20
   (c) 26
   (d) 36
3. Which one of the following species of the honey bee is an Italian species?
   (a) Apis cerana indica
   (b) Apis dorsata
   (c) Apis florae
   (d) Apis mellifera
4. How many micronutrients are required by plants?
   (a) 6
   (b) 10
   (c) 7
   (d) 12
5. Which of the following are Indian cattle?
   (i) Bos indicus
   (ii) Bos domestica
   (iii) Bos bubalis
   (a) (i) and (iii)
   (b) (i) and (ii)
   (c) (ii) and (iii)
   (d) (iii) and (iv)
6. The hybrid breed of buffalo yielding maximum milk is:
   (a) Jamunapari
   (b) Murrah
   (c) Sahiwal
   (d) Barbary
7. This breed of cow gives more milk:
   (a) Bhadawari
   (b) Jaffrabadi
   (c) Murrah
   (d) Sahiwal
8. This hybrid breed of the hen has the world record of laying maximum eggs:
   (a) White leghorn
   (b) Minorca
   (c) Karaknath
   (d) Vasra
9. Which goat is known as the queen of milk?
   (a) Barbary
   (b) Jamunapari
   (c) Sannen
   (d) Bikaneri
10. Which one of the following nutrients is not available in common fertilizers?
    (a) Nitrogen
    (b) Phosphorus
    (c) Iron
    (d) Potassium

Very Short Question:

1. What is the advantage of selecting seeds of crops with wider adaptability for agriculture?
2. Name the type of nutrient that we get from mustard seeds and linseed.
3. Mention any two abiotic factors that affect crop production.
4. Students were asked to select one that is not a source of starch amongst the following rice, wheat, sunflower seeds, and potato tuber.
5. Improved varieties can be produced in both animals and plants. How?
6. Name two protein-containing Rabi crops.
7. Identify two crops from the following which provide us carbohydrates for energy requirement. Black gram, wheat, lentil, and rice.
8. Name two plants which are used as biopesticide in organic farming.
9. Name the two vitamins which are added in the poultry feed.
10. Name the major nutrient which we get from fish.

Short Questions:

1. Mention the names of four marine fish of high economic value.
2. Give two examples of shellfishes.
3. Name two desirable traits for variety improvement in poultry farming.
4. Which method is commonly used for improving cattle breeds and why?
5. What are 'Sahiwal' and 'Jersey' breeds?
6. State the food requirements of dairy animals.
7. What is mixed cropping? How does it help a farmer?
8. State two advantages of fertilizers over manure.

Long Questions:

1. Mention the modern initiatives undertaken in India to supply water to the fields.
2. What do you understand by composite fish culture? Describe in detail with advantages and disadvantages. What are the advantages of composite fish culture?
3. How do plants get their nutrients?

   OR

   List the nutrients supplied by air, water, and soil.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.

   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

   c. Assertion is true but Reason is false.

   d. Both Assertion and Reason are false.

   Assertion: Our natural resources are damaged due to human activities.

   Reason: due to the revolution natural resources are getting used more intensively.

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 Assertion and Reason are correct, and reason is the correct explanation for assertion.

   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

   c. Assertion is true but Reason is false.

   d. Both Assertion and Reason are false.

   Assertion: Our natural resources are damaged due to human activities.

   Reason: Our natural resources damaged by global warming.

Case Study Questions:

1. Different crops require different climatic conditions, temperature and photoperiods for their growth and completion of their life cycle. Photoperiods are related to the duration of sunlight. Growth of plants and flowering are dependent on sunlight. As we all know, plants manufacture their food in sunlight by the process of photosynthesis. There are some crops, which are grown in rainy season, called the kharif season from the month of June to October, and some of the crops are grown in the winter season, called the Rabi season from November to April. Paddy, soyabean, pigeon pea, maize, cotton, green gram and black gram are kharif crops, whereas wheat, gram, peas, mustard, linseed are Rabi crops.

