

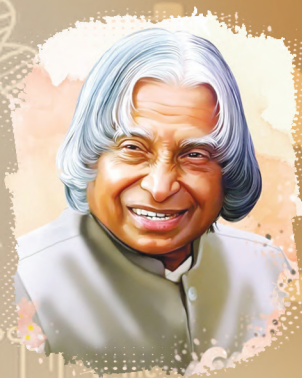
# PHYSICAL SCIENCE

## HANDBOOK

H<sub>2</sub>O



# 9<sup>th</sup> Class



## REVISED VERSION

### FEATURES

- ☛ Mind Map
- ☛ Main Points
- ☛ Intext Questions and Answers
- ☛ Exercises
- ☛ Activities
- ☛ Multiple choice questions
- ☛ CBA Questions

Strengthening  
Foundations,  
Inspiring  
Excellence

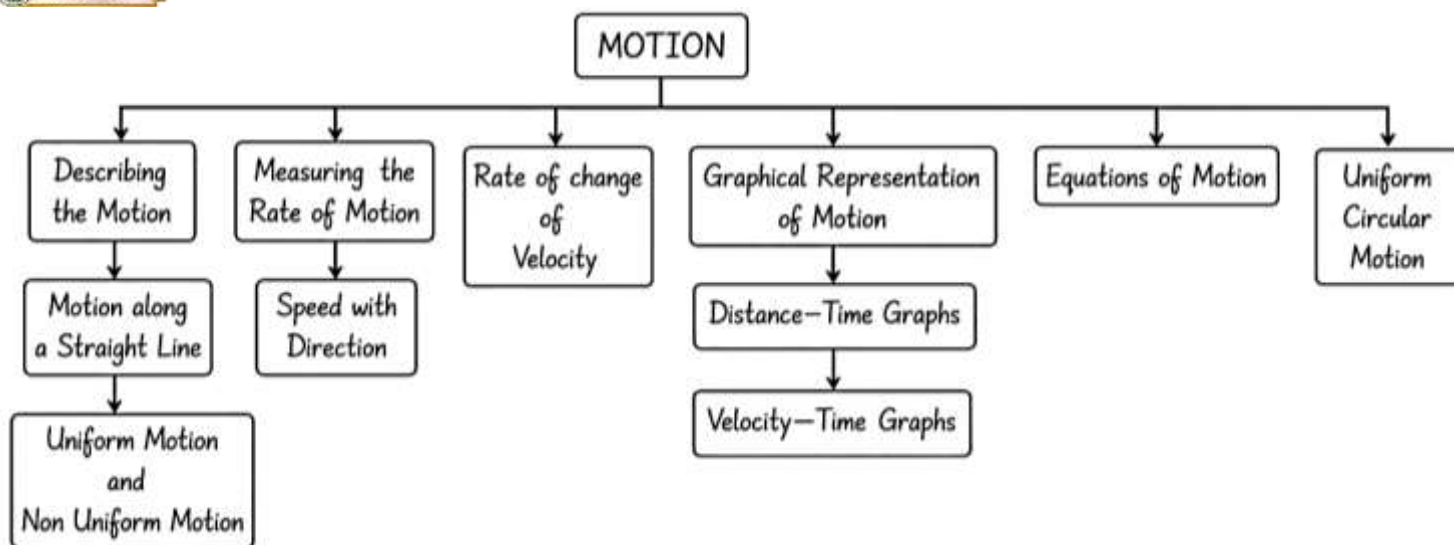
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## Chapter - 1

## MOTION



## Main Points

1. Describe the position of an object to specify a reference point called the origin.
2. The total path length covered by the object is called distance.
3. The shortest distance measured from the initial to the final position of an object is known as the displacement.
4. The object covers equal distances in equal intervals of time, it is said to be in uniform motion.
5. The object covers unequal distances in equal intervals of time, it is said to be in non-uniform motion.
6. The distance travelled by the object in unit time is called as speed. The SI unit of speed is m/s or ms<sup>-1</sup>
7. 
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$
8. The displacement travelled by the object in unit time is called as velocity. The SI unit of velocity is m/s or ms<sup>-1</sup>
9. 
$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$
10. The average speed of an object is obtained by dividing the total distance travelled by the total time taken.  

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$
11. The average velocity of an object is obtained by dividing the total displacement travelled by the total time taken  

$$\text{Average velocity} = \frac{\text{Total displacement travelled}}{\text{Total time taken}}$$

$$\text{Average velocity} = \frac{\text{Initial velocity} + \text{Final velocity}}{2} = \frac{u+v}{2}$$
12. During uniform motion of an object along a straight line, the velocity remains constant with time (the change in velocity of the object for any time interval is zero).
13. During non-uniform motion of an object along a straight line, the velocity varies with time (the change in velocity of the object for any time interval is not zero).
14. The change in the velocity of an object per unit time is called as acceleration. The SI unit is m/s<sup>2</sup> or ms<sup>-2</sup>.  

$$\text{Acceleration (a)} = \frac{\text{Change in velocity}}{\text{Time taken}} = \frac{v-u}{t}$$
15. The acceleration is taken to be positive if it is in the direction of velocity and negative when it is opposite to the direction of velocity.
16. Distance-Time graph: It is the graph between the time t and distance s of a particle relative to a fixed origin. Its slope at any point gives the instantaneous velocity at that point.
17. Velocity-Time graph: It is the graph of time vs velocity. Its slope at any point gives the acceleration at the corresponding instant. Distance covered in time t equals area under the velocity-time graph.
18. Equations of motion:  $v = u + at$        $s = ut + \frac{1}{2} at^2$        $v^2 - u^2 = 2as$
19. If an object moves in a circular path with uniform speed, its motion is called uniform circular motion.
20. If the athlete takes t seconds to go once around the circular path of radius r, the speed v is given by  $v = \frac{2\pi r}{t}$

## Exercises

**1. An athlete completes one round of a circular track of diameter 200 m in 40 s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?**

**Ans:** Given Diameter = 200 m

$$\text{Radius (r)} = 200/2 = 100 \text{ m}$$

$$\text{Time taken} = 2 \text{ minutes } 20 \text{ s} = 2 \times 60 + 20 = 140 \text{ s}$$

$$\text{No. of rounds} = \frac{140}{40} = 3.5 = 3\frac{1}{2}$$

$$\text{i) Distance covered} = 2\pi r \times 3.5 = 2 \times \frac{22}{7} \times 100 \times 3.5 = 2200 \text{ m}$$

ii) At end of his motion, the athlete will be in the diametrically opposite position.

$$\text{Displacement} = \text{Diameter} = 200 \text{ m}$$

**2. What is the nature of the distance-time graphs for uniform and non-uniform motion of an object?**

**Ans:** For uniform motion, the distance-time graph is a straight line because the object covers equal distances in equal intervals of time.

For non-uniform motion, the distance-time graph is a curved (non-linear) line because the object covers unequal distances in equal intervals of time.

**3. Assertion (A):** The area under a velocity-time graph represents the displacement of the body.

**Reason (R):** Displacement is equal to velocity multiplied by time.

**Choose the correct option.**

A) Both A and R are true and R is the correct explanation of A.

B) Both A and R are true but R is not the correct explanation of A.

C) A is true but R is false.

D) A is false but R is true.

**Ans:** A) Both A and R are true and R is the correct explanation of A.

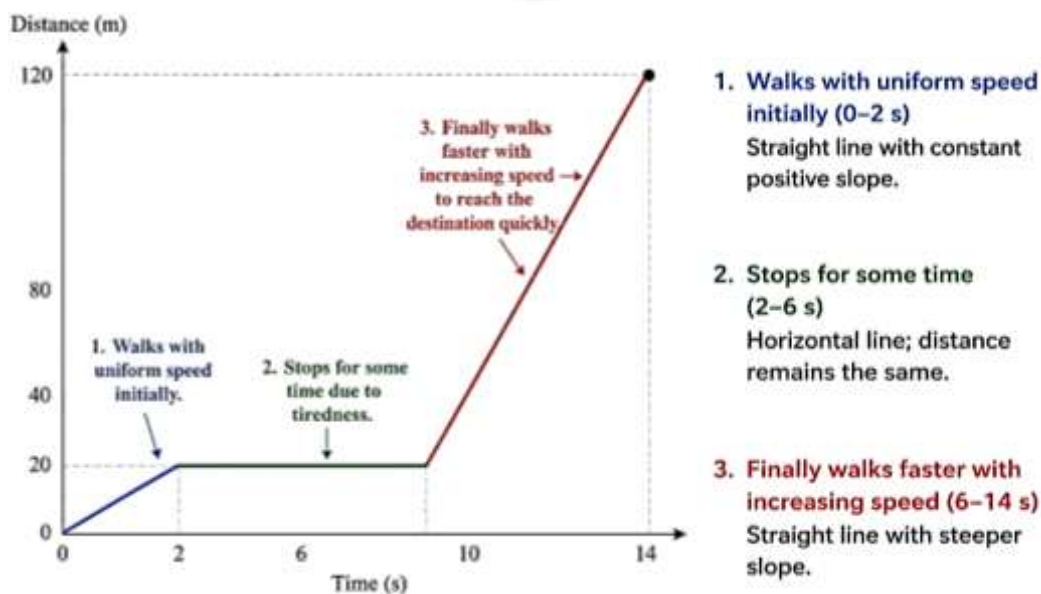
**4. Create a distance-time graph to represent the following situation:**

A person:

1. Walks with uniform speed initially.
2. Stops for some time due to tiredness.
3. Finally walks faster with increasing speed to reach the destination quickly.

**Explain how the graph represents each stage of motion.**

**Ans:**

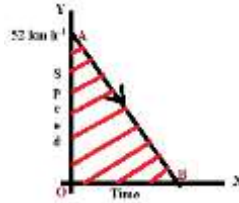


**5. A driver of a car travelling at  $52 \text{ km h}^{-1}$  applies the brakes.**

(a) Shade the area on the graph that represents the distance travelled by the car during the period.

(b) Which part of the graph represents uniform motion of the car?

**Ans:** (a) The shaded region of the graph represents the distance travelled by the car during the period.

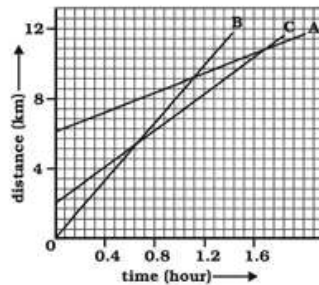


(b) The slope of the velocity-time graph is the same throughout. So, the whole graph represents the uniform motion of the car.

6. An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

**Ans:** Given  $r = 42250 \text{ km} = 42250 \times 1000 \text{ m}$   $T = 24 \text{ h} = 24 \times 60 \times 60 \text{ s}$   
 Speed,  $v = \frac{2\pi r}{T} = \frac{2 \times 3.14 \times 42250 \times 1000}{24 \times 60 \times 60} = 3070.9 \text{ ms}^{-1}$

7. Fig 1.10 shows the distance-time graph of three objects A, B and C. Study the graph and answer the following questions:



- Which of the three is travelling the fastest?
- Are all three ever at the same point on the road?
- How far has C travelled when B passes A?
- How far has B travelled by the time it passes C?

**Ans:** (a) Slope =  $\frac{y\text{-axis}}{x\text{-axis}} = \frac{\text{Distance}}{\text{time}} = \text{speed}$

The slope of the object B is greater than object A and object C. So, object B is travelling fastest.

(b) No, all three do not meet at any point on the road.

(c) 7 square boxes = 4 km

$$\therefore 1 \text{ square box} = \frac{4}{7} \text{ km}$$

C is 4 blocks away from origin position.

$$\text{Initial distance of C from origin} = \frac{16}{7} \text{ km}$$

Distance of C from origin when B passes A = 8 km

$$\text{Distance travelled by C when B passes A} = 8 - \frac{16}{7} = \frac{(56-16)}{7} = \frac{40}{7} = 5.714 \text{ km}$$

(d) Distance travelled by B by the time it passes C = 9 square boxes

$$= 9 \times \frac{4}{7} = \frac{36}{7} = 5.143 \text{ km}$$

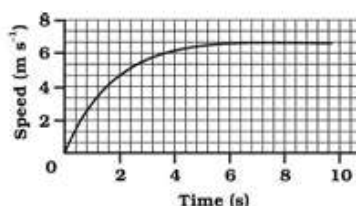
8. A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of  $10 \text{ m s}^{-2}$ , with what velocity will it strike the ground? After what time will it strike the ground?

**Ans:** Given  $u = 0 \text{ m s}^{-1}$   $h = 20 \text{ m}$   $g = 10 \text{ m s}^{-2}$   $v = ?$

$$\text{Final velocity } v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = \sqrt{20 \times 20} = 20 \text{ m s}^{-1}$$

$$\text{Time, } t = \frac{v-u}{a} = \frac{20-0}{10} = 2 \text{ s}$$

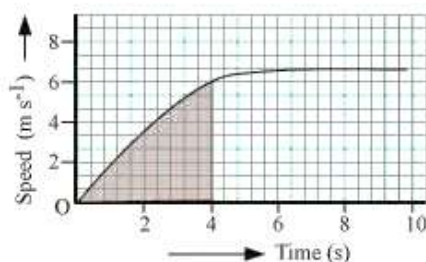
9. The speed-time graph for a car is shown in Fig. 1.11. (a) Find how far does the car travel in the first 4 seconds.



Shade the area on the graph that represents the distance travelled by the car during the period.

(b) Which part of the graph represents uniform motion of the car?

Ans: (a)



The distance travelled by the car in the first 4 s = The shaded area  
 $= \frac{1}{2} \times 4 \times 6$   
 $= 12 \text{ m}$

(b) After 6 s, the car has a uniform motion.

10. State which of the following situations are possible and give an example for each of these:

- (a) an object with a constant acceleration but with zero velocity  
 (b) an object moving with an acceleration but with uniform speed.  
 (c) an object moving in a certain direction with an acceleration in the perpendicular direction.

Ans: (a) Yes. When a body is thrown up, at maximum height its velocity is zero but it has constant acceleration.

(b) Yes. In uniform circular motion, an object moves with a uniform speed but it has an acceleration towards the centre of the circle.

(c) Yes. When the object is moving along a circular motion its path is along the tangent. The direction of the body is always perpendicular to its acceleration.

### In Textbook Questions

1. An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example. (Page No:08)

Ans: Yes, an object which has moved through a distance can have zero displacement. If it comes its initial position.

Example: If person starts at one initial point on circular path and complete one round, the final point and initial points are same.

2. 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 from his initial position? (Page No:08 )

Ans: Side of square field = 10 m

Perimeter =  $4 \times 10 = 40 \text{ m}$

Time taken = 40 s

Given time = 2 minutes 20 second =  $2 \times 60 + 20 = 140 \text{ s}$

No. of rounds = Total time taken/ Time of one complete round =  $\frac{140}{40} = 3.5 = 3 \frac{1}{2}$

So, Farmer moves diagonal opposite point on the square field.

Displacement =  $\sqrt{10^2 + 10^2} = \sqrt{200} = 14.14 \text{ m}$

3. 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.

Ans: (a) False, because displacement can be zero.

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

1. Distinguish between speed and velocity. (Page No:12)

Ans:

| Speed  | Velocity  |
|--|---|
| 1. Speed is the distance travelled by an object in a given interval of time. | 1. Velocity is the displacement of an object in a given interval of time. |
| 2. Speed = distance / time   | 2. Velocity = displacement / time   |
| 3. SI unit is m/s  | 3. SI unit is m/s   |
| 4. Speed is scalar quantity  | 4. Velocity is vector quantity  |

2. Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?

Ans: Only when an object is moving in a straight line.

3. What does the odometer of an automobile measure?

**Ans:** The distance covered by an automobile.

**4. What does the path of an object look like when it is in uniform motion?**

**Ans:** Straight line path

**5. During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station? The signal travels at the speed of light, that is,  $3 \text{ m s}^{-1}$**

**Ans:** Speed =  $3 \times 10^8 \text{ ms}^{-1}$

Time = 5 min =  $5 \times 60 = 300 \text{ secs.}$

Distance = Speed  $\times$  Time

$$= 3 \times 10^8 \times 300 = 9 \times 10^{10} \text{ m}$$

**1. When will you say a body is in (i) uniform acceleration? (ii) non-uniform acceleration? (Page No:14)**

**Ans:** (i) A body is said to be in uniform acceleration if the rate of change of its velocity is constant.

(ii) A body is said to be in nonuniform acceleration if the rate of change of its velocity is not constant.

**2. A bus decreases its speed from  $80 \text{ km h}^{-1}$  to  $60 \text{ km h}^{-1}$  in 5 s. Find the acceleration of the bus.**

**Ans:** Change in speed (v-u) =  $60 \text{ km h}^{-1} - 80 \text{ km h}^{-1} = -20 \text{ km h}^{-1} = -20 \times \frac{5}{18} = -5.55 \text{ m s}^{-1}$

Time (t) = 5 s

Acceleration (a) = (v-u)/t =  $-5.55 \text{ m s}^{-1}/5 \text{ s} = -1.11 \text{ m s}^{-2}$

**3. A train starting from a railway station and moving with uniform acceleration attains a speed  $40 \text{ km h}^{-1}$  in 10 minutes. Find its acceleration.**

**Ans:** Given  $u = 0 \text{ ms}^{-1}$   $v = 40 \text{ km h}^{-1} = 40 \times \frac{5}{18} = \frac{100}{9} \text{ ms}^{-1}$   $t = 10 \text{ min} = 10 \times 60 = 600 \text{ s}$

$$\text{Acceleration, } a = \frac{v-u}{t} = \frac{\frac{100}{9}-0}{600} = \frac{100}{9 \times 600} = \frac{1}{54} \text{ ms}^{-1}$$

**1. What is the nature of the distance-time graphs for uniform and non-uniform motion of an object? (Page No:22)**

**Ans:** The nature of the distance – time graph for uniform motion: Straight line

The nature of the distance – time graph for non-uniform motion: Curve

**2. What can you say about the motion of an object whose distance-time graph is a straight line parallel to the time axis?**

**Ans:** The object is at rest

**3. What can you say about the motion of an object if its speed time graph is a straight line parallel to the time axis?**

**Ans:** The object is moving uniformly.

**4. What is the quantity which is measured by the area occupied below the velocity-time graph?**

**Ans:** The distance covered by the object.

**1. A bus starting from rest moves with a uniform acceleration of  $0.1 \text{ m s}^{-2}$  for 2 minutes. Find (a) the speed acquired, (b) the distance travelled. (Page No:24&26)**

**Ans:** Given  $u = 0 \text{ ms}^{-1}$   $a = 0.1 \text{ ms}^{-2}$   $t = 2 \text{ minutes} = 2 \times 60 = 120 \text{ s}$

(a) The speed acquired,  $v = u + at = 0 + 0.1 \times 120 = 12 \text{ ms}^{-1}$

(b) Distance,  $s = ut + \frac{1}{2}at^2 = 0 \times 120 + \frac{1}{2} \times 0.1 \times (120)^2 = \frac{1440}{2} = 720 \text{ m}$

**2. A train is travelling at a speed of  $90 \text{ km h}^{-1}$ . Brakes are applied so as to produce a uniform acceleration of  $-0.5 \text{ m s}^{-2}$ . Find how far the train will go before it is brought to rest.**

**Ans:** Here  $u = 90 \text{ km h}^{-1} = 90 \times \frac{5}{18} = 25 \text{ m s}^{-1}$   $v = 0 \text{ m s}^{-1}$   $a = -0.5 \text{ m s}^{-2}$

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

$$0^2 - 25^2 = 2 \times (-0.5) \times s$$

$$- 625 = -1s$$

$$s = 625$$

$\therefore$  Distance = 625 m

**3. A trolley, while going down an inclined plane, has an acceleration of  $2 \text{ cm s}^{-2}$ . What will be its velocity 3 s after the start?**

**Ans:** Given  $u = 0 \text{ cm s}^{-1}$   $a = 2 \text{ cm s}^{-2}$   $t = 3 \text{ s}$

$$v = u + at$$

$$= 0 + 2 \times 3 = 6 \text{ cm s}^{-1}$$

**4. A racing car has a uniform acceleration of  $4 \text{ m s}^{-2}$ . What distance will it cover in 10 s after start?**

**Ans:** Given  $u = 0 \text{ ms}^{-1}$   $a = 4 \text{ ms}^{-2}$   $t = 10 \text{ s}$

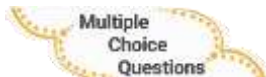
$$\text{Distance, } s = ut + \frac{1}{2} at^2 = 0 \times 10 + \frac{1}{2} \times 4 \times (10)^2 = 200 \text{ m}$$

5. A stone is thrown in a vertically upward direction with a velocity of  $5 \text{ m s}^{-1}$ . If the acceleration of the stone during its motion is  $10 \text{ m s}^{-2}$  in the downward direction, what will be the height attained by the stone and how much time will it take to reach there?

**Ans:** Here  $u = 5 \text{ m s}^{-1}$   $a = 10 \text{ m s}^{-2}$   $v = 0 \text{ m s}^{-1}$

$$\text{Height, } h = \frac{u^2}{2g} = \frac{5 \times 5}{2 \times 10} = \frac{25}{20} = 1.25 \text{ m}$$

$$\text{Time taken, } t = \frac{u}{g} = \frac{5}{10} = 0.5 \text{ s}$$



**1. What is motion?**

- a) The change of position of an object with time  
 b) The colour change of an object  
 c) The size change of an object  
 d) The shape change of an object

**Ans:** a) The change of position of an object with time

**2. Which of the following is the unit of speed?**

- a) m/s b) kg/m c) m/s<sup>2</sup> d) m<sup>3</sup>/s

**Ans:** a) m/s

**3. What does uniform motion mean?**

- a) Changing speed b) Changing direction  
 c) Constant speed d) Constant acceleration

**Ans:** c) Constant speed

**4. What is the formula for speed?**

- a) Speed = Distance  $\times$  Time  
 b) Speed = Distance / Time  
 c) Speed = Time / Distance  
 d) Speed = Distance + Time

**Ans:** b) Speed = Distance / Time

**5. What is the unit of distance?**

- a) Second b) Meter c) Kilogram d) Newton

**Ans:** b) Meter

**6. If an object moves 100 meters in 20 seconds, what is its speed?**

- a) 5 m/s b) 2 m/s c) 10 m/s d) 20 m/s

**Ans:** a) 5 m/s

**7. What is velocity?**

- a) Speed in a particular direction  
 b) Speed in all directions  
 c) Speed without direction d) Distance per unit time

**Ans:** a) Speed in a particular direction

**8. Which of the following is a vector quantity?**

- a) Speed b) Distance c) Velocity d) Mass

**Ans:** c) Velocity

**9. What is acceleration?**

- a) Change in speed b) Change in velocity  
 c) Change in direction d) Change in distance

**Ans:** b) Change in velocity

**10. Which of the following is the unit of acceleration?**

- a) m/s b) m/s<sup>2</sup> c) m d) m<sup>2</sup>/s

**Ans:** b) m/s<sup>2</sup>

**11. If an object accelerates from 0 to 20 m/s in 5 seconds, what is its acceleration?**

- a) 4 m/s<sup>2</sup> b) 5 m/s<sup>2</sup> c) 6 m/s<sup>2</sup> d) 3 m/s<sup>2</sup>

**Ans:** a) 4 m/s<sup>2</sup>

**12. What does the slope of a distance-time graph represent?**

- a) Speed b) Distance c) Time d) Acceleration

**Ans:** a) Speed

**13. What does the slope of a velocity-time graph represent?**

- a) Speed b) Distance c) Acceleration d) Time

**Ans:** c) Acceleration

**14. What is the acceleration of an object moving at constant velocity?**

- a) Zero b) Positive c) Negative d) Infinity

**Ans:** a) Zero

**15. If a car is traveling at 30 m/s and comes to a stop in 10 seconds, what is its acceleration?**

- a) -3 m/s<sup>2</sup> b) -5 m/s<sup>2</sup> c) -10 m/s<sup>2</sup> d) -2 m/s<sup>2</sup>

**Ans:** b) -3 m/s<sup>2</sup>

**16. What is the difference between speed and velocity?**

- a) Speed is a scalar, velocity is a vector  
 b) Speed is a vector, velocity is a scalar  
 c) Speed includes direction, velocity does not  
 d) There is no difference

**Ans:** a) Speed is a scalar, velocity is a vector

**17. If an object covers equal distances in equal intervals of time, it is said to be in \_\_\_\_\_**

- a) Non-uniform motion b) Uniform motion  
 c) Accelerated motion d) Circular motion

**Ans:** b) Uniform motion

**18. What is the formula for acceleration?**

- a) Acceleration = Velocity / Time  
 b) Acceleration = Time / Velocity  
 c) Acceleration = Change in velocity / Time  
 d) Acceleration = Distance / Time

**Ans:** c) Acceleration = Change in velocity / Time

**19. What does a horizontal line on a distance-time graph indicate?**

- a) Constant speed b) Increasing speed  
 c) Stationary object d) Decreasing speed

**Ans:** c) Stationary object

**20. If an object is moving with uniform velocity, what will its acceleration be?**

- a) Zero b) Positive c) Negative d) Variable

**Ans:** a) Zero

**21. Which physical quantity is described by the area under the velocity-time graph?**

- a) Speed                      b) Acceleration  
c) Distance                    d) Displacement

**Ans:** d) Displacement

**22. If a cyclist is moving at a constant speed of 10 m/s, how far will they travel in 5 seconds?**

- a) 50 m    b) 100 m    c) 10 m    d) 5 m

**Ans:** a) 50 m

**23. What kind of motion is described by an object moving in a circular path at constant speed?**

- a) Uniform motion    b) Non-uniform motion  
c) Uniform circular motion  
d) Non-uniform circular motion

**Ans:** c) Uniform circular motion

### Competency - Based Questions

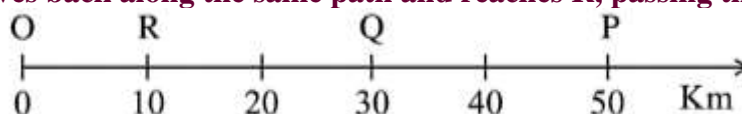
#### Multiple Choice Questions

**1. A marble rolls 6m in 2s. What is the average speed of the marble?**

- A) 0.33 m/s                  B) 0.5 m/s                  C) 3 m/s                  D) 12 m/s

**Ans:** C) 3 m/s

**2. An object starts its journey from O, which is considered the reference point. First, it moves through R and Q to reach P. Then it moves back along the same path and reaches R, passing through Q.**



What is the magnitude of the displacement of the object?

- A) 10 km                  B) 20 km                  C) 40 km                  D) 90 km

**Ans:** A) 10 km

**3. Which of the following statements about displacement is correct?**

- A) The displacement of an object can never be zero.  
B) The displacement of an object can never be equal to the distance it travels.  
C) The magnitude of displacement of an object is always less than or equal to the distance it travels.  
D) The magnitude of displacement of an object is always greater than or equal to the distance it travels.

**Ans:** C) The magnitude of displacement of an object is always less than or equal to the distance it travels.

**4. In which of the following cases is the acceleration zero?**

- A) A stone thrown upwards  
B) An apple freely falling from a tree  
C) A ball moving in a circular path at a constant speed  
D) A train travelling on a straight track with constant speed

**Ans:** D) A train travelling on a straight track with constant speed

**5. There are two statements given below marked as Assertion and Reason.**

**Assertion (A):** If the velocity of an object is constant, then its acceleration is also constant.

**Reason (R):** The acceleration of an object is the change in velocity per unit time.

Choose the correct option:

- A) A is false but R is true.  
B) A is true but R is false.  
C) Both A and R are true. R is the correct explanation of A.  
D) Both A and R are true. R is not the correct explanation of A.

**Ans:** C) Both A and R are true. R is the correct explanation of A.

**6. In which of the following case/cases is/are distance and displacement equal in magnitude?**

- P) A boy walks from home to school on a straight road.  
Q) A girl jogs around a circular track and returns to the starting point.  
R) A boy goes to school in a straight line and returns home by the same path.

- A) Only P                  B) Only Q                  C) Only Q and R                  D) Only P and Q

**Ans:** A) Only P

**7. Imagine a satellite orbiting the Earth in a circular path. After the satellite completes one full revolution, the net displacement of the satellite is equal to \_\_\_\_\_.**

- A) Zero                                  B) The radius of the orbit  
C) The circumference of the orbit                  D) The distance between the centres of the Earth and the satellite

**Ans:** A) Zero

8. A student ties a stone to a 1-meter-long thread and swings it in a circular motion. He then wants to calculate the speed of the stone.

Which of the following does he definitely need for this experiment?

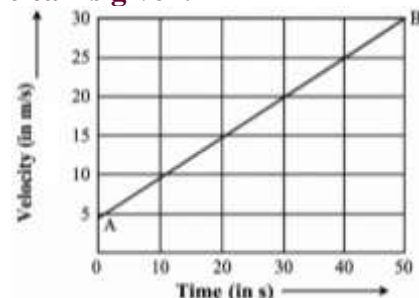
- A) Stopwatch
- B) Graph paper
- C) Measuring tape
- D) Magnetic compass

Ans: A) Stopwatch

9. A car is travelling with a uniform acceleration. The velocity-time graph of the car is given.

Using the data in the graph, select the correct option that shows the total distance covered by the car in 40 seconds.

- A) 400 m
- B) 600 m
- C) 700 m
- D) 1000 m



Ans: B) 600 m

10. The shaded area in the given velocity-time graph represents \_\_\_\_\_.

- A) Velocity of the body
- B) Acceleration of the body
- C) Change in momentum of the body
- D) Magnitude of displacement of the body

Ans: D) Magnitude of displacement of the body

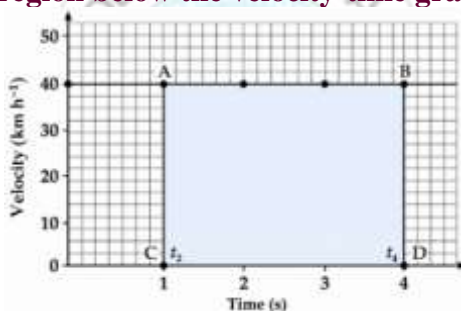
11. What does the Odometer of a vehicle measure?

- A) The instantaneous speed
- B) The total distance travelled
- C) The rate of acceleration
- D) The fuel tank status

Ans: B) The total distance travelled

12. What does the area of the shaded region below the velocity-time graph represent?

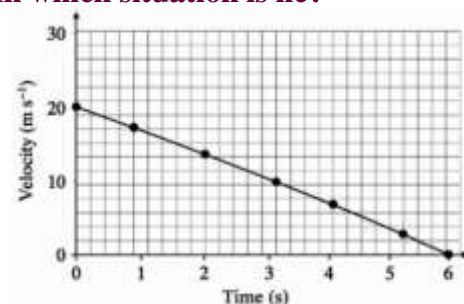
- A) Displacement
- B) Acceleration
- C) Speed
- D) Time



Ans: A) Displacement

13. Ram drew the following velocity-time graph in a situation he involved. In which situation is he?

- A) Dropped a ball from the top of a building.
- B) Applied brakes on his car and comes to rest.
- C) Sitting in a car moving on a straight road at a constant speed.
- D) Sitting in a bus starting from rest and moving with increasing speed.



Ans: B) Applied brakes on his car and comes to rest.

14. The table below shows the speed of a bus in three hours of its travel.

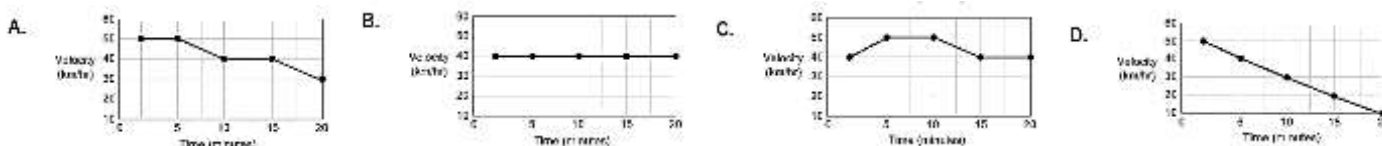
| Hour             | First hour | Second hour | Third hour |
|------------------|------------|-------------|------------|
| Speed of the bus | 35 km/hr   | 60 km/hr    | 40 km/hr   |

What was the average speed of the bus?

- A) 35 km/hr
- B) 40 km/hr
- C) 45 km/hr
- D) 60 km/hr

Ans: C) 45 km/hr

15. Which velocity-time graph shows a period of acceleration in the motion?



Ans: C

16. A student walks 50 m east and then 50 m west. What is the displacement?

- A) 100 m                      B) 50 m                      C) 0 m                      D) 25 m

Ans: C) 0 m

17. A horizontal line on a velocity-time graph indicates

- A) Uniform acceleration      B) Constant velocity      C) Retardation      D) Zero displacement

Ans: B

18. A velocity-time graph with a negative slope represents

- A) Uniform motion      B) Acceleration      C) Retardation (deceleration)      D) Rest

Ans: C

19. A bus moves from A to B and returns to A. Which statement is correct?

- A) Distance = 0                      B) Displacement = Distance  
C) Distance > 0 and Displacement = 0                      D) Distance < Displacement

Ans: C

### 2 Marks Questions

1. Below are the definitions of some physical quantities related to motion. Name each one and write its correct SI unit.

- a) The rate of change of displacement                      b) The rate of change of velocity

Ans: a) Velocity

SI Unit:  $\text{m s}^{-1}$

b) Acceleration

SI Unit:  $\text{m s}^{-2}$

2. A bus starting from rest moves with a uniform acceleration of  $0.2 \text{ m/s}^2$  for 5 minutes.

Find the speed acquired by the bus after 5 minutes.

Ans: Initial velocity,  $u = 0 \text{ m/s}$

Acceleration,  $a = 0.2 \text{ m/s}^2$

Time,  $t = 5 \text{ minutes} = 300 \text{ s}$

Using the equation:  $v = u + at$

$$= 0 + (0.2 \times 300)$$

$$= 60 \text{ m/s}$$

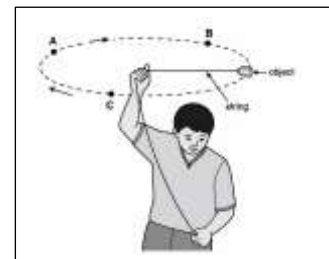
3. The picture below shows a man swinging an object in a uniform circular motion.

A, B and C are three different points on the path of motion of the object.

What is the net displacement of the object after one complete swing? Why?

Ans: Zero.

Initial and final points are same.



4. Why is velocity changing in circular motion even if speed is constant?

Ans: In circular motion the direction of motion changes continuously. Since velocity depends on direction, velocity changes even though speed remains constant.

5. A car travels 100 km in 2 hours. Find its average speed.

Ans: Given

Distance = 100 km, Time = 2 h

$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time}} = \frac{100}{2} = 50 \text{ km/h}$$

6. Define acceleration and explain.

Ans: The change in the velocity of an object per unit time is called as acceleration. The SI unit is  $\text{m/s}^2$  or  $\text{ms}^{-2}$ .

$$\text{Acceleration (a)} = \frac{\text{Change in velocity}}{\text{Time taken}} = \frac{v-u}{t}$$

7. Why is displacement sometimes zero even though distance is not zero?

Ans: When an object returns to its starting point, the initial and final positions coincide. Hence displacement becomes zero but distance travelled is not zero.

8. Why is displacement zero when an object returns to its starting point?

Ans: When an object returns to its starting point, its initial and final positions are the same. Hence, the displacement is zero.

9. Why is average speed used instead of speed in many situations?

Ans: In most cases, the speed of an object is not constant. Therefore, average speed is used to describe the overall rate of motion during the entire journey.

10. Why can the average velocity of an object be zero even though it has travelled some distance?

**Ans:** If an object returns to its starting point, its displacement is zero. Since average velocity depends on displacement, the average velocity becomes zero even though the distance travelled is not zero.

#### 4 Marks Questions

1. State and explain the three equations of motion.

**Ans:** For uniformly accelerated motion,

First Equation  $v = u + at$

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

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

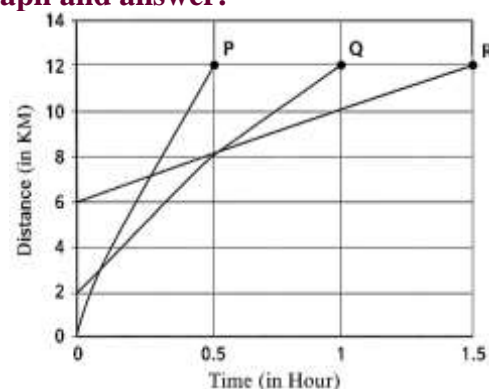
Where  $u$  = Initial velocity,  $v$  = Final velocity,  $a$  = Acceleration,  $t$  = Time,  $s$  = Distance travelled

2. A car travels from Vijayawada to Guntur and returns back. Which quantity will help you know whether the car finally changed its position?

**Ans:** Displacement helps to know the final change in position because it depends only on initial and final positions. Since the car returns to the starting point, displacement is zero.

3. The distance-time graph of three cars P, Q and R is given. Study the graph and answer:

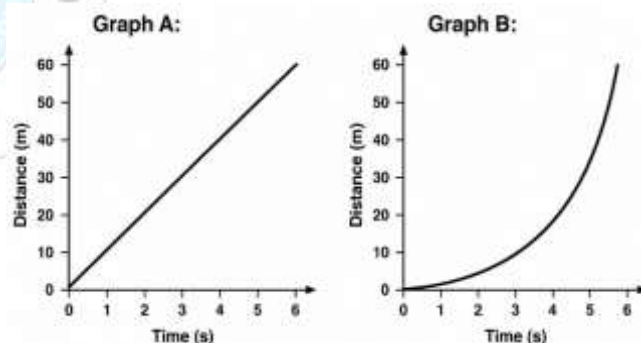
- Which car travels with the least speed?
- Which car has the shortest travel time?
- At what time do cars P and R meet after the journey begins?
- Calculate the speed of car P when it crosses car R.



- Ans:** i) Car R  
 ii) Car P  
 iii) 0.25 hours  
 iv) 24 km/h (Speed = Distance/Time = 12/ 0.5 = 24 km/h)

4. Observe the following two distance-time graphs and answer.

- Which type of motion is represented by Graph A and Graph B?
- Write the difference between the two kinds of motion.



**Ans:** i) Graph A: Uniform Motion, Graph B: Non-uniform Motion

ii)

| Uniform Motion (Graph A)                                      | Non-uniform Motion (Graph B)                                    |
|---|---|
| The object covers equal distances in equal intervals of time. | The object covers unequal distances in equal intervals of time. |
| Speed remains constant.                                       | Speed changes with time.  |
| Distance-time graph is a straight line.                       | Distance-time graph is a curve.                                 |

5. Explain why average speed and average velocity are not always equal.

- Ans:** i) Average speed is calculated using the total distance travelled.  
 ii) Average velocity is calculated using the total displacement.  
 iii) Distance is always greater than or equal to displacement.  
 iv) Therefore, average speed is generally greater than average velocity.  
 v) They are equal only when the object moves in a straight line without changing direction.

#### 8 Marks Questions

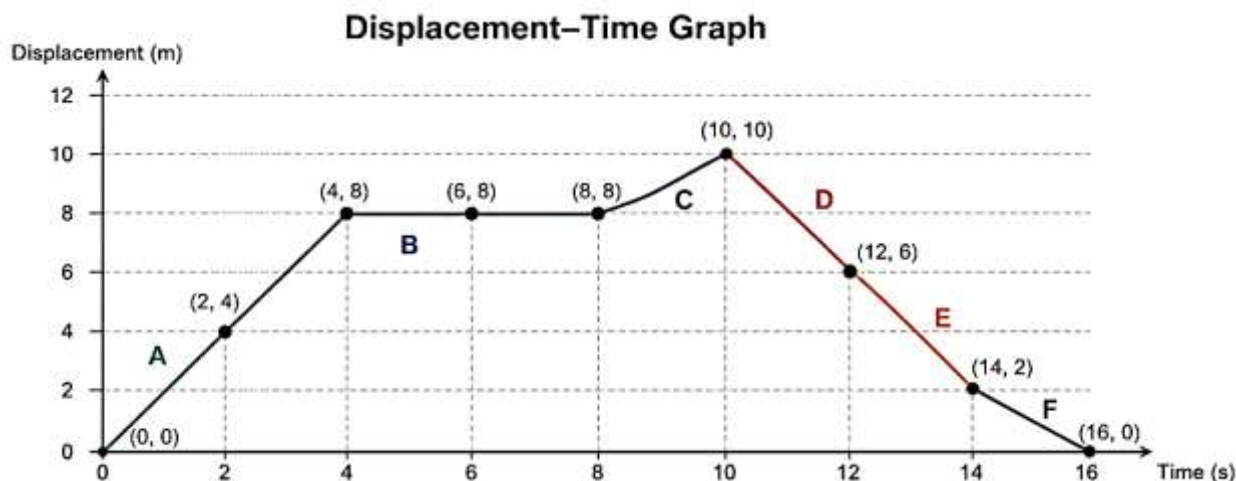
1. Study the data given in the table below.

|                  |   |   |   |   |   |    |    |    |    |
|------------------|---|---|---|---|---|----|----|----|----|
| Time (s)         | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| Displacement (m) | 0 | 4 | 8 | 8 | 8 | 10 | 6  | 2  | 0  |

Using this information, draw a displacement-time graph for the moving object. Label each segment and

explain what each segment represents in terms of motion.

Ans:



- 0–4 s: Moving away from the origin.
- 4–8 s: At rest.
- 8–10 s: Moving further away.
- 10–16 s: Returning towards the origin.
- At 16 s: Returns to the starting position.

2. A train leaves a station and accelerates uniformly from 5 m/s to 15 m/s in 5 seconds.

i) What is the train's acceleration?

ii) What distance does the train cover during this time?

iii) What is the average speed of the train during this 5-second interval?

iv) If the train continues to accelerate at the same rate for another 5 seconds, what will its speed be at the end of 10 seconds?

Ans: Initial speed,  $u=5$  m/s

Final speed,  $v=15$  m/s

Time,  $t=5$  s

i) Acceleration ( $a$ ) =  $\frac{v-u}{t} = \frac{15-5}{5} = \frac{10}{5} = 2$  m/s<sup>2</sup>

ii) Distance,  $s = ut + \frac{1}{2}at^2$   
 $= 5 \times 5 + \frac{1}{2} \times 2 \times (5)^2$   
 $= 25 + 25$   
 $= 50$  m

iii) Average speed =  $\frac{v+u}{2} = \frac{15+5}{2} = \frac{20}{2} = 10$  m/s

iv)  $u = 5$  m/s       $a = 2$  m/s<sup>2</sup>       $t = 10$  sec

Final speed ( $v$ ) =  $u + at = 5 + 2 \times 10 = 25$  m/s

3. Explain distance-time graph and velocity-time graph.

Ans:

#### Distance-Time Graph

- i) Time on X-axis.
- ii) Distance on Y-axis.
- iii) Straight line → Uniform motion.
- iv) Curved line → Non-uniform motion.
- v) Slope gives speed.

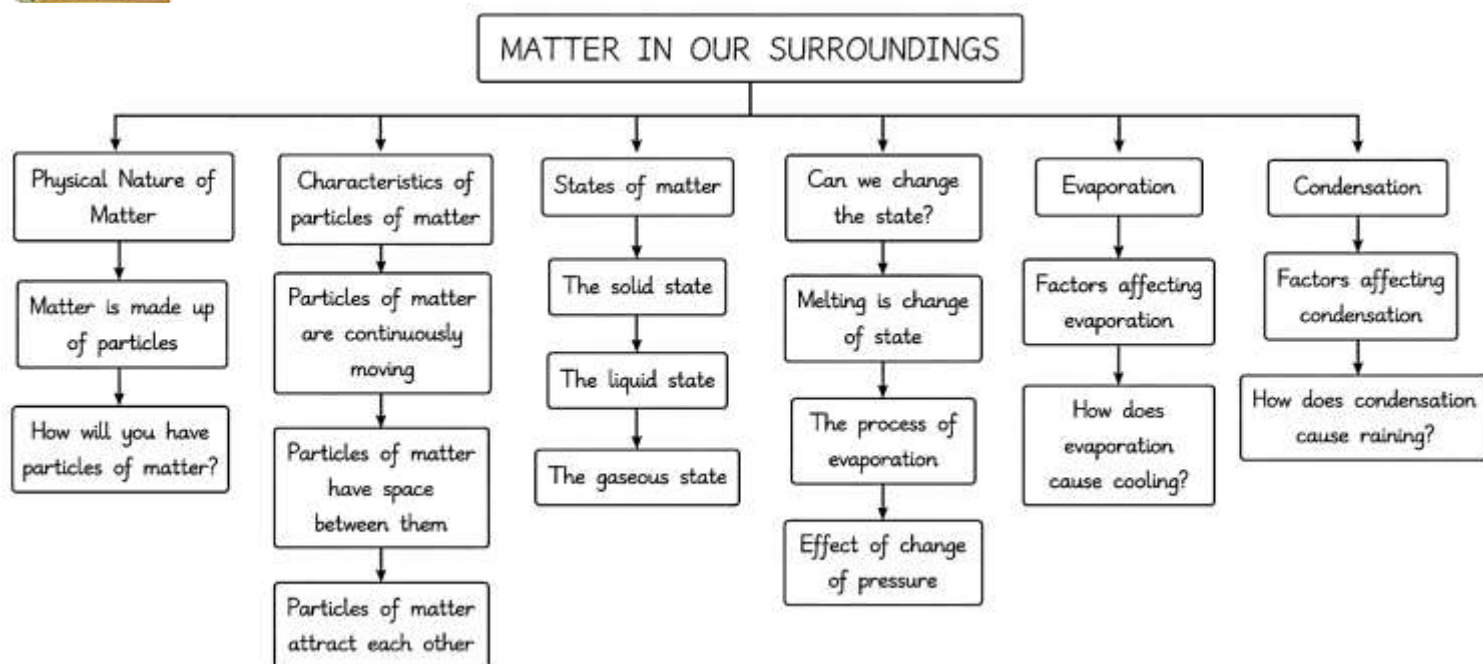
#### Velocity-Time Graph

- i) Time on X-axis.
- ii) Velocity on Y-axis.
- iii) Slope gives acceleration.
- iv) Area under graph gives displacement.
- v) Horizontal line shows uniform velocity.

Graphs help in understanding motion easily.