In India there has been a four times increase in the production of food grains from 1952 to 2010 with only 25% increase in the cultivable land area. This increase in production been achieved through the practices involved in farming, we can divide it into three stages. The first is the choice of seeds for planting. The second is the nurturing of the crop plants. The third is the protection of the growing and harvested crops from loss. Thus, the major groups of activities for improving crop yields can be classified as:

- Crop variety improvement
- Crop production improvement
- Crop protection management.

(i) What is kharif season period?

(a) June to July

(b) June to October

(c) June to November

(d) June to December

(ii) What is Rabi season period?

(a) November to April

(b) November to March

(c) November to February

(d) November to January

(iii) Plants manufacture their food in sunlight by the process called _____.

(a) Photosynthesis

(b) Photoperiod

(c) Photolysis

(d) None of the above

(iv) Enlist the names of Kharif crops.

(v) Enlist the names of Rabi crops.

2. Cattle husbandry is done for two purposes— milk and draught labour for agricultural work such as tilling, irrigation and carting. Indian cattle belong to two different species, Bosindicus, cows, and Bosbubalis, buffaloes. Milk-producing females are called milch animals (dairy animals), while the ones used for farm labour are called draught animals.

Milk production depends on the duration of the lactation period, meaning the period of milk production after the birth of a calf. So, milk production can be increased by increasing the lactation period. Exotic or foreign breeds (for example, Jersey, Brown Swiss) are selected for long lactation periods, while local breeds (for example, Red Sindhi, Sahiwal) show excellent resistance to diseases. The two can be cross-bred to get animals with both the desired qualities.

Proper cleaning and shelter facilities for cows and buffaloes are required for humane farming, for the health of the animals and for production of clean milk as well. The food requirements of dairy animals are of two types: (a) maintenance requirement, which is the food required to support the animal to live a healthy life, and (b) milk producing requirement, which is the type of food required during the lactation period.

Cattle suffer from a number of diseases. The diseases, besides causing death, reduce milk production. The external parasites live on the skin and mainly cause skin diseases. The internal parasites like worms, affect stomach and intestine while flukes damage the liver.

(i) Identify the exotic breed of cow:

(a) Red Sindhi

(b) Sahiwal

(c) Brown Swiss

(d) All of the above

(ii) Identify the correct statements:

Statement 1 – Milk production depends on the duration of the lactation period.

Statement 2 – Exotic or foreign breeds are selected for long lactation periods.

Statement 3 – Local breeds show excellent resistance to diseases.

Statement 4 – Animals used for farm labour are called draught animals.

(a) Both 1 & 2

(b) Only 3

(c) Both 3 & 4

(d) All of the above

(iii) Milk-producing females are termed as

(a) Milch animals

(b) Dairy animals

(c) Draught animals

(d) Both a & b

(iv) Enlist any two Indian cattle species.

(v) What are the food requirements of dairy animals?

Answer Key

Multiple Choice Answers:

1. (b) 25%
2. (a) 16
3. (d) Apis mellifera
4. (c) 7
5. (a) (i) and (iii)
6. (b) Murrah
7. (d) Sahiwal
8. (a) White leghorn
9. (c) Sannen
10. (c) Iron

Very Short Answers:

1. **Answer:** Wider adaptability helps in stabilizing crop production under different environmental conditions.
2. **Answer:** Mustard seeds and linseed are oilseed crops that provide fats.
3. **Answer:** Drought, salinity, waterlogging, heat, cold and frost are the abiotic factors that affect crop production.
4. **Answer:** Sunflower seeds are not a source of starch. They are a source of fats.
5. **Answer:** Improved varieties can be produced in both animals and plants by hybridization and genetic modification.
6. **Answer:** Protein containing Rabi crops are gram and peas.
7. **Answer:** Wheat and rice provide energy.
8. **Answer:** Turmeric and leaves of Neem plant are used as biopesticide in organic farming.
9. **Answer:** Vitamin A and K are the vitamins that are added in the poultry feed.
10. **Answer:** The major nutrient which we get from fish is protein.