## Chapter - 2

## MATTER IN OUR SURROUNDINGS



## Main Points

1. Everything in this universe is made up of material which scientists have named “matter”.
2. Early Indian philosophers classified matter in the form of five basic elements — the “Panch Tatva” — air, earth, fire, sky and water.
3. Matter is made up of small particles.
4. The particles of matter are very small they are small beyond our imagination.
5. Characteristics of Particles of Matter: - i) Particles of matter have spaces between them. ii) Particles of matter are continuously moving. iii) Particles of matter attract each other.
6. The matter around us exists in three states—solid, liquid and gas.
7. The forces of attraction between the particles are maximum in solids, intermediate in liquids and minimum in gases.
8. Solids have a definite shape, distinct boundaries, fixed volumes and negligible compressibility.
9. Liquids have no fixed shape but have a fixed volume. They take up the shape of the container in which they are kept.
10. The rate of diffusion of liquids is higher than that of solids and less than that of gases.
11. Gases are highly compressible as compared to solids and liquids.
12. Liquefied Petroleum Gas (LPG) cylinder that we get in our home for cooking or the oxygen supplied to hospitals in cylinders is compressed gas.
13. Compressed Natural Gas (CNG) is used as fuel these days in vehicles
14. The states of matter are inter-convertible. The state of matter can be changed by changing temperature or pressure.
15. On increasing the temperature of solids, the kinetic energy of the particles increases.
16. Solid carbon dioxide is also known as dry ice.
17. The minimum temperature at which a solid melts to become a liquid at the atmospheric pressure is called its melting point.
18. The temperature at which a liquid starts boiling at the atmospheric pressure is known as its boiling point. Boiling is a bulk phenomenon.
19. The melting point of ice is 273.15 K, Boiling point of water is 373 K (100 °C).
20. Sublimation is the change of solid state directly to gaseous state without going through liquid state.
21. Deposition is the change of gaseous state directly to solid state without going through liquid state.
22. The phenomenon of change of liquid into vapours at any temperature below its boiling point is called Evaporation.
23. The rate of evaporation depends upon the surface area exposed to the atmosphere, the temperature, the humidity and the wind speed.

24. Evaporation is a surface phenomenon. Evaporation causes cooling.  
 25. Latent heat of fusion is the amount of heat energy required to change 1 kg of solid into liquid at its melting point.  
 26. Latent heat of vaporisation is the heat energy required to change 1 kg of a liquid to gas at atmospheric pressure at its boiling point.

### Exercises

**1. Convert the following temperatures to the Celsius scale. (a) 293 K (b) 470 K**

**Ans:**  $^{\circ}\text{C} = \text{K} - 273$

(a)  $293 \text{ K} = 293 - 273 = 20^{\circ}\text{C}$

(b)  $470 \text{ K} = 470 - 273 = 197^{\circ}\text{C}$

**2. Convert the following temperatures to the kelvin scale. (a) 25°C (b) 373°C**

**Ans:**  $\text{K} = ^{\circ}\text{C} + 273$

(a)  $25^{\circ}\text{C} = 20 + 273 = 298 \text{ K}$

(b)  $373^{\circ}\text{C} = 373 + 273 = 646 \text{ K}$

**3. Give reason for the following observations.**

(a) Naphthalene balls disappear with time without leaving any solid.

(b) We can get the smell of perfume sitting several metres away.

**Ans:** (a) Naphthalene is a substance which directly changes from solid to gas on heating by the process of Sublimation. So, Naphthalene balls disappear with time without leaving any solid.

(b) Perfumes have high degree of vaporisation and its vapour diffuses into the air easily. Therefore, we can get the smell of perfume sitting several metres away.

**4. Arrange the following substances in increasing order of forces of attraction between the particles—*water, sugar, oxygen.***

**Ans:** oxygen < water < sugar

**5. What is the physical state of water at—**

(a) 25°C

(b) 0°C

(c) 100°C ?

**Ans:** (a) Liquid state

(b) Solid or/and liquid state (Transition state)

(c) Liquid or/and gaseous state (Transition state)

**6. Give two reasons to justify—**

(a) water at room temperature is a liquid.

(b) an iron almirah is a solid at room temperature.

**Ans:** (a) Water at room temperature is a liquid because it has fluidity also it has no shape but has a fixed volume that is, it occupies the shape of the container in which it is kept.

(b) An iron almirah is a solid at room temperature it has rigid and fixed shape.

**7. Why is ice at 273 K more effective in cooling than water at the same temperature?**

**Ans:** Ice at 273 K has less energy than water (although both are at the same temperature). Water possesses the additional latent heat of fusion. Hence, at 273 K, ice is more effective in cooling than water.

**8. What produces more severe burns, boiling water or steam?**

**Ans:** Steam has more energy than boiling water. It possesses the additional latent heat of vaporisation. Therefore, burns produced by steam are more severe than those produced by boiling water.

**9. Imagine you are a tiny particle inside a block of ice. Now imagine the ice melts into water. Explain what changes happen in your movement and arrangement in the liquid state.**

**Ans:** When the ice melts into water, I gain energy and start moving more freely. In ice, I was closely packed in a fixed position and could only vibrate. In the liquid state, the particles are less tightly packed and can slide past one another. Therefore, my movement increases and my arrangement becomes less orderly.

**10. Statement:** I am the reverse process of sublimation. Which of the following situations best represents me?

A) Ice changing into water on heating

B) Water vapour changing directly into ice crystals on a cold surface

C) Solid camphor changing directly into vapour

D) Water changing into steam on boiling

**Ans:** B) Water vapour changing directly into ice crystals on a cold surface

## In Textbook Questions

1. Which of the following are matter? (Page No:38)

*Chair, air, love, smell, hate, almonds, thought, cold, lemon water, smell of perfume.*

**Ans:** Chair, air, almonds and cold drink

2. Give reasons for the following observation:

**The smell of hot sizzling food reaches you several metres away, but to get the smell from cold food you have to go close.**

**Ans:** Evaporation is directly proportional to temperature, means hot food evaporates easily. Diffusion of hot food vapor with air becomes very fast and can reach to a distant place within a very short time.

3. A diver is able to cut through water in a swimming pool. Which property of matter does this observation show?

**Ans:** The phenomena of cutting the water by the diver show that matter has space between its particles.

4. What are the characteristics of the particles of matter?

**Ans:** i) Particles of matter have spaces between them.  
ii) Particles of matter are continuously moving.  
iii) Particles of matter attract each other.

1. The mass per unit volume of a substance is called density. (density = mass/volume).

**Arrange the following in order of increasing density – air, exhaust from chimneys, honey, water, chalk, cotton and iron. (Page No:44)**

**Ans:** Air, Exhaust from chimneys, water, honey, cotton, chalk and iron.

2. (a) Tabulate the differences in the characteristics of states of matter.

(b) Comment upon the following: rigidity, compressibility, fluidity, filling a gas container, shape, kinetic energy and density.

**Ans: Rigidity:** It is the property of matter to resist the change of its shape.

**Compressibility:** It is the property of matter in which its volume is decreased by applying force.

**Fluidity:** It is the ability of matter to flow.

**Filling a gas container:** On filling a gas takes the shape of the container.

**Shape:** Having definite boundaries.

**Kinetic Energy:** It is the energy possessed by the particles of matter due to its motion.

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

3. Give reasons

(a) A gas fills completely the vessel in which it is kept.

(b) A gas exerts pressure on the walls of the container.

(c) A wooden table should be called a solid.

(d) We can easily move our hand in air but to do the same through a solid block of wood we need a karate expert.

**Ans:** (a) The gas particles have negligible intermolecular forces. These are move freely and occupy all the space available to them.

(b) The gas particles collide with the container walls due to their random motion in all directions, exerting a force on the surface per unit area.

(c) A wooden table has fixed shape and fixed volume. It is very rigid and cannot be compressed.

(d) In air, there is a less force of attraction between the particles. So, very less amount of external force can break it. But in the case of solid, the force of attraction is very strong and the molecular space is so high. Hence a large amount of force is required to break it.

4. Liquids generally have lower density as compared to solids. But you must have observed that ice floats on water. Find out why.

**Ans:** Ice is solid but its density is lower than that of water due to its network structure and forms a cage-like structure with a lot of vacant space. So that's why ice floats on water.

1. Convert the following temperature to Celsius scale: (Page No:50)

a. 300 K

b. 573 K

**Ans:**  $^{\circ}\text{C} = \text{K} - 273$

a)  $300 \text{ K} = 300 - 273 = 27^{\circ}\text{C}$

b)  $573 \text{ K} = 573 - 273 = 300^{\circ}\text{C}$

2. What is the physical state of water at: a.  $250^{\circ}\text{C}$       b.  $100^{\circ}\text{C}$ ?

**Ans:** a. Gaseous State

b. Can exist in both liquid and gaseous form

**3. For any substance, why does the temperature remain constant during the change of state?**

**Ans:** The heat energy being supplied is used to break the bonds between molecules, not to increase their energy and raise the temperature.

**4. Suggest a method to liquefy atmospheric gases.**

**Ans:** High pressure is applied at low temperature.

**1. Why does a desert cooler cool better on a hot dry day? (Page No:52)**

**Ans:** Evaporation increases on temperature and humidity. On a hot dry day, there is high temperature and low humidity. This faster evaporation absorbs heat from the surroundings and a desert cooler cool.

**2. How does the water kept in an earthen pot (matka) become cool during summer?**

**Ans:** An earthen pot is porous in nature. Water gets evaporated through the pores of pot by absorbing heat from the water present inside the pot leading to cooling.

**3. Why does our palm feel cold when we put some acetone or petrol or perfume on it?**

**Ans:** Our palm feels cold when we put some acetone/petrol/perfume on it because evaporation. During the evaporation, liquid absorb energy from the palm. Evaporation is a cooling process.

**4. Why are we able to sip hot tea or milk faster from a saucer rather than a cup?**

**Ans:** When the surface area increases, evaporation also increase. Saucer has larger surface area than the cup. So, we are able to sip hot tea or milk faster than a saucer rather than a cup.

**5. What type of clothes should we wear in summer?**

**Ans:** We should wear cotton cloths during summer season.

**Activities**

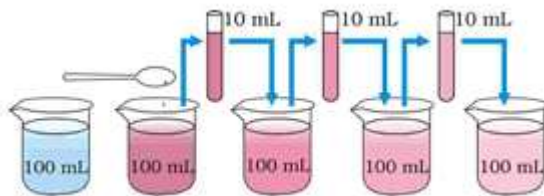
**1. Explain with the help of an activity which shows that particles of matter are very small?**

**Aim:** To shows that particles of matter are very small.

**Required materials:** Potassium permanganate crystals, Beakers, water

**Procedure:**

1. Take 2–3 crystals of potassium permanganate and dissolve them in 100 mL of water.
2. Take out approximately 10 mL of this solution and put it into 90 mL of clear water.
3. Take out 10 mL of this solution and put it into another 90 mL of clear water.
4. Keep diluting the solution like these 5 to 8 times.
5. The water remains coloured till the last dilution.



**Observation:** The particles of matter are very small.

**2. Explain with the help of an activity which shows that particles of matter are continuously moving.**

**Aim:** Shows that particles of matter are continuously moving

**Required materials:** Two glasses/ beakers, Blue or Red ink, Honey

**Procedure:**

1. Take two glasses/beakers filled with water.
2. Put a drop of blue or red ink slowly and carefully along the sides of the first beaker and honey in the same way in the second beaker.
3. Leave them undisturbed in your house or in a corner of the class.
4. Record your observations.
5. The colour of ink starts spreading soon.
6. The honey drops slowly disappear.
7. The colour of ink spreads evenly throughout the water within a few minutes.

**Observation:** Particles of matter are continuously moving.

**3. Explain with the help of an activity which shows that gases can be compressed easily.**

**Aim:** Shows that gases can be compressed easily.

**Required materials:** Syringes, Rubber corks, Water, Pieces of chalk, Vaseline.

**Procedure:**

1. Take three 100 mL syringes and close their nozzles by rubber corks.
2. Remove the pistons from all the syringes.
3. Leaving one syringe untouched, fill water in the second and pieces of chalk in the third.
4. Insert the pistons back into the syringes.
5. Apply some vaseline on the pistons before inserting them into the syringes for their smooth movement.
6. Now, try to compress the content by pushing the piston in each syringe.
7. The piston was pushed in easily in the syringe in the which nothing except air was filled.



**Observation:** Gases can be compressed easily.

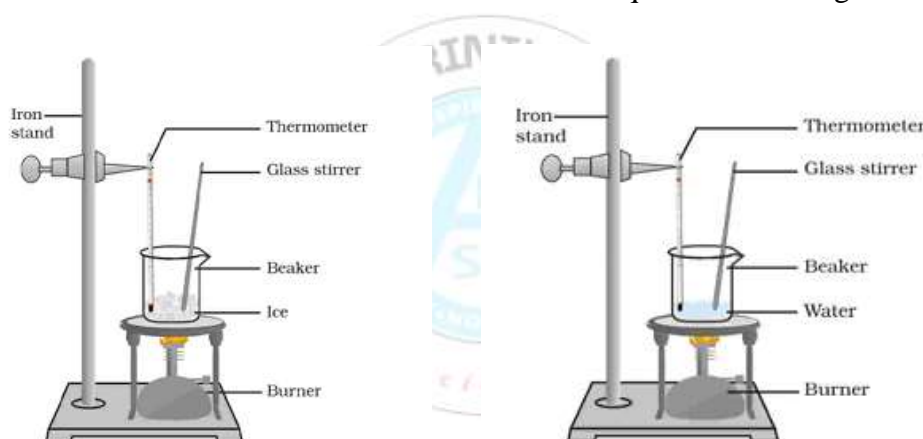
#### 4. Explain with the help of an activity which shows that effect of changes of temperature on substance.

**Aim:** Effect of changes of temperature on substance.

**Required materials:** Ice, Beaker, Thermometer, Iron stand, Burner.

**Procedure:**

1. Take about 150 g of ice in a beaker and suspend a laboratory thermometer so that its bulb is in contact with the ice.
2. Start heating the beaker on a low flame.
3. Note the temperature when the ice starts melting.
4. Note the temperature when all the ice has converted into water.
5. Record your observations for this conversion of solid to liquid state.
6. Now, put a glass rod in the beaker and heat while stirring till the water starts boiling.
7. Keep a careful eye on the thermometer reading till most of the water has vaporised.
8. Record your observations for the conversion of water in the liquid state to the gaseous state.



**Observation:** On increasing the temperature of solids, the kinetic energy of the particles increases.

#### 5. Explain with the help of an activity which shows that sublimation of solid.

**Aim:** To study the changes in state of Sublimate solids on heating.

**Required materials:** Camphor/Ammonium chloride, China dish, Funnel.

**Procedure:**

1. Take some camphor or ammonium chloride. Crush it and put it in a china dish.
2. Put an inverted funnel over the china dish.
3. Put a cotton plug on the stem of the funnel, as shown in figure.
4. Now, heat slowly and observe.
5. Vapour of ammonium chloride get deposited on the inner stem of funnel.

**Observation:** Solid ammonium chloride gets converted into vapours directly.

#### 6. Explain with the help of an activity which shows that factors affecting evaporat

**Aim:** Factors affecting evaporation.

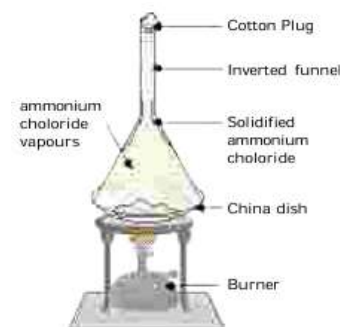
**Required materials:** Test tube, China dish, Water.

**Procedure:**

1. Take 5 mL of water in a test tube and keep it near a window or under a fan.
2. Take 5 mL of water in an open china dish and keep it near a window or under a fan.
3. Take 5 mL of water in an open china dish and keep it inside a cupboard or on a shelf in your class.
4. Repeat the above three steps of activity on a rainy day and record your observations.

**Observation:** 1. Evaporation will be fastest from the china dish kept near the window.

2. The evaporation increases with temperature, surface area of the container and speed of wind.



1. Which of the following cannot be considered a form of matter?

- a) Atom b) Water c) Humidity d) Electron

**Ans:** c) Humidity

2. 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

**Ans:** a) Latent heat

3. What is the physical state of matter in which particles have the least kinetic energy?

- a) Solid b) Liquid c) Gas d) Plasma

**Ans:** a) Solid

4. Which of the following is not characteristic of solid

- a) High Rigidity b) Regular Shape  
c) High Density d) High compressibility

**Ans:** d) High compressibility

5. Which of the following is a characteristic property of solids?

- a) Definite shape and volume  
b) Indefinite shape and volume  
c) Indefinite shape but definite volume  
d) Definite shape but indefinite volume

**Ans:** a) Definite shape and volume

6. What happens to the arrangement of particles when a substance changes from solid to liquid state?

- a) Particles come closer together  
b) Particles move further apart  
c) Particles become arranged in a regular pattern  
d) None of the above

**Ans:** b) Particles move further apart

7. Which of the following statements about gases is true?

- a) Gases have definite shape and volume  
b) Gases have definite shape but indefinite volume  
c) Gases have indefinite shape and volume  
d) Gases have indefinite shape but definite volume

**Ans:** c) Gases have indefinite shape and volume

8. The process of conversion of a solid into a gas without passing through the liquid state is called

- a) Evaporation b) Condensation  
c) Sublimation d) Fusion

**Ans:** c) Sublimation

9. Which of the following substances does not show the property of sublimation?

- a) Iodine b) Camphor c) Naphthalene d) Copper

**Ans:** d) Copper

10. Which of the following is a physical change?

- a) Rusting of iron b) Burning of paper  
c) Melting of ice d) Cooking of food

**Ans:** c) Melting of ice

11. Which of the following has the highest intermolecular force?

- a) Solid b) Liquid c) Gas d) Plasma

**Ans:** a) Solid

12. The process of changing a liquid into a gas is called

- a) Condensation b) Evaporation  
c) Sublimation d) Fusion

**Ans:** b) Evaporation

13. Which of the following is not a characteristic property of matter?

- a) Mass b) Volume c) Colour d) Density

**Ans:** c) Colour

14. A form of matter has no fixed shape but it has a fixed volume. An example of this matter is

- a) Krypton b) Kerosene  
c) Carbon steel d) Carbon dioxide

**Ans:** b) Kerosene

15. When converting 308 K, 329 K, and 391 K to the Celsius scale, what is the correct sequence of temperatures?

- 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

**Ans:** c) 35°C, 56°C and 118°C

16. Which of the following decreases the rate of evaporation?

- a) Surface area b) Humidity c) Temperature d) Wind

**Ans:** b) Humidity

17. Large volume of CNG is available in small cylinders to us due to its property of

- a) High inflammability b) Easy availability  
c) High Compressibility d) Low density

**Ans:** c) High Compressibility

18. Which of the following phenomena always results in the cooling effect?

- a) Condensation b) Evaporation  
c) Sublimation d) None of these

**Ans:** b) Evaporation

19. During evaporation particles of a liquid change into vapours

- a) From the surface b) From the bulk  
c) From the bottom d) From all over the liquid

**Ans:** a) From the surface

20. The boiling point of water is

- a) 100 °C at atmospheric pressure  
b) 273 K at atmospheric pressure  
c) 0 °C at atmospheric pressure  
d) 0 K at atmospheric pressure

**Ans:** a) 100 atmospheric pressure °C at

21. At higher altitudes the boiling points of liquids

- a) Decreases b) Increases  
c) Increases then decreases d) Remains all same

**Ans:** a) Decreases

## Competency - Based Questions

## Multiple Choice Questions

1. Naphthalene balls slowly disappear over time without leaving any solid behind. What is the name of this process?  
 A) Melting                      B) Deposition                      C) Evaporation                      D) Sublimation

**Ans:** D) Sublimation

2. At which of the following temperatures can water exist in both liquid and gaseous states?

A) 100°C                      B) 100 K                      C) 273°C                      D) 273 K

**Ans:** A) 100°C

3. Dry ice is commonly used to create fog effects in stage shows. What is the chemical formula of dry ice?

A) H<sub>2</sub>                      B) H<sub>2</sub>O                      C) CO<sub>2</sub>                      D) It has no chemical formula.

**Ans:** C) CO<sub>2</sub>

4. The cylinder used for cooking in our homes contains liquefied petroleum gas (LPG). How is this gas liquefied?

A) By adding a liquid to the gas                      B) By increasing the pressure of the gas  
 C) By increasing the temperature of the gas                      D) By mixing the gas with special chemicals

**Ans:** B) By increasing the pressure of the gas

5. A student dropped 2–3 crystals of potassium permanganate into 100 ml of water. The water gradually turned purple in colour.

What does this activity demonstrate about the nature of liquids?

A) Liquids have a fixed volume.                      B) Liquids do not have a fixed shape.  
 C) The particles of liquids are closely spaced.                      D) The particles of liquids are continuously moving.

**Ans:** D) The particles of liquids are continuously moving.

6. Anjali and Vijaya were playing a game. Vijaya had to identify a substance by asking questions. Anjali can answer only “yes” or “no”.

Vijaya: Does it have a fixed shape?

Anjali: No

Vijaya: Does it have a fixed volume?

Anjali: Yes

Which of the following could be that substance?

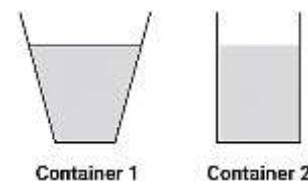
A) Salt                      B) Water                      C) Oxygen                      D) Rubber band

**Ans:** B) Water

7. Given below are two containers with different shapes. Both are filled with water.

What do you observe after a few days when both containers are placed in a dark room?

- A) Water evaporates the fastest from Container 1.  
 B) Water evaporates the fastest from Container 2.  
 C) Water does not evaporate from the containers at all.  
 D) Water evaporates at the same rate from both the containers.



**Ans:** A) Water evaporates the fastest from Container 1.

8. Which of the following particles have the highest energy?

A) Particles of ice at 0°C                      B) Particles of water at 0°C  
 C) Particles of water at 100°C                      D) Particles of water vapour at 100°C

**Ans:** D) Particles of water vapour at 100°C

9. Rani observes different changes of state in her daily life. In which of the following situations does the change of state involve absorption of heat energy?

P) Water boils in a kettle to form steam.                      Q) Water in the freezer turns into ice cubes.  
 R) Steam from hot tea condenses on the lid of the cup.                      S) An ice cube kept on a plate melts into water.  
 A) P only                      B) P and Q only                      C) P and S only                      D) P, Q and R only

**Ans:** C) P and S only

10. A tightly closed container contains 300 ml of gas. Now the gas is carefully transferred into a 1000 ml container without any leakage. What is the volume of the gas in the new container?

A) 300 ml                      B) 600 ml                      C) 1000 ml                      D) 2000 ml

**Ans:** C) 1000 ml

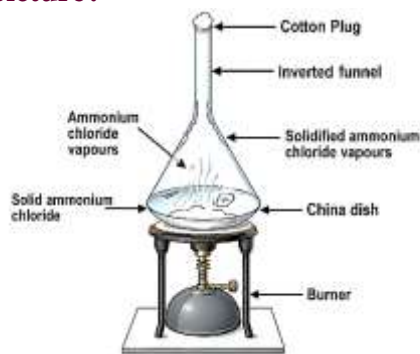
11. Why does acetone poured on the palm feel cold?

- A) It freezes      B) It evaporates rapidly      C) It condenses      D) It melts

**Ans:** B) It evaporates rapidly

**12. What is the process shown in this picture?**

- A) Melting  
B) Evaporation  
C) Sublimation  
D) Condensation



**Ans:** C) Sublimation

**13. Why are LPG cylinders painted light colours?**

- A) To reduce heating      B) To increase pressure      C) To increase evaporation      D) To increase volume

**Ans:** A) To reduce heating

**14. A drop of ink spreads faster in hot water because**

- A) Water becomes coloured      B) Density decreases      C) Particle movement increases      D) Ink becomes heavier

**Ans:** C) Particle movement increases

**15. Why is water stored in earthen pots during summer?**

- A) Freezing occurs      B) Evaporation causes cooling      C) Condensation occurs      D) Diffusion stops

**Ans:** B) Evaporation causes cooling

**16. Which of the following shows sublimation?**

- A) Ice → Water      B) Water → Steam      C) Camphor → Vapour      D) Steam → Water

**Ans:** C) Camphor → Vapour

**17. Rani added a spoon of sugar to water and observed that the water level did not increase significantly.**

**What does this show?**

- A) Sugar disappears completely      B) Water particles are destroyed  
C) There are spaces between water particles      D) Sugar changes into water

**Ans:** C) There are spaces between water particles

**18. A student sprays perfume in one corner of a room. After some time, students throughout the room can smell it. Which property of matter is demonstrated?**

- A) Compressibility      B) Diffusion      C) Sublimation      D) Freezing

**Ans:** B) Diffusion

**19. Why do gases spread faster than liquids?**

- A) Stronger intermolecular forces      B) Larger particle size  
C) Greater intermolecular spaces and kinetic energy      D) Lower temperature

**Ans:** C

### 2 Marks Questions

**1. Answer the following questions.**

- a) Name the three states of matter.  
b) Arrange the following substances in increasing order of the forces of attraction between their particles:  
Honey, Salt and Carbon dioxide.

**Ans:** a) Solid, Liquid, Gas

b) Carbon dioxide < Honey < Salt

**2. Temperature of two cities at different times is given below:**

| City     | At 6 AM | At 11 AM | At 6 PM |
|----------|---------|----------|---------|
| Simla    | 3°C     | 300 K    | 3°C     |
| Srinagar | 270 K   | 27°C     | 275 K   |

**Observe the table and answer:**

**A) In which city is the morning temperature at 6 o'clock relatively high?**

**B) At what time are both cities having the same temperature?**

**Ans:** a) Simla, because 3°C is higher than 270 K (-3°C).

b) At 11 AM, because both cities have 27°C (300 K = 27°C).

3. Kavya noticed that the smell of hot samosas reached her from a long distance, whereas she had to go near cold food to smell it.

Answer the following

a) Which property of matter explains this?

b) Why does hot food smell travel faster?

Ans: a) Diffusion.

b) Particles move faster at higher temperature due to greater kinetic energy.

4. A diver jumps into a swimming pool and moves through water easily.

Answer the following questions:

a) What property of matter allows this?

b) Why can the diver move through water?

Ans: a) Spaces between particles.

b) Water particles have spaces and weaker intermolecular forces compared to solids.

5. Why do wet clothes dry faster when they are spread out than when they are folded?

Ans: Wet clothes dry faster when they are spread out because a larger surface area is exposed to the air. This increases the rate of evaporation of water. When clothes are folded, only a small surface area is exposed, so evaporation is slower and the clothes take longer to dry.

6. Why are we able to sip hot tea or milk faster from a saucer than from a cup?

Ans: A saucer provides a larger surface area than a cup. Hence, evaporation is faster, and the tea or milk cools more quickly.

7. Why does water kept in an earthen pot (matka) become cool during summer?

Ans: Water slowly evaporates through the tiny pores of the earthen pot. During evaporation, heat is absorbed from the water, making it cool.

8. Why do we feel cool when acetone or perfume is poured on our palm?

Ans: Acetone or perfume evaporates quickly by absorbing heat from the palm. This loss of heat produces a cooling effect.

9. Why do water droplets appear on the outside of a glass containing ice-cold water?

Ans: Water vapour present in the air loses heat on coming into contact with the cold surface of the glass and condenses into water droplets.

#### 4 Marks Questions

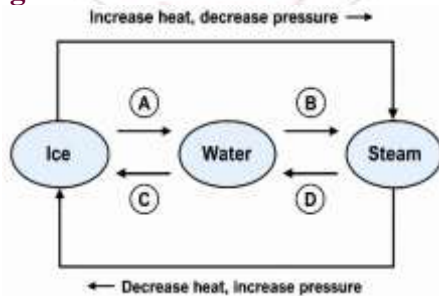
1. What are the characteristics of particles of matter?

Ans: i) Particles of matter have spaces between them.

ii) Particles of matter are continuously moving.

iii) Particles of matter attract each other.

2. Study the diagram showing the changes in the state of matter.



Name the processes A, B, C and D.

Ans: A = Melting or fusion.

C = Condensation or liquification.

B = Evaporation or vaporization.

D = Freezing or solidification.

3. Explain the following terms:

a) Latent heat of vaporisation

b) Latent heat of fusion

Ans: a) Latent heat of fusion is the amount of heat energy required to change 1 kg of solid into liquid at its melting point.

b) Latent heat of vaporisation is the heat energy required to change 1 kg of a liquid to gas at atmospheric pressure at its boiling point.

4. Why should we wear cotton clothes in summer?

Ans: During summer, we perspire more to keep our body cool. Cotton clothes absorb sweat easily. The absorbed sweat evaporates into the atmosphere. During evaporation, heat is absorbed from the body. This cools the body and keeps us comfortable. Therefore, we should wear cotton clothes in summer.

5. Why do we see water droplets on the outer surface of a glass containing ice-cold water?

Ans: Water vapour is present in the air. When it comes in contact with the cold outer surface of a glass containing ice-cold water, it loses heat energy. As a result, the water vapour changes into liquid water. This process is called condensation. Therefore, water droplets appear on the outer surface of the glass.

**6. Why is evaporation considered a surface phenomenon?**

- Ans:** i) Evaporation takes place only from the surface of a liquid.  
 ii) Only the surface particles gain enough energy to escape into the vapour state.  
 iii) The particles inside the liquid do not escape directly.  
 iv) Hence, evaporation is called a surface phenomenon.

**7. LPG is supplied in cylinders, whereas oxygen is supplied in cylinders under high pressure. Explain the scientific reason.**

- Ans:** i) Gases can be compressed by applying pressure.  
 ii) Under high pressure, LPG is converted into the liquid state.  
 iii) Liquid LPG occupies less space and is easy to store and transport.  
 iv) Therefore, LPG is stored in cylinders under pressure.

**8 Marks Questions****1. Explain evaporation and factors affecting it. Write its applications.**

**Ans:** The phenomenon of change of liquid into vapours at any temperature below its boiling point is called Evaporation.

**Factors affecting evaporation**

- Surface area: Larger surface area increases evaporation.
- Temperature: Higher temperature increases evaporation.
- Humidity: Lower humidity increases evaporation.
- Wind speed: Higher wind speed increases evaporation.

**Applications:** Drying clothes, Cooling by sweating, Cooling of water in earthen pots.

**2. Explain why evaporation causes cooling.**

**Ans:** During evaporation, particles with higher kinetic energy escape from the liquid surface. To regain this energy, the liquid absorbs heat from the surroundings. As a result, the surroundings lose heat and become cool.

Examples: i) Acetone on palm gives a cooling sensation.

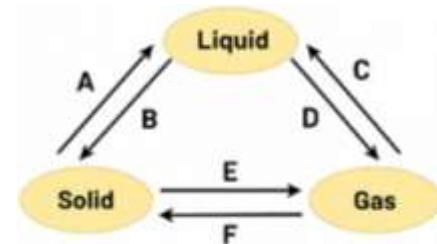
- Sweating cools the body.
- Water in an earthen pot remains cool.
- Desert coolers work effectively in hot and dry weather.

**3. Explain the effect of temperature on the state of matter.**

- Ans:** 1. Matter is made up of particles having kinetic energy.  
 2. When temperature increases, kinetic energy increases.  
 3. Solid particles vibrate faster and melt into liquids.  
 4. Further heating converts liquids into gases.  
 5. During melting and boiling, heat is absorbed as latent heat.  
 6. When temperature decreases, gases condense into liquids.  
 7. Liquids freeze into solids.  
 8. Thus temperature controls the change of state of matter.

**4. Observe the figure and Identify all the processes involved in the interconversion of states of matter.**

- Ans:** A-Fusion  
 B-Solidification  
 C-Vaporisation  
 D-Condensation  
 E-Sublimation  
 F-Deposition

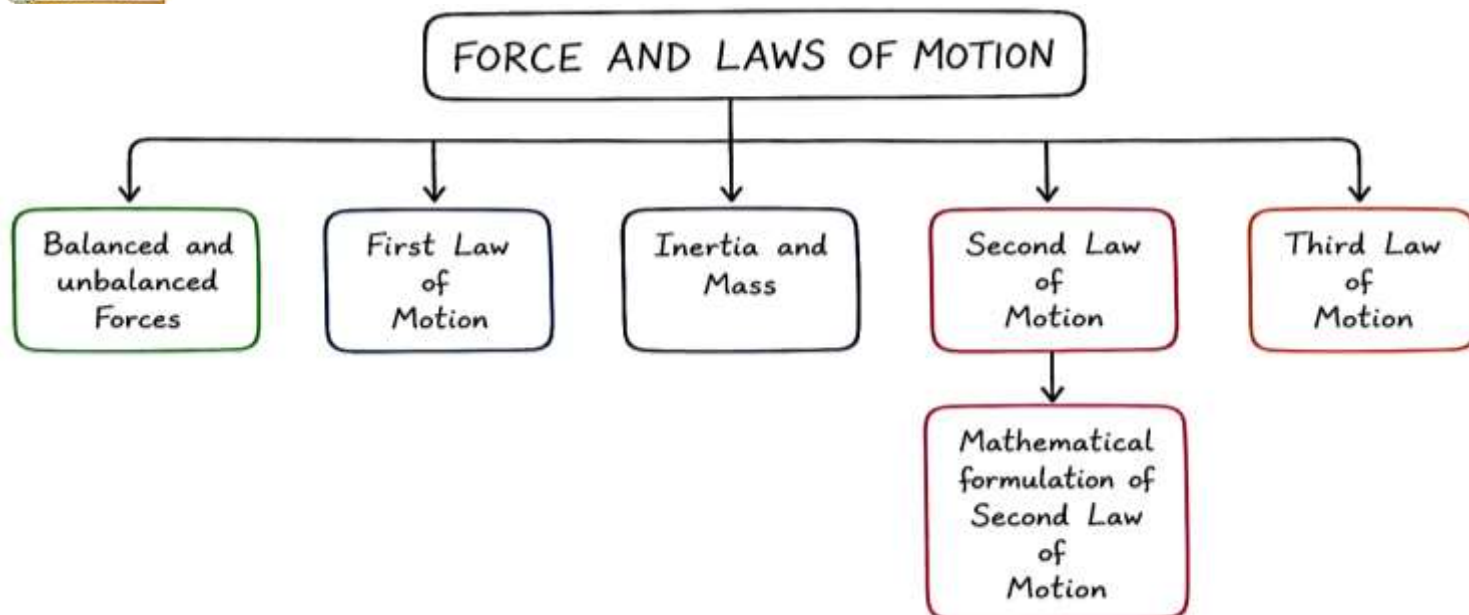
**5. Differentiate between solids, liquids and gases.**

**Ans:**

| Property             | Solids         | Liquids             | Gases              |
|----------------------|----------------|---------------------|--------------------|
| Shape                | Definite       | No definite shape   | No definite shape  |
| Volume               | Definite       | Definite            | No definite volume |
| Particle arrangement | Closely packed | Less closely packed | Far apart          |
| Force of attraction  | Very strong    | Moderate            | Very weak          |
| Compressibility      | Negligible     | Very little         | Very high          |
| Diffusion            | Very slow      | Faster              | Fastest            |
| Rigidity             | Rigid          | Not rigid           | Not rigid          |
| Kinetic energy       | Minimum        | Moderate            | Maximum            |

## Chapter - 3

## FORCE AND LAWS OF MOTION



## Main Points

1. A force can be used to change the magnitude of velocity or change its direction of motion or change the shape and size of objects
2. If the resultant of several forces acting on a body is zero, the forces are said to be Balanced forces.
3. If the resultant of several forces acting on a body is not zero, the forces are said to be Unbalanced forces.
4. An object moves with a uniform velocity when the forces acting on the object are balanced and there is no net external force on it.
5. If an unbalanced force is applied on the object, there will be a change either in its speed or in the direction of its motion
6. First law of motion: An object continues to be in a state of rest or of uniform motion along a straight line unless acted upon by an unbalanced force.
7. The first law of motion is also known as the law of inertia.
8. The natural tendency of objects to resist a change in their state of rest or of uniform motion is called inertia.
9. Inertia: a) Inertia of rest    b) Inertia of motion    c) Inertia of direction
10. The mass of an object is a measure of its inertia. Its SI unit is kilogram (kg).
11. Heavier or more massive objects offer larger inertia.
12. The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. Its SI unit is  $\text{kg m s}^{-1}$
13. 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.
14. Mathematical formula of Newton's second law of motion is  $F = ma$  (or)  $F = m \frac{v-u}{t}$
15. Force of friction always opposes motion of objects.
16. The unit of force is  $\text{kg m s}^{-2}$  or newton, which has the symbol N.
17. One Newton: A force of one newton produces an acceleration of  $1 \text{ m s}^{-2}$  on an object of mass 1 kg.
18. Third law of motion: To every action, there is an equal and opposite reaction and they act on two different bodies.

## Exercises

**1. An object experiences a net zero external unbalanced force. Is it possible for the object to be travelling with a non-zero velocity? If yes, state the conditions that must be placed on**

**Ans:** Yes, an object may travel with a non-zero velocity even when the net external force on it is zero. A rain drop falls down with a constant velocity. The weight of the drop is balanced by the upthrust and the viscosity of air. The net force on the drop is zero.

**2. When a carpet is beaten with a stick, dust comes out of it, Explain.**

**Ans:** When a carpet is beaten with a stick, then the carpet comes to motion. But, the dust particles try to resist their state of rest. According to Newton's first law of motion, the dust particles stay in a state of rest, while the carpet moves. Hence, the dust particles come out of the carpet.

**3. Why is it advised to tie any luggage kept on the roof of a bus with a rope?**

**Ans:** When the bus accelerates and moves forward, it acquires a state of motion. The luggage kept on the roof of a bus to its inertia, tends to remain in its state of rest. Hence, with the forward movement of the bus, the luggage tends to remain at its original position and ultimately falls from the roof of the bus. To avoid this, it is advised to tie any luggage kept on the roof of a bus with a rope.

**4. A batsman hits a cricket ball which then rolls on a level ground. After covering a short distance, the ball comes to rest. The ball slows to a stop because**

- (a) the batsman did not hit the ball hard enough.
- (b) velocity is proportional to the force exerted on the ball.
- (c) there is a force on the ball opposing the motion.
- (d) there is no unbalanced force on the ball, so the ball would want to come to rest.

**Ans:** (c)

**5. A truck starts from rest and rolls down a hill with a constant acceleration. It travels a distance of 400 m in 20 s. Find its acceleration. Find the force acting on it if its mass is 7 tonnes (Hint: 1 tonne = 1000 kg.)**

**Ans:** Given  $m = 7$  tonnes  $= 7 \times 1000$  kg  $= 7000$  kg       $u = 0$  ms<sup>-1</sup>       $s = 400$  m       $t = 20$  s

From 2<sup>nd</sup> equation of motion,  $s = ut + \frac{1}{2}at^2$

$$400 = 0 \times 20 + \frac{1}{2} \times a \times 20^2$$

$$400 = 200a$$

$$a = 2 \text{ ms}^{-2}$$

$$\text{Force, } F = ma = 7000 \times 2 = 14000 \text{ N}$$

**6. A stone of 1 kg is thrown with a velocity of 20 m s<sup>-1</sup> across the frozen surface of a lake and comes to rest after travelling a distance of 50 m. What is the force of friction between the stone and the ice?**

**Ans:** Given  $m = 1$  kg       $u = 20$  ms<sup>-1</sup>       $v = 0$  ms<sup>-1</sup>       $s = 50$  m

From 3<sup>rd</sup> equation of motion,  $v^2 - u^2 = 2as$

$$(0)^2 - (20)^2 = 2a(50)$$

$$a = -\frac{400}{100} = -4 \text{ ms}^{-2}$$

$$\text{Friction force, } F = ma = 1 \times (-4) = -4 \text{ N}$$

**7. A 8000 kg engine pulls a train of 5 wagons, each of 2000 kg, along a horizontal track. If the engine exerts a force of 40000 N and the track offers a friction force of 5000 N, then calculate:**

- (a) the net accelerating force and
- (b) the acceleration of the train.

**Ans:** Mass of engine = 8000 kg

$$\text{Mass of 5 wagons} = 5 \times 2000 = 10000 \text{ kg}$$

$$\text{Total mass} = 8000 + 10000 = 18000 \text{ kg}$$

$$(a) \text{ The net accelerating force, } F = \text{Engine force} - \text{Friction force} \\ = 40000 - 5000 = 35000 \text{ N}$$

$$(b) \text{ The acceleration of train, } a = \frac{F}{m} = \frac{35000}{18000} = \frac{35}{18} = 1.94 \text{ ms}^{-2}$$

**8. An automobile vehicle has a mass of 1500 kg. What must be the force between the vehicle and road if the vehicle is to be stopped with a negative acceleration of 1.7 m s<sup>-2</sup>?**

**Ans:** Given  $m = 1500$  kg       $a = -1.7$  m s<sup>-2</sup>

$$\text{The force between the vehicle and road, } F = ma = 1500 \times (-1.7) = -2550 \text{ N}$$

**9. What is the momentum of an object of mass  $m$ , moving with a velocity  $v$ ?**

- (a)  $(mv)^2$
- (b)  $mv^2$
- (c)  $\frac{1}{2}mv^2$
- (d)  $mv$

**Ans:** (d)

**10. Using a horizontal force of 200 N, we intend to move a wooden cabinet across a floor at a constant velocity. What is the friction force that will be exerted on the cabinet?**

**Ans:** The cabinet will move with constant velocity only when the net force on it is zero.

From Newton's third law of motion, an equal amount of friction force will act in the opposite direction.

$\therefore$  The frictional force exerted on the cabinet = 200 N.

**11. According to the third law of motion when we push on an object, the object pushes back on us with an**

equal and opposite force. If the object is a massive truck parked along the roadside, it will probably not move. A student justifies this by answering that the two opposite and equal forces cancel each other.

Comment on this logic and explain why the truck does not move.

**Ans:** Action and reaction always act on different bodies, so they cannot cancel each other. When we push a massive truck, the friction force between its tyres and the road is very large and so the truck does not move.

**12. A hockey ball of mass 200 g travelling at 10 m s<sup>-1</sup> is struck by a hockey stick so as to return it along its original path with a velocity at 5 m s<sup>-1</sup>. Calculate the magnitude of change of momentum occurred in the motion of the hockey ball by the force applied by the hockey stick.**

**Ans:** Given  $m = 200 \text{ g} = 0.2 \text{ kg}$        $u = 10 \text{ m s}^{-1}$        $v = -5 \text{ m s}^{-1}$

Change in momentum =  $m(v - u) = 0.2(-5 - 10) = -3 \text{ kg m s}^{-1}$

**13. A bullet of mass 10 g travelling horizontally with a velocity of 150 m s<sup>-1</sup> strikes a stationary wooden block and comes to rest in 0.03 s. Calculate the distance of penetration of the bullet into the block. Also calculate the magnitude of the force exerted by the wooden block on the bullet.**

**Ans:** Given  $m = 10 \text{ g} = 0.01 \text{ kg}$        $u = 150 \text{ m s}^{-1}$        $v = 0 \text{ m s}^{-1}$        $t = 0.03 \text{ s}$

Acceleration,  $a = \frac{v-u}{t} = \frac{0-150}{0.03} = -5000 \text{ m s}^{-2}$

The distance of penetration of the bullet,  $s = ut + \frac{1}{2}at^2$   
 $= 150 \times 0.03 + \frac{1}{2} \times (-5000) \times (0.03)^2$   
 $= 4.5 - 2.25$   
 $= 2.25 \text{ m}$

The magnitude of the force,  $F = ma = 0.01 \times 5000 = 50 \text{ N}$

**14. An object of mass 1 kg travelling in a straight line with a velocity of 10 m s<sup>-1</sup> collides with, and sticks to, a stationary wooden block of mass 5 kg. Then they both move off together in the same straight line. Calculate the total momentum just before the impact and just after the impact. Also, calculate the velocity of the combined object.**

**Ans:** Mass of object ( $m_1$ ) = 1 kg

Mass of wooden block ( $m_2$ ) = 5 kg

Initial velocity ( $u_1$ ) = 10 m/s

Initial velocity ( $u_2$ ) = 0 m/s

Let the velocity of combined after the collision =  $v$

Total momentum just before the impact =  $m_1 u_1 + m_2 u_2 = 1 \times 10 + 5 \times 0 = 10 \text{ kg m/s}$

Total momentum just after the impact =  $m_1 v + m_2 v = (m_1 + m_2) v = (1 + 5) v = 6v \text{ kg m/s}$

From conservation of momentum, Total momentum before collision = Total momentum after collision

$$6v = 10$$

$$v = 10/6 = 1.67 \text{ m/s}$$

**15. An object of mass 100 kg is accelerated uniformly from a velocity of 5 m s<sup>-1</sup> to 8 m s<sup>-1</sup> in 6 s. Calculate the initial and final momentum of the object. Also, find the magnitude of the force exerted on the object.**

**Ans:** Given  $m = 100 \text{ kg}$        $u = 5 \text{ m s}^{-1}$        $v = 8 \text{ m s}^{-1}$        $t = 6 \text{ s}$

Initial momentum ( $p_1$ ) =  $mu = 100 \times 5 = 500 \text{ kg m s}^{-1}$

Final momentum ( $p_2$ ) =  $mv = 100 \times 8 = 800 \text{ kg m s}^{-1}$

The magnitude of the force exerted on the object,  $F = \frac{p_2 - p_1}{t} = \frac{800 - 500}{6} = \frac{300}{6} = 50 \text{ N}$

**16. 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. Comment on these suggestions.**

**Ans:** Both the motorcar and insect experience the equal force and same change in their momentum. So, I agree with Rahul.

**17. How much momentum will a dumb-bell of mass 10 kg transfer to the floor if it falls from a height of 80 cm? Take its downward acceleration to be 10 m s<sup>-2</sup>.**

**Ans:** Given  $m = 10 \text{ kg}$ ,  $u = 0 \text{ m/s}$ ,  $h = 80 \text{ cm} = 0.8 \text{ m}$ ,  $g = 10 \text{ m s}^{-2}$

Final velocity ( $v$ ) =  $\sqrt{2gh} = \sqrt{2 \times 10 \times 0.8} = \sqrt{16} = 4 \text{ m/s}$

Momentum of a dumb-bell ( $p$ ) =  $mv = 10 \times 4 = 40 \text{ kg m/s}$

## In Textbook Questions

1. Which of the following has more inertia:

- (a) a rubber ball and a stone of the same size?  
 (b) a bicycle and a train?  
 (c) a five rupees coin and a one-rupee coin? (Page No:68)

**Ans:** We know that, heavier or more massive objects offer larger inertia.

- (a) Stone (b) Train (c) A five-rupee coin

2. In the following example, try to identify the number of times the velocity of the ball changes: "A football player kicks a football to another player of his team who kicks the football towards the goal. The goalkeeper of the opposite team collects the football and kicks it towards a player of his own team". Also identify the agent supplying the force in each case.

**Ans:** The velocity of ball changes 3 times.

1<sup>st</sup> time, the velocity changes when **football player of one team** kicks the ball.

2<sup>nd</sup> time, the velocity changes when **another player of same team** kicks the football.

3<sup>rd</sup> time, the velocity changes when **goalkeeper of the opposite team** kicks the football

3. Explain why some of the leaves may get detached from a tree if we vigorously shake its branch.

**Ans:** When a tree is vigorously shaken, the branches of the tree come in motion but the leaves tend to continue in their state of rest due to inertia of rest. As result, leaves get detached from a tree.

4. Why do you fall in the forward direction when a moving bus brakes to a stop and fall backwards when it accelerates from rest?