Short Answer:

1. **Answer:** Fishes like mullets, bhetki, pearl spots and prawns are of high economic value.
2. **Answer:** Shellfish include prawns, mussels and oysters.
3. **Answer:** The two desirable traits for variety improvement in poultry farming are:
   - number and quality of chicks;
   - dwarf broiler parent for commercial chick production.
4. **Answer:** Crossbreeding between the indigenous and exotic breeds is commonly used for improving cattle breeds. This is done as it helps to incorporate the desirable qualities like a long lactation period of exotic breeds with the disease resistance of indigenous breeds in the progeny.
5. **Answer:** Sahiwal is an indigenous breed of cow whereas Jersey is the exotic breed of cow.
6. **Answer:** The food requirements of dairy animals are of two types:
   - Maintenance requirement, which is the food required to support the animal to live a healthy life.
   - Milk producing a requirement, which is the type of food required during the lactation period.
7. **Answer:** Mixed cropping is the practice of growing two or more crops simultaneously on the same piece of land. For example, wheat and gram, or wheat and mustard, or groundnut and sunflower. It helps the farmer as it reduces the risk and gives some insurance against the failure of one of the crops.
8. **Answer:** Fertilizers are more advantageous than manure as:
   - Fertilizers are nutrient specific and provide the specific nutrients like N, P, K to the soil.
   - They are not bulky, so are easier to transport.

Long Answer:

1. **Answer:** Indian agriculture is mainly dependent on the monsoons. The irregular or scarcity of rainfall often results in crop failure. To overcome the problem, different types of irrigation systems are in practice in India for the supply of water in agricultural fields. Wells, canals, river lift systems, tanks, etc. are used for irrigation. Some new initiatives like rainwater harvesting and watershed management are being used.

For this small check-dams are constructed to stop the rainwater from flowing and lead to an increase in groundwater levels. The different types of irrigation systems are:

- **Wells:** There are two types of wells – dug wells and tube wells. In a dug well, water is collected from water-bearing strata. Tube wells can tap water from the deeper strata. From these wells, water is lifted by pumps for irrigation.
- **Canals:** In this system canals receive water from one or more reservoirs or from rivers. The main canal is divided into branch canals having further distributed to irrigate fields.
- **River Lift Systems:** In this system, water is directly drawn from the rivers for supplementing irrigation in areas close to rivers.
- **Tanks:** These are small storage reservoirs, which intercept and store the run-off of smaller catchment areas.

2. Answer:

A combination of five or six fish species is used in a single fish pond in the composite fish culture system. The selected species do not compete for food among them as they have different types of food habits.

The types of fishes used are:

Callas are surface feeders, Rohus feed in the middle-zone of the pond, Mrigals, and Common Carps are bottom feeders, and Grass Carps feed on the weeds. As a result, the food available in all the parts of the pond is used.

Advantages of Composite fish culture:

- The species of fishes in the pond utilize all the food available in the pond.
- The species do not compete with each other for food as they have different food habits.
- The yield of fish is increased by such a culture system.

The disadvantage of Composite fish culture:

A major problem in fish farming is the lack of availability of good quality fish seeds.

3. Answer:

Nutrients supplied by air, water and soil	
Source	**Nutrients**
Air Water Soil	Carbon, oxygen Hydrogen, oxygen (i) **Macronutrients:** nitrogen, phosphours, potassium calcium, magnesium, sulphur. (ii) **Micronutrients:** iron, manganese, boron, zinc, copper, molybdenum, chlorine

Assertion Reason Answer:

1. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

2. (c) Assertion is true but Reason is false.

Case Study Answers:

1. (i) (b) June to October

(ii) (a) November to April

(iii) (a) Photosynthesis

(iv) Kharif crops

Paddy, soyabean, pigeon pea, maize, cotton, green gram and black gram

(v) Rabi crops

Wheat, gram, peas, mustard, linseed are.

2. (i) (c) Brown Swiss

(ii) (d) All of the above

(iii) (d) Both a & b

(iv) Indian cattle belong to two different species

- Bosindicus – cows.
- Bosbubalis – buffaloes

(v) The food requirements of dairy animals are of two types

- Maintenance requirement – which is the food required to support the animal to live a healthy life.

  Milk producing requirement -which is the type of food required during the lactation period.