**Ans:** When a moving bus brakes to a stop, we fall in the forward direction due to inertia of motion.

When the bus accelerates from rest, we fall in the backward direction due to inertia of rest.

## Additional Exercises

A1. The following is the distance-time table of an object in motion:

|              |   |   |   |    |    |     |     |     |
|--------------|---|---|---|----|----|-----|-----|-----|
| Time (s)     | 0 | 1 | 2 | 3  | 4  | 5   | 6   | 7   |
| Distance (m) | 0 | 1 | 8 | 27 | 64 | 125 | 216 | 343 |

(a) What conclusion can you draw about the acceleration? Is it constant, increasing, decreasing, or zero?

(b) What do you infer about the forces acting on the object?

**Ans:** (a) The distances are  $0^3, 1^3, 2^3, 3^3, 4^3, 5^3, 6^3, 7^3$ .

The distance covered in each second increases rapidly, which means the velocity is increasing continuously.

The acceleration is increasing (non-uniform acceleration).

(b) According to Newton's Second Law, acceleration is produced by an unbalanced force.

An unbalanced force is acting on the object, and its magnitude is increasing with time.

A2. Two persons manage to push a motorcar of mass 1200 kg at a uniform velocity along a level road. The same motorcar can be pushed by three persons to produce an acceleration of  $0.2 \text{ m s}^{-2}$ . With what force does each person push the motorcar? (Assume that all persons push the motorcar with the same muscular effort.)

**Ans:** Mass of motorcar,  $m = 1200 \text{ kg}$

Acceleration produced by 3 persons,  $a = 0.2 \text{ m s}^{-2}$

Total force (F) =  $ma = 1200 \times 0.2 = 240 \text{ N}$

Since 3 persons apply equal force,

Force by each person =  $\frac{240}{3} = 80 \text{ N}$

A3. A hammer of mass 500 g, moving at  $50 \text{ m s}^{-1}$ , strikes a nail. The nail stops the hammer in a very short time of 0.01 s. What is the force of the nail on the hammer?

**Ans:** Mass of hammer = 500 g = 0.5 kg

Initial velocity,  $u = 50 \text{ m s}^{-1}$

Final velocity,  $v = 0 \text{ m s}^{-1}$

Time,  $t = 0.01 \text{ s}$

Acceleration (a) =  $\frac{v-u}{t} = \frac{0-50}{0.01} = -5000 \text{ ms}^{-2}$

Force (F) =  $ma = 0.5 \times (-5000) = -2500 \text{ N}$

The force exerted by the nail on the hammer is **2500 N** (opposite to the motion).

A4. A motorcar of mass 1200 kg is moving along a straight line with a uniform velocity of 90 km/h. Its velocity is slowed down to 18 km/h in 4 s by an unbalanced external force. Calculate the acceleration and change in

momentum. Also calculate the magnitude of the force required.

**Ans:** Mass,  $m = 1200 \text{ kg}$

Initial velocity,  $u = 90 \text{ km/h} = 25 \text{ m/s}$

Final velocity,  $v = 18 \text{ km/h} = 5 \text{ m/s}$

Time,  $t = 4 \text{ s}$

(i) Acceleration  $(a) = \frac{v-u}{t} = \frac{5-25}{4} = -5 \text{ ms}^{-2}$

(ii) Change in Momentum  $(\Delta p) = m(v-u)$   
 $= 1200(5-25) = 1200(-20) = -24000 \text{ kg m s}^{-1}$

(iii) Force Required  $(F) = ma = 1200 \times (-5) = -6000 \text{ N}$

Magnitude of force =  $6000 \text{ N}$

### Activities

#### 1. Describe an activity of a body will remain at rest unless acted upon by an unbalanced force.

**Aim:** A body will remain at rest unless acted upon by an unbalanced force. (Inertia of rest)

**Materials required:** Carom board, Carom coins.

**Procedure:**

1. Make a pile of similar carom coins on a table, as shown in Figure.
2. Attempt a sharp horizontal hit at the bottom of the pile using another carom coin or the striker.
3. If the hit is strong enough, the bottom coin moves out quickly.
4. Once the lowest coin is removed, the inertia of the other coins makes them 'fall' vertically on the table.



**Observation/Conclusion:** A body will remain at rest unless acted upon by an unbalanced force.

#### 2. Describe an activity of a body will remain at rest unless acted upon by an unbalanced force.

**Aim:** A body will remain at rest unless acted upon by an unbalanced force. (Inertia of rest)

**Materials required:** Five-rupee coin, Glass tumbler, Stiff card.

**Procedure:**

1. Set a five-rupee coin on a stiff card covering an empty glass tumbler standing on a table as shown in Figure.
2. Give the card a sharp horizontal flick with a finger.
3. If we do it fast then the card shoots away, allowing the coin to fall vertically into the glass tumbler due to its inertia.
4. The inertia of the coin tries to maintain its state of rest even when the card flows off



**Observation/Conclusion:** A body will remain at rest unless acted upon by an unbalanced force.

### Multiple Choice Questions

1. What is the ultimate outcome when balanced forces act upon an object?

- a) The object remains stationary.  
 b) The object accelerates c) The object decelerates  
 d) The object moves at a constant velocity

**Ans:** a) The object remains stationary

2. According to the fundamental law of motion, an object persists in its state of rest or uniform motion unless influenced by what?

- a) Unbalanced forces b) Balanced forces  
 c) Frictional forces d) Gravitational forces

**Ans:** a) Unbalanced forces.

3. Inertia embodies the resistance of an object to alterations in which of the following?

- a) Direction b) Velocity  
 c) Acceleration d) All the mentioned

**Ans:** d) All the mentioned.

4. As per the second law of motion, what parameter is directly linked to the acceleration of an object?

- a) Its mass b) Its inertia c) The applied force d) None

**Ans:** c) The applied force.

5. What is the precise mathematical expression representing the second law of motion?

- a)  $F = m \times a$  b)  $F = m / a$  c)  $F = m + a$  d)  $F = m - a$

**Ans:** a)  $F = m \times a$ .

6. If a person exerts a force of 500 N against a wall, what is the corresponding reaction force applied by the wall?

- a) 500 N      b) 0 N      c) 250 N      d) 100 N.

**Ans:** b) 0 N.

7. Which of the following scenarios best illustrates Newton's first law of motion?

- a) A ball rolling down a hill.  
b) A book sliding on a table coming to a stop.  
c) A person riding a bicycle at a steady pace.  
d) A car accelerating after being at rest.

**Ans:** c) A person riding a bicycle at a steady pace.

8. When a force of 10 N is applied to an object weighing 2 kg, what would be the resultant acceleration of the object?

- a) 20 m/s<sup>2</sup>      b) 5 m/s<sup>2</sup>      c) 2 m/s<sup>2</sup>      d) 0.2 m/s<sup>2</sup>

**Ans:** b) 5 m/s<sup>2</sup>

9. Which of the following is an example of Newton's third law of motion?

- a) A rocket launching into space  
b) A car accelerating on a straight road  
c) A person pushing a box across the floor  
d) A book resting on a table

**Ans:** a) A rocket launching into space

10. An object of mass 10 kg is subjected to a force of 20 N. What is the acceleration of the object?

- a) 0.5 m/s<sup>2</sup>      b) 2 m/s<sup>2</sup>      c) 200 m/s<sup>2</sup>      d) 10 m/s<sup>2</sup>

**Ans:** b) 2 m/s<sup>2</sup>

11. Which of the following is a unit of force in the SI system?

- a) kg      b) m/s      c) N      d) Pa

**Ans:** c) N

12. A force of 50 N is applied to an object of mass 10 kg. What is the net force acting on the object if it is moving with a constant velocity?

- a) 5 N      b) 10 N      c) 50 N      d) 0 N

**Ans:** d) 0 N

13. Which of the following is an example of inertia?

- a) A ball rolling down a hill  
b) A car turning around a curve  
c) A book at rest on a table remaining stationary

d) A person pushing a heavy box

**Ans:** c) A book at rest on a table remaining stationary

14. If the mass of an object is doubled while the force acting on it remains constant, what happens to its acceleration?

- a) It doubles      b) It remains the same  
c) It halves      d) It quadruples

**Ans:** c) It halves

15. Which of Newton's laws states that an object will remain at rest or in uniform motion unless acted upon by an external force?

- a) Newton's First Law      b) Newton's Second Law  
c) Newton's Third Law      d) Law of Gravitation

**Ans:** a) Newton's First Law

16. When a car accelerates on a straight road, the force responsible for its acceleration is primarily due to

- a) Frictional force      b) Gravitational force  
c) Applied force      d) Normal force

**Ans:** c) Applied force

17. According to Newton's second law of motion, the acceleration of an object is directly proportional to the

- a) Net force acting on the object  
b) Mass of the object      c) Velocity of the object  
d) Weight of the object

**Ans:** a) Net force acting on the object

18. When a person jumps from a boat to then shore, the boat moves backward due to:

- a) Action-reaction force      b) Gravitational force  
c) Frictional force      d) Buoyant force

**Ans:** a) Action-reaction force

19. Inertia is a measure of

- a) Mass      b) Velocity      c) Force      d) Acceleration

**Ans:** a) Mass

20. What is the SI unit of linear momentum

- a) kg ms<sup>-1</sup>      b) kg ms      c) kg ms<sup>-2</sup>      d) kg

**Ans:** a) kg ms<sup>-1</sup>

21. Which is more inertia

- a) Bicycle      b) Bike      c) Car      d) Bus

**Ans:** d) Bus

### Competency - Based Questions

#### Multiple Choice Questions

1. A fast-moving bus does not stop immediately after the brakes are applied but comes to rest after covering some distance. This is due to

- A) Newton's third law of motion      B) Conservation of momentum  
C) Inertia of rest      D) Inertia of motion

**Ans:** D) Inertia of motion

2. Momentum of an object of mass 'm' moving with velocity 'v' is

- A) mv<sup>2</sup>      B) mv      C) (mv)<sup>2</sup>      D) ½mv<sup>2</sup>

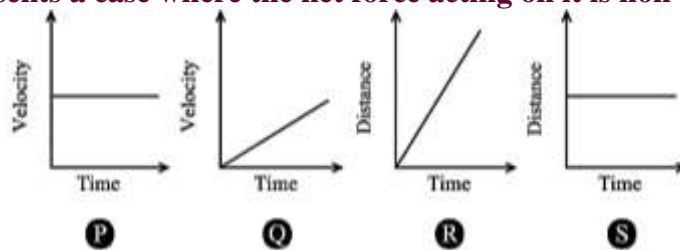
**Ans:** B) mv

3. A man applied 500 N of force to give 10 m/s<sup>2</sup> acceleration to an object. Then the mass of the object is

- A) 50 kg      B) 500 kg      C) 2500 kg      D) 5000 kg

**Ans:** A) 50 kg

4. The velocity-time graphs for objects P and Q, and the distance-time graphs for objects R and S, are shown below. Which object represents a case where the net force acting on it is non-zero?



- A) P                      B) Q                      C) R                      D) S

**Ans:** A) P

5. Two objects have the same momentum. Which statement must be true?

- A) They have the same mass.                      B) They have the same velocity.  
C) They have the same kinetic energy.                      D) The product of their mass and velocity is the same.

**Ans:** D) The product of their mass and velocity is the same.

6. A man is carrying a tray of bowls filled completely with soup in a moving train towards the front coaches. When the train comes to a sudden halt, what happens to the soup?

- A) The soup spills forward because it tries to maintain its motion.  
B) The soup remains unaffected because it is inside the bowls.  
C) The soup spills backward because of the sudden stop.  
D) The soup stays still because the tray stops suddenly.

**Ans:** A) The soup spills forward because it tries to maintain its motion.

7. An egg is dropped from a certain height onto a soft mattress instead of a hard floor. The egg does not break. This is because the mattress:

- A) Exerts a larger force on the egg.                      B) Increases the speed of the egg's fall.  
C) Increases the time taken to stop the egg.                      D) Increases the rate of change in momentum of the egg.

**Ans:** C) Increases the time taken to stop the egg.

8. Which object has the least inertia?



- A) Black board (60 kg)                      B) School bag (3 kg)                      C) School bell (15 kg)                      D) Table (20 kg)

**Ans:** B) School bag (3 kg)

9. If the velocity of an object is doubled, how does its momentum change?

- A) It becomes half.                      B) It remains the same.                      C) It becomes double.                      D) It becomes four times.

**Ans:** C) It becomes double.

10. When a carpet is beaten with a stick, dust comes out. Why does this happen?

- A) Due to the inertia of stick.                      B) Due to the conservation of momentum.  
C) Due to the inertia of carpet.                      D) Due to the inertia of dust on the carpet.

**Ans:** D) Due to the inertia of dust on the carpet.

### 2 Marks Questions

1. Using a horizontal force of 100 N, we intend to move a wooden slab across a floor at constant velocity. What is the amount of frictional force acting on the block?

**Ans:** Since the block is moving with constant velocity, the net force acting on it is zero.  
The frictional force is equal and opposite to the applied force.  
Frictional force = 100 N

2. A boy is jumping off a small boat into water.

- A) When he jumps forward, in which direction does the boat move?  
B) Name the law of motion that explains this.

**Ans:** A) The boat moves backward, opposite to the direction in which the boy jumps.  
B) Newton's Third Law of Motion.

3. Why is Newton's First Law also called the Law of Inertia?

**Ans:** Newton's First Law states that every object resists any change in its state of rest or uniform motion. This property is called inertia. Therefore, the First Law is known as the Law of Inertia.

**4. Why does a cricket fielder pull his hands backwards while catching a fast-moving ball?**

**Ans:** By pulling his hands backwards, the fielder increases the time taken to stop the ball. This reduces the force of impact and prevents injury.

**5. A football lying on the ground starts moving when a player kicks it. Which law explains this? Why?**

**Ans:** Newton's First Law of Motion explains this. The football remains at rest until an unbalanced external force (kick) acts on it and changes its state of rest.

**6. Why do leaves fall from a tree when its branch is shaken vigorously?**

**Ans:** When the branch is shaken suddenly, the branch moves but the leaves tend to remain at rest due to inertia of rest. As a result, the leaves get detached and fall.

**7. Why does a passenger in a moving bus fall forward when the driver applies sudden brakes?**

**Ans:** Due to inertia of motion, the passenger's body tends to continue moving forward even though the bus stops suddenly. Hence, the passenger falls forward.

**8. A coin placed on a card over a glass falls into the glass when the card is flicked quickly. Explain.**

**Ans:** The coin tends to remain at rest due to inertia of rest. When the card is flicked away quickly, the coin falls vertically into the glass under the action of gravity.

**9. Two students stand on separate skateboards and throw a heavy bag to each other. Why do both move backward?**

**Ans:** When one student throws the bag, an action force acts on the bag, and an equal and opposite reaction force acts on the student. Therefore, both students move backward according to Newton's Third Law.

**10. What is momentum? Write its SI unit.**

**Ans:** Momentum is the product of the mass and velocity of an object.

$$p = mv$$

SI Unit:  $\text{kg m s}^{-1}$  (or  $\text{kg m/s}$ ).

**4 Marks Questions****1. State Newton's Third Law.**

**Identify the action and reaction in the following scenarios:**

**A) During the journey of a rocket.**

**B) A man hits a wall with a force of 10 N.**

**Ans:** To every action, there is an equal and opposite reaction and they act on two different bodies.

A) Action: The rocket expels hot gases downward.

Reaction: The rocket moves upward.

B) Action: The man applies a force of 10 N on the wall.

Reaction: The wall applies an equal and opposite force of 10 N on the man.

**2. What is inertia? Mention its types.**

**Ans:** The natural tendency of objects to resist a change in their state of rest or of uniform motion is called inertia.

**Types of Inertia:** a) Inertia of rest    b) Inertia of motion    c) Inertia of direction

**3. Write any four applications of Newton's Laws of Motion in daily life.**

**Ans:** i) Wearing seat belts in cars.

ii) Catching a cricket ball by pulling the hands backward.

iii) Recoil of a gun after firing.

iv) A sailor jumping from a boat causes the boat to move backward.

**4. Why are seat belts and airbags provided in cars?**

**Ans:** i) During sudden braking, passengers continue moving forward due to inertia.

ii) Seat belts prevent the body from moving forward suddenly.

iii) Airbags increase the time of impact and reduce the force on the passenger.

iv) Thus, they reduce injuries during accidents.

**5. A loaded truck is harder to stop than an empty truck moving at the same speed. Explain the reason.**

**Ans:** The loaded truck has greater mass. Therefore, it has greater momentum and greater inertia. A larger force is needed to stop it. Hence, it is harder to stop than an empty truck.

**6. Observe the following situations and identify the law of motion involved.**

| Situation   | Law of Motion |
|---|---------------|
| Passenger falls forward when a bus stops suddenly         | -----         |
| Cricket player pulls hands backward while catching a ball | -----         |
| Gun recoils after firing                                  | -----         |
| Rocket moves upward                                       | -----         |

**Ans:**

| Situation   | Law of Motion       |
|---|---------------------|
| Passenger falls forward when a bus stops suddenly         | Newton's First      |
| Cricket player pulls hands backward while catching a ball | Newton's Second Law |
| Gun recoils after firing                                  | Newton's Third Law  |
| Rocket moves upward                                       | Newton's Third Law  |

### 8 Marks Questions

1. a) Derive  $F = ma$ .

b) Anu applied a force of 15 N on a toy car and produced an acceleration of  $1 \text{ m/s}^2$ .

How much force should she apply on the same toy car to produce an acceleration of  $3 \text{ m/s}^2$ ?

**Ans:** a) Let Mass of the object =  $m$

Initial velocity =  $u$

Final velocity =  $v$

Time taken =  $t$

Initial momentum( $p_1$ ) =  $mu$

Final momentum( $p_2$ ) =  $mv$

Change in momentum  $\propto p_2 - p_1$

$$\propto mv - mu$$

$$\propto m(v - u)$$

$$\text{Rate of change of momentum} \propto \frac{mv - mu}{t}$$

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

$$F \propto ma$$

$$F = kma$$

In the SI system,  $k=1$ .

$$F = ma$$

b)  $F_1 = 15 \text{ N}$

$$a_1 = 1 \text{ m/s}^2$$

$F_2 = ?$

$$a_2 = 3 \text{ m/s}^2$$

$$\frac{F_2}{F_1} = \frac{a_2}{a_1} \rightarrow F_2 = F_1 \times \frac{a_2}{a_1} = 15 \times 3 = 45 \text{ N}$$

2. Explain Newton's Laws of Motion with suitable examples.

**Ans: First law of motion:** An object continues to be in a state of rest or of uniform motion along a straight line unless acted upon by an unbalanced force.

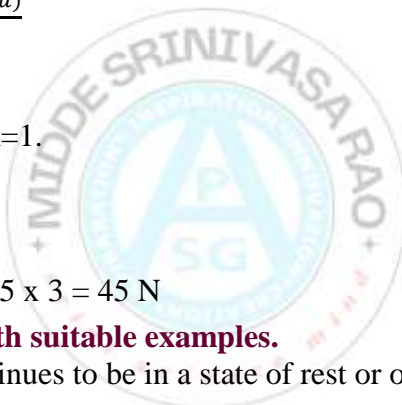
**Example:** A passenger falls forward when a moving bus stops suddenly.

**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.  $F=ma$

**Example:** A football accelerates when kicked.

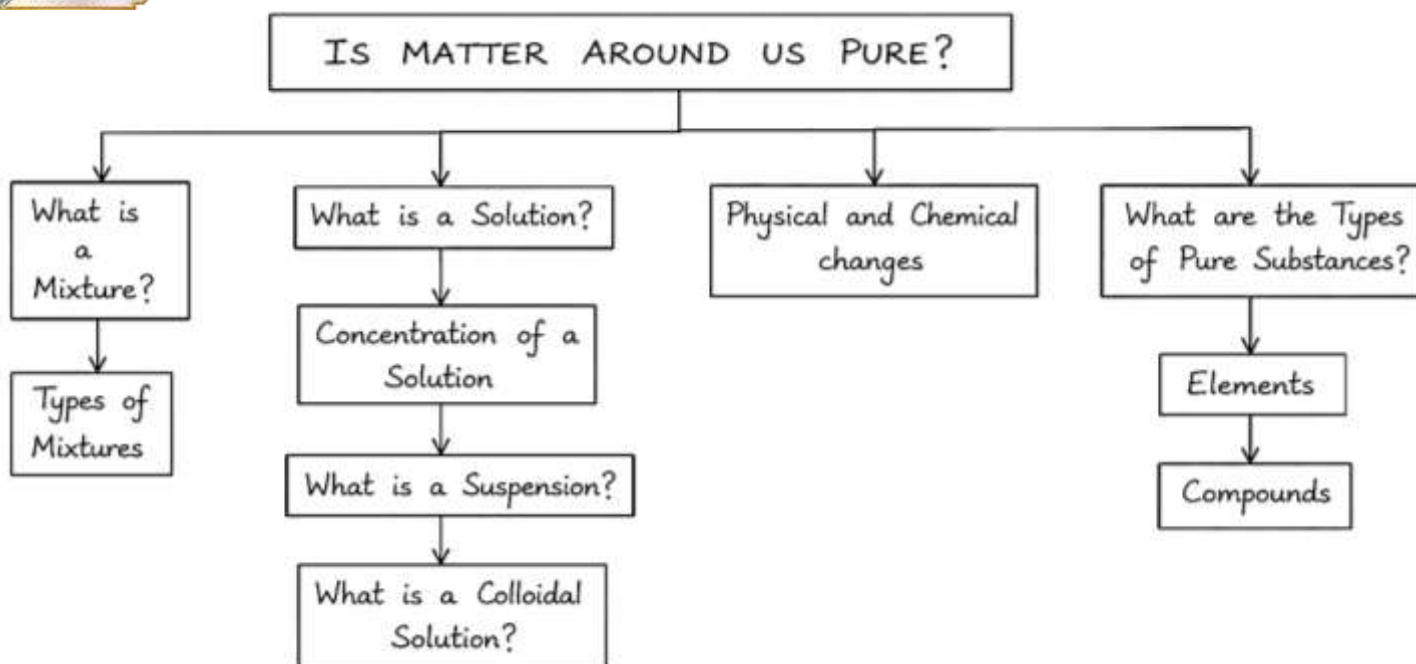
**Third law of motion:** To every action, there is an equal and opposite reaction and they act on two different bodies.

**Example:** While walking, we push the ground backward and the ground pushes us forward.



## Chapter – 4

## IS MATTER AROUND US PURE?



## Main Points

1. Pure substances have the same colour, composition, taste and texture at a given temperature and pressure.
2. A mixture contains more than one substance mixed in any proportion.
3. If the mixture has a uniform composition throughout, then it is called homogeneous mixtures or solutions.
4. If the mixture has physically distinct parts and has non-uniform compositions, then it is called heterogeneous mixture.
5. Mixtures can be separated into pure substances using appropriate separation techniques.
6. A solution is a homogeneous mixture of two or more substances.
7. The component of the solution that dissolves the other component in it (usually the component present in larger amount) is called the solvent. The component of the solution that is dissolved in the solvent (usually present in lesser quantity) is called the solute.
8. They do not scatter a beam of light passing through the solution. So, the path of light is not visible in a solution.
9. Depending upon the amount of solute present in a solution, it can be called dilute, concentrated or saturated solution.
10. The amount of the solute present in the saturated solution at this temperature is called its solubility.
11. The concentration of a solution is the amount of solute present in a given amount of solution.
12. There are various ways of expressing the concentration of a solution.

$$\text{Mass by mass percentage of a solution} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$\text{Mass by volume percentage of a solution} = \frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$$

$$\text{Volume by volume percentage of a solution} = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

13. A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium. Particles of a suspension are visible to the naked eye and unstable.
14. Colloids are heterogeneous mixtures in which the particle size is too small to be seen with the naked eye. The particles are called the dispersed phase and the medium in which they are distributed is called the dispersion medium.
15. Scattering of a beam of light is called the Tyndall effect.
16. Colloids are classified according to the state (solid, liquid or gas) of the dispersing medium and the dispersed phase.
17. A physical change brings change in the state of matter, without a change in composition and no change in the chemical nature of the substance.
18. Chemical change brings change in the chemical properties of matter and we get new substances.
19. Pure substances can be classified either as elements or compounds.

20. An element as a basic form of matter that cannot be broken down into simpler substances by chemical reactions.
21. Elements can be normally divided into metals, non-metals and metalloids.
22. A compound is a substance composed of two or more different types of elements, chemically combined in a fixed proportion.

### Exercises

1. Which separation techniques will you apply for the separation of the following?
- Sodium chloride from its solution in water
  - Ammonium chloride from a mixture containing sodium chloride and ammonium chloride
  - Small pieces of metal in the engine oil of a car
  - Different pigments from an extract of flower petals
  - Butter from curd
  - Oil from water
  - Tea leaves from tea
  - Iron pins from sand
  - Wheat grains from husk
  - Fine mud particles suspended in water

- Ans:** (a) Crystallization or evaporation (b) Sublimation  
 (c) Centrifugation or sedimentation (d) Chromatography  
 (e) Centrifugation (f) Separating funnel  
 (g) Filtration (h) Magnetic separation  
 (i) Winnowing (j) Centrifugation

2. Write the steps you would use for making tea. Use the words **solution, solvent, solute, dissolve, soluble, insoluble, filtrate and residue**.

**Ans:** Take one cup of water as solvent and boil it for few minutes. When solvent boils, add solutes, i.e., milk, tea leaves, sugar. Boil the solution for a few minutes. Milk is soluble in water. Sugar also dissolves in the solution but tea leaves remain as filtrate. The insoluble residue of tea leaves is filtered using a strainer and the tea is ready.

3. Pragma tested the solubility of three different substances at different temperatures and collected the data as given below (results are given in the following table, as grams of substance dissolved in 100 grams of water to form a saturated solution).

| Substance Dissolved | Temperature in K |     |     |     |     |
|---------------------|------------------|-----|-----|-----|-----|
|                     | 283              | 293 | 313 | 333 | 353 |
|                     | Solubility       |     |     |     |     |
| Potassium nitrate   | 21               | 32  | 62  | 106 | 167 |
| Sodium chloride     | 36               | 36  | 36  | 37  | 37  |
| Potassium chloride  | 35               | 35  | 40  | 46  | 54  |
| Ammonium chloride   | 24               | 37  | 41  | 55  | 66  |

- What mass of potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50 grams of water at 313 K?
- Pragma makes a saturated solution of potassium chloride in water at 353 K and leaves the solution to cool at room temperature. What would she observe as the solution cools? Explain.
- Find the solubility of each salt at 293 K. Which salt has the highest solubility at this temperature?
- What is the effect of change of temperature on the solubility of a salt?

- Ans:** (a) At 313 K, 62 gm of potassium is added in 100 gm of water to form a saturated solution. So, 50 gm of water requires 31 gm potassium nitrate.
- (b) As solution cools, potassium chloride gets crystallized or precipitated. The solubility of potassium chloride is 54 gm and at room temperature is 35 g. So, excess of potassium chloride dissolved gets precipitated.
- (c) Solubility of potassium nitrate at 293 K = 32 g  
 Solubility of sodium chloride at 293 K = 36 g  
 Solubility of potassium chloride at 293 K = 35 g  
 Solubility of ammonium chloride at 293 K = 37 g  
 Ammonium chloride has the highest solubility at 293 K.

(d) The solubility of the salt increases with an increase in temperature.

**4. Explain the following giving examples.**

- (a) Saturated solution      (b) Pure substance      (c) Colloid      (d) Suspension

**Ans:** (a) **Saturated solution:** At any particular temperature, a solution that has dissolved as much solute as it is capable of dissolving, is said to be a saturated solution.

Example: When no more solute (sugar) can be dissolved in a solution (water sugar solution) at a given Temperature.

(b) **Pure substance:** Pure substances can be elements or compounds. An element is a form of matter that cannot be broken down by chemical reactions into simpler substances. A compound is a substance composed of two or more different types of elements, chemically combined in a fixed proportion.

Example: Gold, Iron, Water, Table salt.

(c) **Colloid:** Colloids are heterogeneous mixtures in which the particle size is too small to be seen with the naked eye. The particles are called the dispersed phase and the medium in which they are distributed is called the dispersion medium. It shows Tyndall effect.

Example: Milk, fog, blood.

(d) **Suspension:** A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium. Particles of a suspension are visible to the naked eye and unstable. It shows Tyndall effect.

Example: Muddy water, Chalk powder in water.

**5. Classify each of the following as a homogeneous or heterogeneous mixture.**

*Soda water, wood, air, soil, vinegar, filtered tea.*

**Ans:** **Homogeneous mixture:** Soda water, air, vinegar, filtered tea.

**Heterogeneous mixture:** Wood, soil.

**6. How would you confirm that a colourless liquid given to you is pure water?**

**Ans:** Every liquid has a characteristic boiling point at 1 atmospheric pressure. If the given colourless liquid boils exactly at  $100^{\circ}\text{C}$  or  $373\text{ K}$ , then it is pure water.

**7. Which of the following materials fall in the category of a “pure substance”?**

- |                       |                   |             |
|-----------------------|-------------------|-------------|
| (a) Ice               | (b) Milk          | (c) Iron    |
| (d) Hydrochloric acid | (e) Calcium oxide | (f) Mercury |
| (g) Brick             | (h) Wood          | (i) Air     |

**Ans:** Ice, Iron, Hydrochloric acid, Calcium oxide, Mercury.

**8. Identify the solutions among the following mixtures.**

- |          |               |         |          |                |
|----------|---------------|---------|----------|----------------|
| (a) Soil | (b) Sea water | (c) Air | (d) Coal | (e) Soda water |
|----------|---------------|---------|----------|----------------|

**Ans:** Sea water, Air, Soda water

**9. Which of the following will show “Tyndall effect”?**

- |                   |          |                              |                     |
|-------------------|----------|------------------------------|---------------------|
| (a) Salt solution | (b) Milk | (c) Copper sulphate solution | (d) Starch solution |
|-------------------|----------|------------------------------|---------------------|

**Ans:** Milk and Starch solution are colloids and will show Tyndall effect.

**10. Classify the following into elements, compounds and mixtures.**

- |             |                       |                    |
|-------------|-----------------------|--------------------|
| (a) Sodium  | (b) Soil              | (c) Sugar solution |
| (d) Silver  | (e) Calcium carbonate | (f) Tin            |
| (g) Silicon | (h) Coal              | (i) Air            |
| (j) Soap    | (k) Methane           | (l) Carbon dioxide |
| (m) Blood   |                       |                    |

**Ans:** **Elements:** Sodium, Silver, Tin, Silicon

**Compounds:** Calcium carbonate, Methane, Carbon dioxide

**Mixtures:** Soil, Sugar, Coal, Air, Soap, Blood

**11. Which of the following are chemical changes?**

- |                         |                       |                                     |
|-------------------------|-----------------------|-------------------------------------|
| (a) Growth of a plant   | (b) Rusting of iron   | (c) Mixing of iron filings and sand |
| (d) Cooking of food     | (e) Digestion of food | (f) Freezing of water               |
| (g) Burning of a candle |                       |                                     |

**Ans:** (a) Growth of a plant, (b) Rusting of iron, (d) Cooking of food, (e) Digestion of food, (g) Burning of a candle

**12. A startup company launches three new products:**

1. A room freshener spray
2. A medicinal antacid suspension (like milk of magnesia)
3. A coloured decorative glass panel

Which of the following correctly identifies the type of colloid in each product?

A) Spray – Foam; Antacid – Emulsion; Glass – Gel

B) Spray – Aerosol; Antacid – Sol; Glass – Solid sol

C) Spray – Emulsion; Antacid – Gel; Glass – Aerosol

D) Spray – Sol; Antacid – Foam; Glass – Emulsion

**Ans:** B) Spray – Aerosol; Antacid – Sol; Glass – Solid sol

### In Textbook Questions

**1. What is meant by a substance? (Page No:88)**

**Ans:** A substance is a specific type of matter that has a uniform and definite composition. It can be made up of one type of particles or more than one type of particles.

**2. List the points of differences between homogeneous and heterogeneous mixtures.**

**Ans:**

| Homogeneous mixture   | Heterogeneous mixture   |
|---|---|
| If the mixture has a uniform composition throughout, then it is called homogeneous mixtures | If the mixture has physically distinct parts and has non-uniform compositions, then it is called heterogeneous mixture. |
| It does not show Tyndall effect   | It shows Tyndall effect   |
| It has no visible boundary or boundaries of separation between its constituents.            | It has visible boundary or boundaries of separation between its constituents.   |

**1. Differentiate between homogeneous and heterogeneous mixtures with examples. (Page No:94)**

**Ans:**

| Homogeneous mixture   | Heterogeneous mixture   |
|---|---|
| If the mixture has a uniform composition throughout, then it is called homogeneous mixtures | If the mixture has physically distinct parts and has non-uniform compositions, then it is called heterogeneous mixture. |
| It does not show Tyndall effect   | It shows Tyndall effect   |
| It has no visible boundary or boundaries of separation between its constituents.            | It has visible boundary or boundaries of separation between its constituents.   |
| Ex: a mixture of alcohol and water  | Ex: a mixture of sodium chloride and sand   |

**2. How are sol, solution and suspension different from each other?**

**Ans:** A sol is a type of colloid with solid particles dispersed in a liquid.

Solutions are homogeneous mixtures where a solute is completely dissolved in a solvent.

Suspensions are heterogeneous mixtures where larger particles remain suspended but settle out over time.

**3. To make a saturated solution, 36 g of sodium chloride is dissolved in 100 g of water at 293 K. Find its concentration at this temperature.**

**Ans:** Mass of sodium chloride = 36 g

Mass of water = 100 g

Mass of solution = 36 + 100 = 136 g

Concentration of a solution =  $\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100 = \frac{36}{136} \times 100 = 26.47\%$

**1. Classify the following as chemical or physical changes: (Page No:96)**

a) cutting of trees,

b) melting of butter in a pan,

c) rusting of almirah,

d) boiling of water to form steam,

e) passing of electric current, through water and the water breaking down into hydrogen and oxygen gases,

f) dissolving common salt in water,

g) making a fruit salad with raw fruits, and

h) burning of paper and wood.

**Ans:** a) Physical change

b) Physical change

c) Chemical change

d) Physical change

e) Chemical change

f) Physical change

g) Physical change

h) Chemical change

**2. Try segregating the things around you as pure substances or mixtures.**

**Ans:** Pure substances: Copper wire, Distilled water, Diamond, Sugar, Salt, Pure gold, Ice, Baking soda etc.

Mixtures: Air, Paper, Milk, Curd, Cooking oils, Steel, Ice cream, Ink, LPG, Lemon juice etc.

### Activities

**1. Explain with the help of an activity which shows that homogeneous and heterogeneous mixtures.**

**Aim:** Identification of homogeneous and heterogeneous mixtures.

**Materials required:** Beakers, Water, Spatula, Copper sulphate powder, Potassium permanganate/ Common salt

**Procedure:**

1. Let us divide the class into groups A, B, C and D.
2. Group A takes a beaker containing 50 mL of water and one spatula full of copper sulphate powder. Group B takes 50 mL of water and two spatula full of copper sulphate powder in a beaker.
3. Groups C and D can take different amounts of copper sulphate and potassium permanganate or common salt (sodium chloride) and mix the given components to form a mixture.
4. Report the observations on the uniformity in colour and texture.
5. Groups A and B have obtained a mixture which has a uniform composition throughout. Compare the colour of the solutions of the two groups. Though both the groups have obtained copper sulphate solution but the intensity of colour of the solutions is different. This shows that a homogeneous mixture can have a variable composition.
6. Groups C and D have obtained mixtures, which contain physically distinct parts and have non-uniform compositions. Such mixtures are called heterogeneous mixtures.

**Observation/Conclusion:** Identification of homogeneous and heterogeneous mixtures.

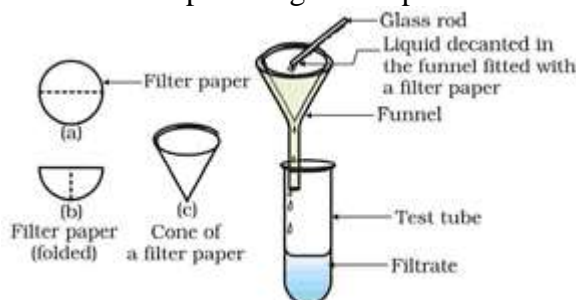
**2. Explain with the help of an activity which shows that solution, suspension and colloidal solution.**

**Aim:** Preparation of solution, suspension and colloidal solution.

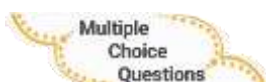
**Materials required:** Crystal of copper sulphate, Chalk powder/Wheat flour, Milk/Ink, Test tubes, Torch light, Filter paper, Funnel,

**Procedure:**

1. Let us again divide the class into four groups— A, B, C and D.
2. Distribute the following samples to each group:
  - Few crystals of copper sulphate to group A.
  - One spatula full of copper sulphate to group B.
  - Chalk powder or wheat flour to group C.
  - Few drops of milk or ink to group D.
3. Each group should add the given sample in water and stir properly using a glass rod.
4. Particles of mixture are visible only in case of group C.
5. Direct a beam of light from a torch through the beaker containing the mixture and observe from the front.
6. The path of beam of light was visible in the case of group C and D.
7. Leave the mixtures undisturbed for a few minutes (and set up the filtration apparatus in the meantime).
8. The Particles settle down after sometime in the case of group C.
9. Filter the mixture. Residue will be left in case of group C.
10. Groups A and B have got a solution. Group C has got a suspension. Group D has got a colloidal solution.



**Observation/Conclusion:** Identification and preparation of solution, suspension and colloidal solution.



**1. Which of the following is a homogeneous mixture?**

- a) Saltwater                      b) Sand and iron filings  
c) Oil and water                  d) Milk and water

**Ans:** a) Saltwater

**2. The process of separating a mixture of liquids with different boiling points is called?**

- a) Filtration                        b) Evaporation  
c) Distillation                      d) Condensation

**Ans:** c) Distillation

**3. Which of the following is a pure substance?**

- a) Air    b) Sugar solution    c) Salt solution    d) Gold

**Ans:** d) Gold

**4. The process of conversion of a solid directly into gas without passing through the liquid state is called?**

- a) Melting                            b) Evaporation  
c) Sublimation                      d) Condensation

**Ans:** c) Sublimation

5. A solution that cannot dissolve any more solute at a given temperature is said to be?

- a) Unsaturated                      b) Saturated  
c) Supersaturated                  d) Dilute

**Ans:** b) Saturated

6. Which method is used to separate a mixture of salt and water?

- a) Filtration                              b) Evaporation  
c) Decantation                          d) Sublimation

**Ans:** b) Evaporation

7. Which of the following is not a physical change?

- a) Boiling of water                      b) Rusting of iron  
c) Freezing of water                      d) Melting of wax

**Ans:** b) Rusting of iron

8. Which of the following statements about solutions is true?

- a) Solutions are always homogeneous mixtures.  
b) Solutions can be separated into their components by filtration.  
c) The solute is present in larger quantity than the solvent in a solution.  
d) Solutions cannot be formed with gases.

**Ans:** a) Solutions are always homogeneous mixtures.

9. Which of the following is a chemical change?

- a) Freezing water to form ice  
b) Cutting a piece of wood into smaller pieces  
c) Digesting food in the stomach  
d) Melting chocolate to form a liquid

**Ans:** c) Digesting food in the stomach

10. The smallest particle of an element that retains all the properties of that element is called

- a) Atom    b) Molecule    c) Compound    d) Mixture

**Ans:** a) Atom

11. Cloud is an example of

- a) Solid dispersed in a gas  
b) Liquid dispersed in a gas  
c) Liquid dispersed in a solid  
d) Solid dispersed in a gas

**Ans:** b) Liquid dispersed in a gas

12. A colloidal solution is

- a) Homogeneous mixture  
b) Heterogeneous and transparent mixture

c) Heterogeneous mixture, Particles can be seen with naked eyes

d) Heterogeneous mixture, Particles cannot be seen with naked eyes

**Ans:** d) Heterogeneous mixture, Particles cannot be seen with naked eyes

13. What is the primary difference between a compound and a mixture?

- a) Mixtures have a fixed composition  
b) Compounds are chemically bonded  
c) Mixtures are always pure substances  
d) Compounds can be separated by physical methods

**Ans:** b) Compounds are chemically bonded

14. Name the mixture whose particles are large enough to scatter light.

- a) Colloid                                      b) True solutions  
c) Homogeneous solution                  d) All of the above

**Ans:** a) Colloid

15. Which method is used to separate cream from milk?

- a) Centrifugation                          b) Adsorption  
c) Distillation                                  d) Crystallization

**Ans:** a) Centrifugation

16. If a solution contains 60g of common salt in 340g of water, the mass by mass percentage will be

- a) 25 %    b) 15 %    c) 20 %    d) 17.6 %

**Ans:** b) 15 %

17. Which of the following is a true solution?

- a) Milk    b) Chalk powder in water  
c) Salt solution                                  d) Blood

**Ans:** c) Salt solution

18. Which of the following are homogeneous in nature?

- a) Ice, Soil    b) Wood, Air    c) Wood, Soil    d) Ice, Air

**Ans:** d) Ice, Air

19. Which of the following parameters of a substance does not alter during a physical change?

- a) State    b) Mass    c) Volume    d) Size

**Ans:** b) Mass

20. An example of a liquid metal and a liquid non-metal is

- a) gallium, mercury                          b) mercury, chlorine  
c) mercury, bromine                          d) bromine, sulphur

**Ans:** c) mercury, bromine

### Competency - Based Questions

#### Multiple Choice Questions

1. Which of the following is not a pure substance?

- A) Oxygen                      B) Sugar                      C) Iron                      D) Milk

**Ans:** D) Milk

2. Identify the non-metal that exists in liquid state at room temperature.

- A) Boron                      B) Iodine                      C) Mercury                      D) Bromine

**Ans:** D) Bromine

3. Following observations were made for three mixtures X, Y and Z.

X: Homogeneous and components cannot be separated by filtration.

Y: Heterogeneous and components cannot be separated by filtration.

Z: Heterogeneous and components can be separated by filtration.

Choose the correct classification:

A) X-Solution, Y-Suspension, Z-Colloid

B) X-Solution, Y-Colloid, Z-Suspension

C) X-Colloid, Y-Suspension, Z-Solution

D) X-Suspension, Y-Solution, Z-Colloid

**Ans:** B) X-Solution, Y-Colloid, Z-Suspension

**4. Which of the following metals will melt when kept in your palm?**

A) Iron

B) Copper

C) Gallium

D) Mercury

**Ans:** C) Gallium

**5. Which of the following are chemical changes?**

P. Curding of milk

Q. Cutting of wood

R. Cooking of egg

S. Melting of ice

A) P and Q

B) P and R

C) R and S

D) Q and R

**Ans:** B) P and R

**6. Match the following properties of metals with their correct descriptions:**

| Property     | Description                             |
|--------------|---|
| A) Lustrous  | 1) Can be drawn into thin wires         |
| B) Sonorous  | 2) Produces a ringing sound when struck |
| C) Malleable | 3) Can be beaten into thin sheets       |
| D) Ductile   | 4) Shiny in appearance                  |

A) A-1, B-3, C-2, D-4

B) A-3, B-1, C-4, D-2

C) A-2, B-4, C-1, D-3

D) A-4, B-2, C-3, D-1

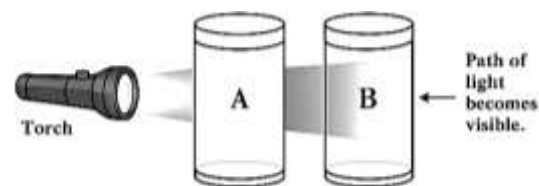
**Ans:** D) A-4, B-2, C-3, D-1

**7. In the given experiment, a torch light passes through two liquids.**

In bottle A, the path of light is not visible.

In bottle B, the path of light becomes visible.

Identify the liquids



A) A–Salt solution, B–Water

B) A–Sugar solution, B–Starch solution

C) A–Starch solution, B–Sugar solution

D) A–Starch solution, B–Distilled water

**Ans:** B) A–Sugar solution, B–Starch solution

**8. Substances X and Y react to form a new substance XY.**



Which of the following statements about XY are incorrect?

(i) XY is a compound formed by chemical combination of X and Y.

(ii) XY retains the individual properties of X and Y.

(iii) XY is an element.

A) (i) and (ii)

B) (i) and (iii)

C) (ii) and (iii)

D) All of the above

**Ans:** C) (ii) and (iii)

**9. Which of the following is the property of a solution?**

A) It has solute particles larger than 1 nm.

B) Solution is a heterogeneous mixture.

C) Its solute particles settle down when left undisturbed.

D) Solution does not scatter the beam of light passing through it.

**Ans:** D) Solution does not scatter the beam of light passing through it.

**10. The solvent in the tincture of iodine solution is \_\_\_\_\_.**

A) Alcohol

B) Water

C) Iodine

D) Petrol

**Ans:** A) Alcohol

**11. What are the components of a mixture that can be separated using a separating funnel?**

A) Two miscible liquids

B) Two immiscible liquids

C) A gas dissolved in a liquid.

D) A solid dissolved in a liquid

**Ans:** B) Two immiscible liquids

**12. Which of these is an alloy?**

A) Silver

B) Copper

C) Bronze

D) Aluminium

**Ans:** C) Bronze

## 2 Marks Questions

1. Brass is an alloy.

Write its composition and any one use.

**Ans:** Brass is an alloy of copper and zinc.

It is used for making utensils, musical instruments, screws, locks, or decorative items. (Any one)

2. The table shows the processes required to separate different mixtures in four separate jars.

| Jar     | Jar 1        | Jar 2      | Jar 3       | Jar 4       |
|---------|--------------|------------|-------------|-------------|
| Process | distillation | filtration | evaporation | sublimation |

a) Which jar contains a mixture of two solids?      b) What process does not involve heating?

**Ans:** a) Jar 4 (Sublimation)

b) Filtration (Jar 2)

3. A gas cylinder has the following symbol on its surface.

Which property of the gas is represented by the symbol? Why?

**Ans:** The gas is flammable (highly combustible).

The flame symbol indicates that the gas catches fire easily.

Therefore, it should be kept away from heat, sparks, and open flames to prevent fire accidents.



4. What is a solution? Name its components.

**Ans:** A solution is a homogeneous mixture of two or more substances.

Its components are Solvent, Solute

5. Why does a true solution not show the Tyndall effect?

**Ans:** The particles of a true solution are extremely small and do not scatter light. Therefore, a true solution does not show the Tyndall effect.

6. Why is milk considered a colloid?

**Ans:** Milk contains tiny fat globules dispersed in water. These particles scatter light and remain uniformly distributed, so milk is a colloid.

7. How does a compound differ from a mixture?

**Ans:** A compound contains elements chemically combined in a fixed proportion, whereas a mixture contains substances physically mixed in any proportion.

8. Lakshmi prepared a salt solution and observed that the salt completely disappeared.

Answer the following questions.

a) What type of mixture is formed?

b) Identify the solute and solvent.

**Ans:** a) Homogeneous mixture (solution).

b) Solute – Salt; Solvent – Water.

9. A student added chalk powder to water and left it undisturbed.

Answer the following questions.

a) What happens after some time?

b) What type of mixture is it?

**Ans:** a) Chalk particles settle at the bottom.

b) Suspension.

10. A jeweller melts gold with copper to prepare ornaments. Is the product a pure substance or a mixture? Explain.

**Ans:** The product is a homogeneous mixture (alloy) because gold and copper are mixed physically to improve the hardness of gold.

## 4 Marks Questions

1. Write the physical state of dispersed phase and dispersion medium for the following:

| Substance         | Dispersed Phase | Dispersion Medium |
|-------------------|-----------------|-------------------|
| Milk              |                 |                   |
| Fog               |                 |                   |
| Coloured Gemstone |                 |                   |
| Milk of Magnesia  |                 |                   |

**Ans:**

| Substance         | Dispersed Phase | Dispersion Medium |
|-------------------|-----------------|-------------------|
| Milk              | Liquid          | Liquid            |
| Fog               | Liquid          | Gas               |
| Coloured Gemstone | Solid           | Solid             |
| Milk of Magnesia  | Solid           | Liquid            |

2. Write any four properties of colloids.

**Ans:** i) Colloidal particles are very small and cannot be seen with the naked eye.

ii) They scatter light (show the Tyndall effect).

- iii) The particles do not settle down on standing.
- iv) Colloids cannot be separated by ordinary filtration.

### 3. Write any four properties of suspension.

- Ans:** i) A suspension is a heterogeneous mixture.      ii) The suspended particles are visible to the naked eye.  
 iii) The particles settle down on standing.      iv) The particles can be separated by filtration.

### 4. Differentiate between Solution, Colloid and Suspension.

**Ans:**

| Property       | Solution    | Colloid       | Suspension    |
|----------------|-------------|---------------|---------------|
| Nature         | Homogeneous | Heterogeneous | Heterogeneous |
| Particle size  | Very small  | Intermediate  | Large         |
| Visibility     | Not visible | Not visible   | Visible       |
| Tyndall effect | No          | Yes           | Yes           |

### 5. Write any four characteristics of a pure substance.

- Ans:** a) Made up of only one kind of particles.      b) Has fixed composition.  
 c) Has definite properties.      d) Cannot be separated by physical methods.

### 6. Praveena prepared a saturated potassium chloride solution at 353 K and cooled it to room temperature.

**What happens? Explain.**

- Ans:** a) The solubility of potassium chloride decreases when temperature decreases.  
 b) Therefore excess potassium chloride crystallizes out from the solution.  
 c) Crystals of potassium chloride are formed.

### 7. Observe the following data.

Answer the following questions

- a) Classify each mixture.
- b) Which mixture shows Tyndall effect?
- c) Which mixture can be filtered easily?
- d) Which mixture is homogeneous?

| Mixture              | Observation        |
|----------------------|--------------------|
| Salt + Water         | Clear solution     |
| Milk                 | Light beam visible |
| Chalk Powder + Water | Particles settle   |

- Ans:** a) Salt water – Solution; Milk – Colloid; Chalk powder + water – Suspension.  
 b) Milk.  
 c) Chalk powder suspension.  
 d) Salt solution.

### 8. What is the Tyndall effect? Mention two examples.

**Ans:** Scattering of a beam of light is called the Tyndall effect.

- Examples: 1) Sunlight entering a dusty room.  
 2) Car headlights visible in fog.

## 8 Marks Questions

### 1. Define the term Concentration of Solution.

A solution was prepared by dissolving 4 g of salt in 36 g of water.

Calculate the concentration of the solution in terms of mass by mass percentage.

**Ans:** The concentration of a solution is the amount (mass or volume) of solute present in a given amount (mass or volume) of solution.

Given Mass of solute (salt) = 4 g      Mass of solvent (water) = 36 g

Mass of solution = Mass of solute + Mass of solvent

$$= 4 \text{ g} + 36 \text{ g} = 40 \text{ g}$$

$$\begin{aligned} \text{Mass by mass percentage} &= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100 \\ &= \frac{4}{40} \times 100 \\ &= 10\% \end{aligned}$$

### 2. Explain why a suspension is considered a heterogeneous mixture.

- Ans:** i) A suspension contains large insoluble particles.  
 ii) The particles are not uniformly distributed.  
 iii) They are visible to the naked eye.  
 iv) They settle down on standing and can be separated by filtration.  
 v) Hence, a suspension is a heterogeneous mixture.

**3. Differentiate between a mixture and a compound.**

| Mixture                             | Compound   |
|-------------------------------------|--|
| Components are physically mixed.    | Components are chemically combined.                |
| Variable composition.               | Fixed composition.                                 |
| Components retain their properties. | New substance with different properties is formed. |
| Separated by physical methods.      | Separated only by chemical methods.                |

**4. What is a solution? Explain the properties of a true solution.**

**Ans:** A solution is a homogeneous mixture of two or more substances.

Properties of a True Solution: 1. It is homogeneous.

2. The particle size is less than 1 nm.

3. The particles are not visible to the naked eye.

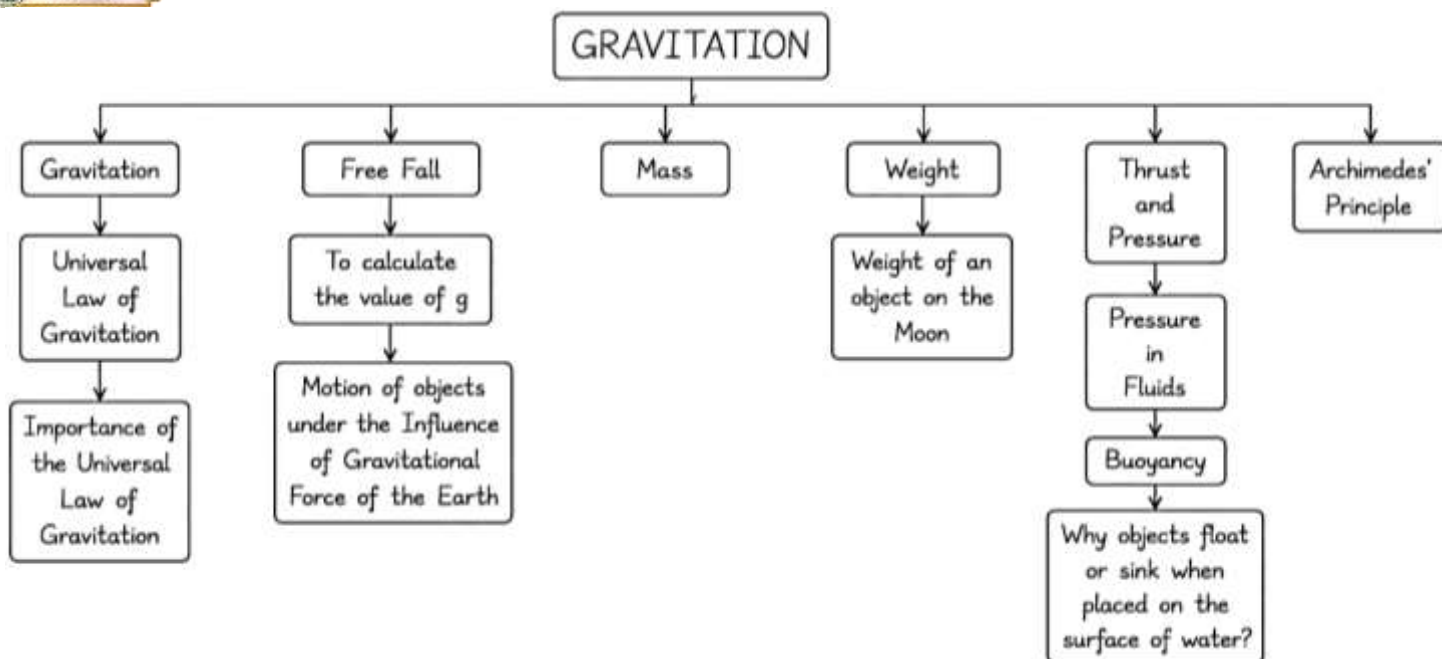
4. The particles do not settle on standing.

5. The particles cannot be separated by filtration.

6. It does not show the Tyndall effect.

## Chapter - 5

## GRAVITATION



## Main Points

1. Gravitation: It is the force of attract–on between any two bodies in the universe.
2. The force of attraction between any two objects in the universe is called the gravitational force.
3. Universal law of gravitation: 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.

$$F = G \frac{M \times m}{d^2} \quad \text{where } G \text{ is Universal gravitation constant}$$

4. The SI unit of  $G$  is  $\text{Nm}^2 \text{kg}^{-2}$  and  $G = 6.67 \times 10^{-11} \text{Nm}^2 \text{kg}^{-2}$
5. The value of  $G$  was found out by Henry Cavendish by using a sensitive balance.
6. Whenever an object falls towards the earth, an acceleration is involved. This acceleration is due to the earth's gravitational force. Therefore, this acceleration is called the acceleration due to gravity.
7. The value of acceleration due to gravity of the earth,  $g = 9.8 \text{ m s}^{-2}$ .
8. The force of gravity decreases with altitude. It also varies on the surface of the earth, decreasing from poles to the equator.
9. Relation between  $g$  and  $G$  is  $g = \frac{GM}{R^2}$
10. Acceleration due to gravity independent of the mass of the object.
11. The motion of a body under the influence of force of gravity alone is called a free fall.
12. The mass of a body is the quantity of matter contained in it. SI unit is kg.
13. The weight of an object is the force with which it is attracted towards the earth. SI unit is newton (N).

$$W = m \times g.$$

14. The weight may vary from place to place but the mass stays constant.
15. Weight of the object on the moon =  $\frac{1}{6} \times \text{Its weight on the earth}$
16. The force acting on an object perpendicular to the surface is called thrust.
17. The thrust on unit area is called pressure. The SI unit is  $\text{Nm}^{-2}$ .

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

18. The SI unit of pressure is called pascal, denoted as Pa.
19. Pressure exerted in any confined mass of fluid is transmitted undiminished in all directions.
20. The upward force acting on a body immersed in a fluid is called upthrust or buoyant force.
21. All objects experience a force of buoyancy when they are immersed in a fluid.

22. Objects having density less than that of the liquid in which they are immersed, float on the surface of the liquid.  
 23. Object having density more than the density of the liquid in which it is immersed then it sinks in the liquid.  
 24. The mass of the object per unit volume is called as density. The SI unit is  $\text{kg m}^{-3}$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

25. 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.  
 26. Archimedes' principle is used in designing ships, submarines, Lactometers and hydrometers.

### Exercises

#### 1. How does the force of gravitation between two objects change when the distance between them is reduced to half ?

**Ans:** According to universal law of gravitation,  $F = G \frac{m_1 m_2}{d^2}$

When the distance is reduced to half ( $d/2$ )

$$F = G \frac{m_1 m_2}{(d/2)^2} = G \frac{m_1 m_2}{d^2/4} = 4 G \frac{m_1 m_2}{d^2}$$

Thus, the gravitational force becomes 4 times increased.

#### 2. Gravitational force acts on all objects in proportion to their masses. Why then, a heavy object does not fall faster than a light object?

**Ans:** Gravitational force acts on the object is directly proportional to mass. But acceleration due to gravity does not depends on mass of the objects. Hence, heavy objects do not fall faster than light objects.

#### 3. What is the magnitude of the gravitational force between the earth and a 1 kg object on its surface? (Mass of the earth is $6 \times 10^{24}$ kg and radius of the earth is $6.4 \times 10^6$ m.)

**Ans:** Mass of the earth ( $M$ ) =  $6 \times 10^{24}$  kg

Radius of the earth  $R$  =  $6.4 \times 10^6$  m

Mass of the object ( $m$ ) = 1 kg

$G = 6.7 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$

According to universal law of gravitation,  $F = G \frac{M m}{R^2}$

$$F = \frac{6.7 \times 10^{-11} \times 6 \times 10^{24} \times 1}{(6.4 \times 10^6)^2} = 9.8 \text{ N}$$

#### 4. The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth? Why?

**Ans:** According to universal law of gravitation, two objects with masses attract each other with equal gravitational force, but in opposite directions. So, the earth attracts the moon with the same force with which the moon attracts the earth.

#### 5. If the moon attracts the earth, why does the earth not move towards the moon?

**Ans:** According to universal law of gravitation, the Earth and the moon experience equal gravitational forces from each other. The mass of the Earth is much larger than the mass of the moon. Hence, it accelerates at a rate lesser than the acceleration rate of the moon towards the Earth. So, the Earth does not move towards the moon.

#### 6. What happens to the force between two objects, if

(i) the mass of one object is doubled?

(ii) the distance between the objects is doubled and tripled?

(iii) the masses of both objects are doubled?

**Ans:** According to universal law of gravitation,  $F \propto m_1 m_2$  and  $F \propto \frac{1}{d^2}$

(i)  $F$  is directly proportional to the masses of the objects. If the mass of one object is doubled, then the gravitational force will also get doubled.

(ii)  $F$  is inversely proportional to the square of the distances between the objects. If the distance is doubled, then the gravitational force becomes one-fourth of its original value.

If the distance is tripled, then the gravitational force becomes one-ninth of its original value.

(iii)  $F$  is directly proportional to the product of masses of the objects. If the masses of both the objects are doubled, then the gravitational force becomes four times the original value.

#### 7. What is the importance of universal law of gravitation?

**Ans:** (i) the force that binds us to the earth

(ii) the motion of the moon around the earth

(iii) the motion of planets around the Sun

(iv) the tides due to the moon and the Sun

#### 8. What is the acceleration of free fall?

**Ans:** Whenever an object falls towards the earth, an acceleration is involved. This acceleration is due to the earth's

gravitational force. Therefore, this acceleration is called the acceleration due to gravity.

**9. What do we call the gravitational force between the earth and an object?**

**Ans:** Weight of the object.

**10. Amit buys few grams of gold at the poles as per the instruction of one of his friends. He hands over the same when he meets him at the equator. Will the friend agree with the weight of gold bought? If not, why? [Hint: The value of g is greater at the poles than at the equator.]**

**Ans:** No. The value of g at the equator is less than that at the poles. The few grams of gold at poles will measure less when taken to the equator. Hence, Amit's friend will not agree with the weight of the gold bought.

**11. Why will a sheet of paper fall slower than one that is crumpled into a ball?**

**Ans:** A sheet of paper has a larger surface area in comparison to a crumpled paper ball. The larger surface area will experience a larger air resistance. Hence, a sheet of paper falls slower than the crumpled ball.

**12. Gravitational force on the surface of the moon is only 1/6 as strong as gravitational force on the earth. What is the weight in newtons of a 10 kg object on the moon and on the earth?**

**Ans:** Mass of the object (m) = 10 kg

$$\text{Weight of the object on the earth (W)} = mg = 10 \times 9.8 = 98 \text{ N}$$

$$\text{Weight of the object on the moon (W)} = \frac{1}{6} \times \text{Weight of the object on the earth} = \frac{1}{6} \times 98 = 16.3 \text{ N}$$

**13. A ball is thrown vertically upwards with a velocity of 49 m/s. Calculate**

**(i) the maximum height to which it rises,**

**(ii) the total time it takes to return to the surface of the earth.**

**Ans:** Initial velocity,  $u = 49 \text{ m/s}$       Acceleration due to gravity ( $g$ ) =  $9.8 \text{ m s}^{-2}$

$$\text{(i) Maximum height (h)} = \frac{u^2}{2g} = \frac{49 \times 49}{2 \times 9.8} = \frac{245}{2} = 122.5 \text{ m}$$

$$\text{(ii) Total time taken} = \frac{2u}{g} = \frac{2 \times 49}{9.8} = 2 \times 5 = 10 \text{ s}$$

**14. A stone is released from the top of a tower of height 19.6 m. Calculate its final velocity just before touching the ground.**

**Ans:** Initial velocity ( $u$ ) =  $0 \text{ m s}^{-1}$       Height ( $h$ ) =  $19.6 \text{ m}$       Acceleration due to gravity ( $g$ ) =  $9.8 \text{ m s}^{-2}$

$$\text{Final velocity (v)} = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6} = \sqrt{19.6 \times 19.6} = 19.6 \text{ m/s}$$

**15. A stone is thrown vertically upward with an initial velocity of 40 m/s. Taking  $g = 10 \text{ m/s}^2$ , find the maximum height reached by the stone. What is the net displacement and the total distance covered by the stone?**

**Ans:** Initial velocity ( $u$ ) =  $40 \text{ m/s}$       Acceleration due to gravity ( $g$ ) =  $10 \text{ m/s}^2$

$$\text{Maximum height (h)} = \frac{u^2}{2g} = \frac{40 \times 40}{2 \times 10} = 80 \text{ m}$$

$$\text{Net displacement} = 80 - 80 = 0$$

$$\text{Total distance} = h + h = 80 + 80 = 160 \text{ m}$$

**16. Calculate the force of gravitation between the earth and the Sun, given that the mass of the earth =  $6 \times 10^{24} \text{ kg}$  and of the Sun =  $2 \times 10^{30} \text{ kg}$ . The average distance between the two is  $1.5 \times 10^{11} \text{ m}$ .**

**Ans:** Mass of the earth ( $m_1$ ) =  $6 \times 10^{24} \text{ kg}$       Mass of the sun ( $m_2$ ) =  $2 \times 10^{30} \text{ kg}$        $d = 1.5 \times 10^{11} \text{ m}$

$$\text{Gravitational force, } F = G \frac{m_1 m_2}{d^2}$$

$$F = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 2 \times 10^{30}}{(1.5 \times 10^{11})^2} = 3.56 \times 10^{22} \text{ N}$$

**17. A stone is allowed to fall from the top of a tower 100 m high and at the same time another stone is projected vertically upwards from the ground with a velocity of 25 m/s. Calculate when and where the two stones will meet.**

**Ans:** Let the two stones meet after a time =  $t$

Let the displacement of the stone in time  $t$  from the top of the tower =  $S_1$

Let the displacement of the stone in time  $t$  from the ground =  $S_2$

Height of the tower =  $S_1 + S_2 = 100 \text{ m}$

**When the stone dropped from the tower:**  $S_1 = \frac{1}{2} gt^2$

**When the stone thrown upwards:**  $S_2 = ut - \frac{1}{2} gt^2$

$$S_1 + S_2 = ut$$

$$\text{Two stones will meet (t)} = \frac{S_1 + S_2}{u} = \frac{100}{25} = 4 \text{ s}$$

**18. A ball thrown up vertically returns to the thrower after 6 s. Find**

**(a) the velocity with which it was thrown up,**

**(b) the maximum height it reaches, and (c) its position after 4 s.**

**Ans:** Total time of flight = 6 s, So time of ascent or time of decent = 3 s

- (a) Initial velocity ( $u$ ) =  $g \times t = 9.8 \times 3 = 29.4 \text{ m s}^{-1}$   
 (b) Maximum height ( $h$ ) =  $\frac{u^2}{2g} = \frac{29.4 \times 29.4}{2 \times 9.8} = \frac{29.4 \times 3}{2} = 44.1 \text{ m}$   
 (c) Time for downward fall =  $4 - 3 = 1 \text{ s}$   
 $h = \frac{1}{2} g t^2 = \frac{1}{2} \times 9.8 \times 1 = 4.9 \text{ m}$   
 Position after 4 s =  $44.1 - 4.9 = 39.2 \text{ m}$

**19. In what direction does the buoyant force on an object immersed in a liquid act?**

**Ans:** Vertically upward direction.

**20. Why does a block of plastic released under water come up to the surface of water?**

**Ans:** The upthrust or buoyant force exerted by water brings the plastic block to the surface of water.

**21. The volume of 50 g of a substance is  $20 \text{ cm}^3$ . If the density of water is  $1 \text{ g cm}^{-3}$ , will the substance float or sink?**

**Ans:** Mass ( $m$ ) = 50 g      Volume ( $v$ ) =  $20 \text{ g/cm}^3$   
 Density of given substance =  $\frac{\text{Mass}}{\text{Volume}} = \frac{50}{20} = 2.5 \text{ g/cm}^3$   
 Density of water =  $1 \text{ g/cm}^3$   
 Density of substance is greater than that of water, so the substance will sink in water.

**22. The volume of a 500 g sealed packet is  $350 \text{ cm}^3$ . Will the packet float or sink in water if the density of water is  $1 \text{ g cm}^{-3}$ ? What will be the mass of the water displaced by this packet?**

**Ans:** Mass of sealed packet ( $m$ ) = 500 g      Volume ( $v$ ) =  $350 \text{ g/cm}^3$   
 Density of sealed packet =  $\frac{\text{Mass}}{\text{Volume}} = \frac{500}{350} = 1.43 \text{ g/cm}^3$   
 Density of water =  $1 \text{ g/cm}^3$   
 Density of sealed packet is greater than that of water, so the substance will sink in water.  
 Mass of water displaced = Volume  $\times$  Density =  $350 \times 1 = 350 \text{ g}$ .

**23. An astronaut carries a toolbox of mass 10 kg from Earth to the Moon.**

**On Earth, its weight is approximately 100 N. The gravitational force on the Moon is about one-sixth of that on Earth.**

**After reaching the Moon, which of the following statements could be correct?**

- A) The mass becomes 1.67 kg and the weight becomes 100 N.  
 B) The mass remains 10 kg and the weight becomes 16.7 N.  
 C) The mass becomes 60 kg and the weight remains 100 N.  
 D) Both mass and weight become one-sixth of their values.

**Ans:** B) The mass remains 10 kg and the weight becomes 16.7 N.

### In Textbook Questions

**1. State the universal law of gravitation. (Page No:114)**

**Ans:** 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. The force is along the line joining the centres of two objects.

**2. Write the formula to find the magnitude of the gravitational force between the earth and an object on the surface of the earth.**

**Ans:**  $F = G \frac{Mm}{R^2}$

**1. What do you mean by free fall? (Page No:118)**

**Ans:** The earth attracts objects towards it. This is due to the gravitational force. Whenever objects fall towards the earth under this force alone, we say that the objects are in free fall.

**2. What do you mean by acceleration due to gravity?**

**Ans:** The acceleration produced in an object under the influence of the gravitational force alone is called acceleration due to gravity.

**1. What are the differences between the mass of an object and its weight? (Page No:122)**

**Ans:**

| Mass  | Weight   |
|---|--|
| The mass of a body is the quantity of matter contained in it. | The weight of an object is the force with which it is attracted towards the earth. |
| $M = \frac{F}{a}$   | $W = mg$   |
| SI unit is kg   | SI unit is newton (N).   |

|  |  |
|--|--|
| The mass stays constant at all places. | The weight may vary from place to place. |
| Scalar quantity                        | Vector quantity                          |
| It is measured by common balance       | It is measured by spring balance         |

## 2. Why is the weight of an object on the moon $1/6^{\text{th}}$ its weight on the earth?

**Ans:** Weight of an object depends on Acceleration due to gravity. Acceleration due to gravity on the moon is one-sixth of that on the earth. Hence, the weight of an object on the moon  $1/6^{\text{th}}$  its weight on the earth.

## 1. Why is it difficult to hold a school bag having a strap made of a thin and strong string? (Page No:128)

**Ans:** The thin string has smaller area and exerts a large pressure on our hand. So, it is difficult to hold a school bag having thin string.

## 2. What do you mean by buoyancy?

**Ans:** The upward force acting on a body immersed in a fluid is called upthrust or buoyant force and this phenomenon is called buoyancy.

## 3. Why does an object float or sink when placed on the surface of water?

**Ans:** An object sinks in water if its density is greater than that of water.

An object floats on water if its density is less than that of water.

## 1. You find your mass to be 42 kg on a weighing machine. Is your mass more or less than 42 kg? (Page No:130)

**Ans:** More than 42 kg. The weighing machine reads slightly less value due to the upthrust of air acting on our body.

## 2. You have a bag of cotton and an iron bar, each indicating a mass of 100 kg when measured on a weighing machine. In reality, one is heavier than other. Can you say which one is heavier and why?

**Ans:** We know that 100 kg of cotton bag has a much more volume than the 100 kg of iron bar. 100 kg of cotton bag will displace much more weight of air than 100 kg of iron bar. The cotton bag experiences larger upthrust of air than the iron bar. So, reality 100 kg of cotton bag weighed in air will be heavier than 100 kg of iron weighed in air.

### Activities

## 1. Explain with help of an activity which shows that motion of objects under the influence of gravitational force of earth.

**Aim:** To understand whether all objects hollow or solid, big or small, will fall from a height at the same rate.

**Materials required:** Paper sheet, Stone.

### Procedure:

1. Take a sheet of paper and a stone. Drop them simultaneously from the first floor of a building.
2. Observe whether both of them reach the ground simultaneously. We see that paper reaches the ground little later than the stone.
3. This happens because of air resistance. The air offers resistance due to friction to the motion of the falling objects.
4. The resistance offered by air to the paper is more than the resistance offered to the stone.
5. If we do the experiment in a glass jar from which air has been sucked out, the paper and the stone would fall at the same rate.

**Observations/ Conclusion:** All objects hollow or solid, big or small, will fall from a height at the same rate.

## 2. Explain with help of an activity which shows that the concept of buoyance.

**Aim:** To understand the concept of buoyance.

**Materials required:** Empty plastic bottle, Airtight stopper, Bucket, Water.

### Procedure:

1. Take an empty plastic bottle. Close the mouth of the bottle with an airtight stopper.
2. Put it in a bucket filled with water. You see that the bottle floats. Push the bottle into the water.
3. You feel an upward push. Try to push it further down.
4. You will find it difficult to push deeper and deeper. This indicates that water exerts a force on the bottle in the upward direction.
5. The upward force exerted by the water goes on increasing as the bottle is pushed deeper till it is completely immersed.
6. Now, release the bottle. It bounces back to the surface.
7. The gravitational attraction of the earth act on this bottle in a downward direction. The upward buoyant force exerted by the water is greater than the downward force of gravity acting on the bottle.

**Observations/ Conclusion:** 1. When the bottle is immersed, the upward force exerted by the water on the bottle is greater than its weight. Therefore, it rises up when released.

2. The upward force exerted by the water on the bottle is known as upthrust or buoyant force.

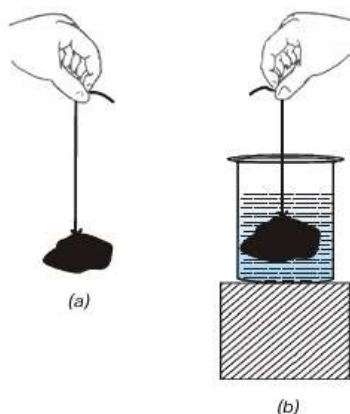
### 3. Explain with help of an activity which shows that the concept of force of buoyancy.

**Aim:** To understand the concept of force of buoyancy.

**Materials required:** Stone, Rubber string/Spring balance, Bucket.

**Procedure:**

1. Take a piece of stone and tie it to one end of a rubber string or a spring balance.
2. Suspend the stone by holding the balance or the string as shown in Figure (a).
3. Note the elongation of the string or the reading on the spring balance due to the weight of the stone.
4. Now, slowly dip the stone in the water in a container as shown in Figure(b).
5. Observe what happens to elongation of the string or the reading on the balance.
6. The elongation of the string or the reading on the balance will decrease.



**Observations/ Conclusion:** The extension decreases once the stone is lowered in water, it means that some force acts on the stone in upward direction. As a result, the net force on the string decreases and hence the elongation also decreases.

Multiple  
Choice  
Questions

#### 1. Which scientist is credited with formulating the law of universal gravitation?

- a) Isaac Newton      b) Albert Einstein  
c) Galileo Galilei    d) Johannes Kepler

**Ans:** a) Isaac Newton

#### 2. What is the SI unit of gravitational force?

- a) Newton    b) Joule    c) Kilogram    d) Watt

**Ans:** a) Newton

#### 3. The force of gravity between two objects depends on

- a) The mass of both objects and the distance between them  
b) The mass of one object only  
c) The distance between the objects only  
d) The speed of the objects

**Ans:** a) The mass of both objects and the distance between them

#### 4. If the distance between two objects is doubled, how does the gravitational force between them change?

- a) It becomes four times as strong  
b) It becomes half as strong  
c) It becomes one-fourth as strong  
d) It remains the same

**Ans:** c) It becomes one-fourth as strong

#### 5. What happens to the gravitational force between two objects if the mass of one of the objects is doubled?

- a) Force doubles      b) Force halves  
c) Force quadruples    d) Force remains the same

**Ans:** a) Force doubles

#### 6. Which of the following is not an example of gravitational force?

- a) A person standing on the ground  
b) A satellite orbiting Earth  
c) A magnet attracting an iron nail  
d) An apple falling from a tree

**Ans:** c) A magnet attracting an iron nail

#### 7. The acceleration due to gravity on Earth's surface is approximately

- a)  $10 \text{ m s}^{-2}$     b)  $5 \text{ m s}^{-2}$     c)  $9.8 \text{ m s}^{-2}$     d)  $15 \text{ m s}^{-2}$

**Ans:** c)  $9.8 \text{ m/s}^2$

#### 8. What happens to the gravitational force between two objects if the distance between them is tripled?

- a) It becomes nine times weaker  
b) It becomes three times weaker  
c) It becomes three times stronger  
d) It remains the same

**Ans:** a) It becomes nine times weaker

#### 9. Which law states that the gravitational force between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers?

- a) Kepler's First Law    b) Kepler's Second Law  
c) Newton's First Law  
d) Newton's Law of Universal Gravitation

**Ans:** d) Newton's Law of Universal Gravitation

#### 10. Two objects with masses 5 kg and 10 kg are separated by a distance of 2 meters. What is the gravitational force between them?

- a) 0.05 N b) 0.5 N c) 5 N d) 50 N

**Ans:** b) 0.5 N

**11. If the mass of an object is doubled, how does its weight change near the surface of the Earth?**

- a) It doubles b) It halves  
c) It quadruples d) It remains the same

**Ans:** a) It doubles

**12. What is the relationship between weight and mass?**

- a) Weight is independent of mass  
b) Weight is inversely proportional to mass  
c) Weight is proportional to mass  
d) Weight is proportional to volume

**Ans:** c) Weight is proportional to mass

**13. Which of the following objects experiences gravitational force?**

- a) Only the moon b) Any object with mass  
c) Only objects near the Earth's surface d) Only Earth

**Ans:** b) Any object with mass

**14. What is buoyant force-**

- a) An upward force on an object immersed in a liquid  
b) Partially downward force  
c) A downward force on an object immersed in a liquid  
d) None of the above.

**Ans:** a) An upward force on an object immersed in a liquid

**15. An object weighs 10 N in air. When immersed fully in water, it weighs only 8 N. The weight of the liquid displaced by the object will be**

- a) 2 N b) 8 N c) 10 N d) 12 N

**Ans:** a) 2 N

**16. A sharp edge blade is more effective in cutting than a blunt blade due to**

- a) Low force b) Low pressure  
c) Large contact area d) Small contact area

**Ans:** d) Small contact area

**17. Weight of 1 kg is**

- a) 9.8 N b) 1 kg-wt c) both a & b d) either a or b

**Ans:** a) 9.8 newton

**18. A mass weighing W can float if the upthrust U is related as**

- a)  $U > W$  b)  $U = W$  c)  $U < W$  d)  $U \geq W$

**Ans:** a)  $U > W$

**19. According to Archimedes' principle when a body is submerged in a liquid, its apparent weight**

- a) decreases b) increases  
c) remains unchanged d) may increase or decrease

**Ans:** a) decreases

**20. Archimedes' principle holds for**

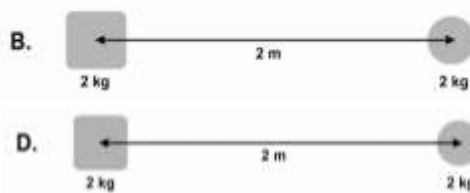
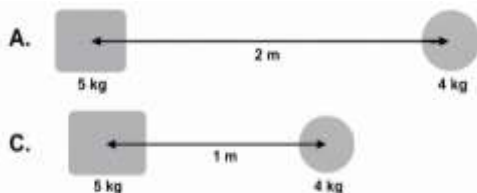
- a) liquids only b) gases only  
c) liquids and gases both d) neither liquids nor gases

**Ans:** c) liquids and gases both

### Competency - Based Questions

#### Multiple Choice Questions

**1. Which pair of objects will have the strongest force of gravity between them?**



**Ans:** C

**2. Identify the incorrect statement about a freely falling body.**

- A) Gravity and air resistance act in opposite directions. B) Air resistance does negative work on the body.  
C) Gravity does positive work on the body. D) No force acts on the body.

**Ans:** D) No force acts on the body.

**3. Four different objects are placed in a tumbler of water. Which object will displace more water than its own weight?**



**Ans:** B) Steel bowl

**4. Weight of a person on Earth is 60 kg-wt. His weight on the Moon is**

- A) 5 kg-wt B) 10 kg-wt C) 30 kg-wt D) 60 kg-wt

**Ans:** B) 10 kg-wt

**5. A student says that pressure depends on both thrust and area. Which statement is correct?**

- A) Pressure increases with area. B) Pressure decreases with thrust.  
C) Pressure increases with thrust and decreases with area. D) Pressure is independent of thrust.

**Ans:** C) Pressure increases with thrust and decreases with area.

**6. Sunil observed the construction of a pillar and noticed that its base was made wider and reinforced with**

iron rods and concrete. Why is the base of a pillar designed wider in this way?



- A) To increase the pressure on the ground by increasing area of contact.  
 B) To reduce the pressure on the ground by increasing area of contact.  
 C) To prevent the pillar from bending at the middle under wind forces.  
 D) To make the structure look attractive.

**Ans:** B) To reduce the pressure on the ground by increasing area of contact.

7. Arjun pours the same amount of four different liquids in separate cylinders.

The cylinders are of the same size. He then drops a glass marble in each of the four cylinders. Arjun notes the time the marble takes to reach the bottom of each cylinder. The table shows the results.

| Liquid   | Liquid 1 | Liquid 2 | Liquid 3 | Liquid 4 |
|--|----------|----------|----------|----------|
| Time taken by the marble to reach the bottom of the cylinder | 1.8 sec  | 1.5 sec  | 0.8 sec  | 1.0 sec  |

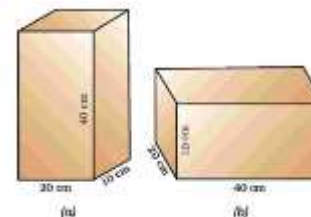
Which liquid exerted the most upward force on the marble?

- A) Liquid 1                      B) Liquid 2                      C) Liquid 3                      D) Liquid 4

**Ans:** A) Liquid 1

8. Two cuboidal blocks (a) and (b) have the same weight and are placed on the ground as shown. Which block exerts more pressure on the ground?

- A) Block (a)  
 B) Block (b)  
 C) Both exert equal pressure  
 D) Cannot be determined



**Ans:** A) Block (a)

9. In the figure, why does the rubber string elongate less when the stone is immersed in water?

- A) Water increases the weight of the stone  
 B) Water exerts an upward buoyant force on the stone  
 C) Gravity decreases in water  
 D) The stone loses its mass



**Ans:** B) Water exerts an upward buoyant force on the stone

10. An object falls freely from a height. During free fall, its

- A) Mass increases                      B) Speed increases                      C) Weight becomes zero                      D) Density decreases

**Ans:** B

### 2 Marks Questions

1. The formula for calculating the force of gravity between two objects is as follows:

$$F = G \frac{m_1 m_2}{r^2}$$

- a) What does G stand for in the formula?      b) What is the value of G

**Ans:** a) Universal Gravitational Constant.

b)  $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

2. An object floats on water. What should be the relative density of the object?

**Ans:** The relative density of the object should be less than 1.

3. Why do all objects fall with the same acceleration?

**Ans:** The acceleration due to gravity is independent of the mass of the object. Therefore, all freely falling objects fall with the same acceleration.

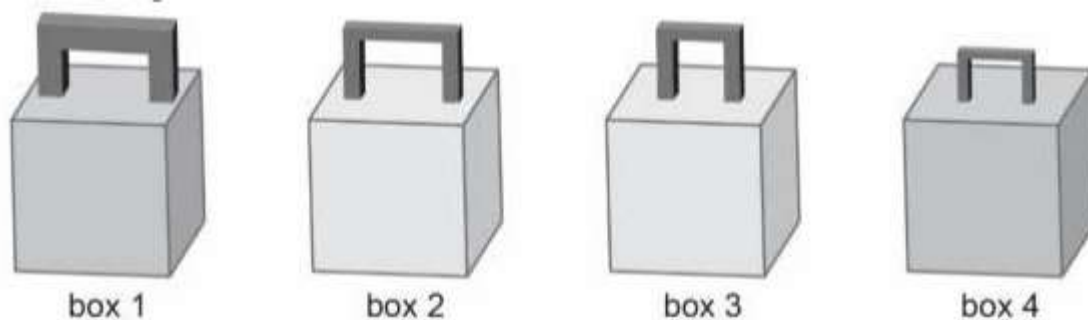
4. Why does a crumpled paper fall faster than a flat sheet?

**Ans:** A flat sheet experiences more air resistance than a crumpled paper. Hence the crumpled paper falls faster.

5. If the Earth suddenly became twice as massive, what would happen to your weight?

**Ans:** Weight depends on gravitational force. If the Earth's mass increased, the gravitational pull would increase and your weight would become greater.

6. Ayesha has four solid boxes. The handles of the boxes are of different thickness and size. All the boxes along with their handles have the same mass.



a) Ayesha tries to lift the four boxes one by one. Which box will be the most difficult to lift?

b) Which box has the most weight?

**Ans:** a) Box 4

b) All four boxes have the same weight, because they all have the same mass.

7. A feather and a stone are dropped from the same height. Why does the stone reach the ground first?

**Ans:** Air resistance affects the feather more than the stone. In the absence of air (vacuum), both would fall with the same acceleration due to gravity and reach the ground together.

8. Why is the weight of a person on the Moon less than on the Earth?

**Ans:** The Moon has less mass and smaller gravitational pull than the Earth. Therefore, the weight of an object on the Moon is about  $\frac{1}{6}$ th of its weight on the Earth.

9. A person carries a 10 kg bag on Earth and then on the Moon. What changes and what remains the same?

**Ans:** The mass (10 kg) remains the same because mass is constant. The weight decreases on the Moon because gravitational acceleration is smaller there.

10. Why is it difficult to walk on loose sand?

**Ans:** Our weight acts on a small area of the feet, producing high pressure on the sand. The feet sink into the sand, making walking difficult.

11. Why do camels have broad feet?

**Ans:** Broad feet increase the area of contact with the ground, reducing pressure on the sand. Therefore, camels can walk easily on deserts without sinking.

12. Why does a sharp knife cut vegetables more easily than a blunt knife?

**Ans:** A sharp knife has a smaller contact area. For the same force, it exerts greater pressure, making cutting easier.

13. Why is it easier to lift a bucket of water while it is inside a well than after taking it out?

**Ans:** When the bucket is immersed in water, an upward buoyant force acts on it, reducing its apparent weight. After taking it out, this buoyant force is absent.

14. Why do ships made of iron float whereas a small iron nail sinks?

**Ans:** A ship is hollow and displaces a large volume of water, producing sufficient buoyant force. An iron nail displaces very little water, so it sinks.

15. Why does a school bag with broad straps feel more comfortable than one with thin straps?

**Ans:** Broad straps increase the area of contact on the shoulders. This reduces pressure and makes carrying the bag more comfortable.

16. Why does a person feel lighter while swimming?

**Ans:** Water exerts an upward buoyant force on the body, which reduces the apparent weight of the person.

#### 4 Marks Questions

1. Why is it essential for deep-sea diving vessels to be built of thick sheets of steel?

**Ans:** The water pressure increases with depth. Thick steel sheets can withstand the enormous pressure exerted by deep-sea water and protect the vessel from collapsing.

2. Explain why the Earth does not move towards the Moon although the Moon attracts the Earth.

**Ans:** According to Newton's third law, the Earth and Moon attract each other with equal forces. However, the Earth's mass is much larger than the Moon's mass. Therefore, the acceleration produced in the Earth is extremely small and not noticeable.

3. Explain why an object floats or sinks in water.

**Ans:** i) If the density of an object is less than the density of water, it floats.

ii) If the density of an object is greater than the density of water, it sinks.

iii) Floating depends on buoyant force and density.

4. Explain why buoyant force acts on an object immersed in a fluid.

- Ans:** i) The pressure in a fluid increases with depth.  
 ii) Therefore, the pressure at the bottom of an immersed object is greater than at the top.  
 iii) This pressure difference produces an upward force.  
 iv) This upward force is called buoyant force or upthrust.

**5. Explain the factors affecting buoyant force.**

- Ans:** Buoyant force depends on i) Density of the liquid. ii) Volume of liquid displaced.  
 iii) Acceleration due to gravity. iv) Depth of immersion.

**6. A body of mass 5 kg is on Earth. Calculate its weight.**

- Ans:** Given Mass (m) = 5 kg  $g = 9.8 \text{ m/s}^2$   
 Weight = mg  
 $= 5 \times 9.8$   
 $= 49 \text{ N}$

**7. A ball is thrown vertically upwards with a velocity of 49 m/s. Find the maximum height reached.**

- Ans:** Given  $u = 49 \text{ m/s}$   $v = 0$   $g = 9.8 \text{ m/s}^2$   
 $v^2 = u^2 - 2gh$   
 $0 = 49^2 - 2 \times 9.8 \times h$   
 $h = 2401 / 19.6$   
 $h = 122.5 \text{ m}$

**8 Marks Questions**

**1. State the Universal Law of Gravitation. Derive its mathematical expression.**

**Ans:** Every object attracts every other object in the universe with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Derivation: Let, Masses of two bodies = **M** and **m**  
 Distance between their centres = **d**

According to the law,  $F \propto Mm$  -----> 1

And  $F \propto 1/d^2$  -----> 2

Combining Eq.1 and Eq.2

$$F \propto \frac{Mm}{d^2}$$

$$F = G \frac{M \times m}{d^2}$$

Where **G** is the Universal Gravitational Constant.

**2. Calculate the changes in the following cases when all other physical quantities are kept constant.**

a) If the area of a contacting surface is doubled, how will the pressure change?

b) If the distance between two objects is doubled, how will the gravitational force between them change?

**Ans:** a) Pressure is inversely proportional to the area.  $P = F/A$

If the area is doubled, the pressure becomes half of its original value.

b) Gravitational force is inversely proportional to the square of the distance.

$$F = G \frac{m_1 m_2}{d^2}$$

If the distance is doubled ( $d \rightarrow 2d$ ),

$$F' = G \frac{m_1 m_2}{(2d)^2} = G \frac{m_1 m_2}{4d^2} = F/4$$

Therefore, the gravitational force becomes one-fourth ( $1/4$ ) of its original value.

**3. State Archimedes' Principle and write their applications.**

**Ans:** 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.

Archimedes' principle is used in i) Designing ships

ii) Submarines

iii) Lactometers

iv) Hydrometers.

**4. A toolbox has a mass of 10 kg on Earth. What will be its mass and weight on the Moon?**

**Ans:** Given Mass = 10 kg,

Weight on Earth = mg

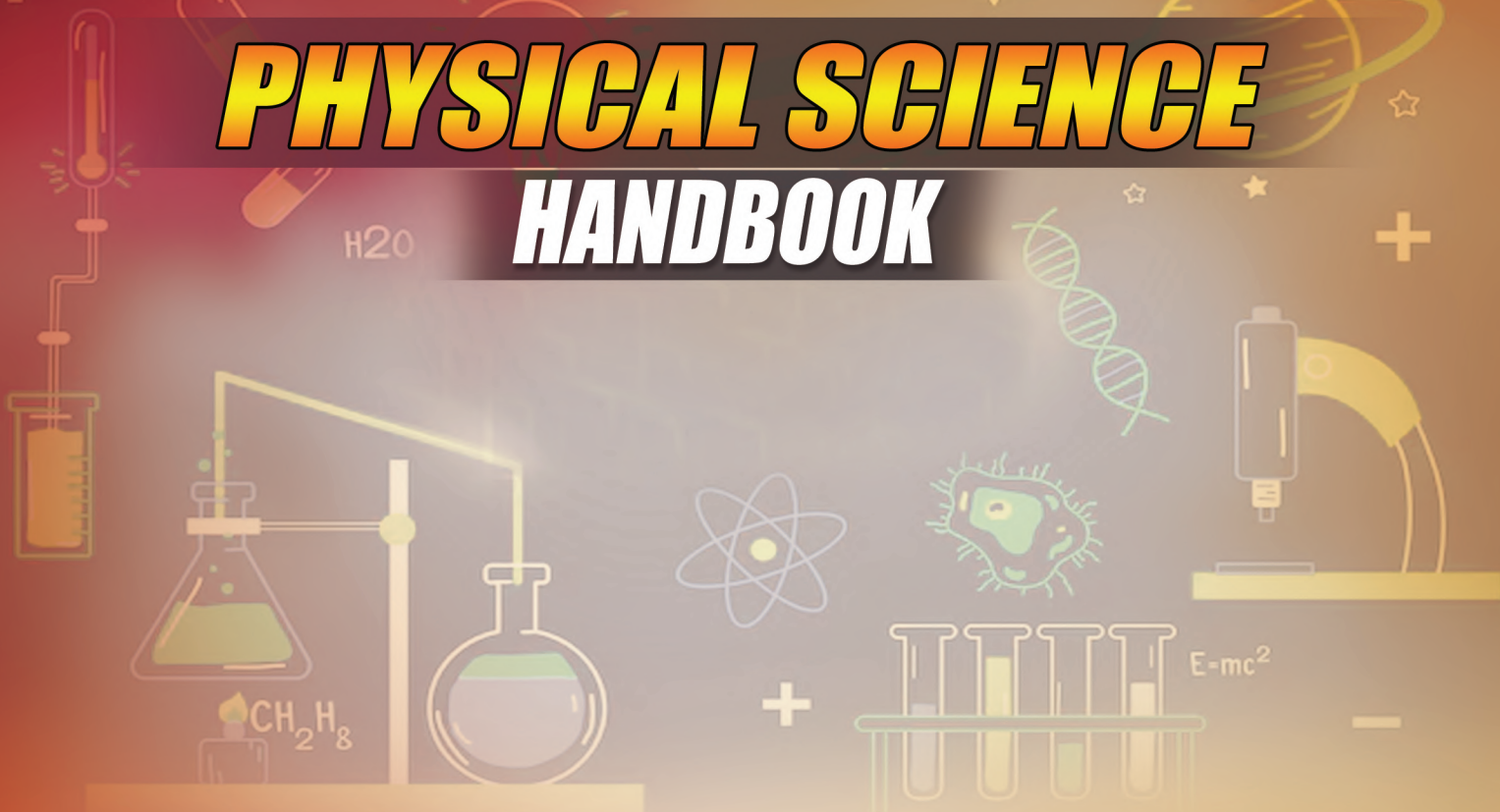
$$= 10 \times 9.8$$

$$= 98 \text{ N}$$

Moon's gravity =  $1/6$  of Earth's gravity

$$\text{Weight on Moon} = 98/6 = 16.3 \text{ N}$$

# PHYSICAL SCIENCE HANDBOOK



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