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Strictly based on the Common Board Textbook prescribed  
for Standard X by Government of Tamil Nadu

*Diamond*

**Science**

*Learning Simplified*

**BASED ON NEW TEXT BOOK**

**10**

- ◆ Based on the New Textbook 2019-20
- ◆ All Textual Exercises fully solved
- ◆ More number of additional questions in all sections

by

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## Publishers Note

We are immensely pleased to introduce Standard X *Diamond* Science study material based on the NEW SYLLABUS and NEW Textbook of Govt. Tamil Nadu 2019-20 for the ready use of the teaching fraternity and the extensive use of learning community.

This book has been authored by B. Varalakshmi, T.K. Jagatheeswari and M. Uma Maheswari. This book will serve as a teaching companion and quick refresher to qualified teachers.

### **Salient Features**

- Exhaustive Study Material.
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- Attractive and well labelled illustrations and figures to reinforce the facts.

We are looking forward to receiving your valuable patronage and constructive suggestions.

**1**

**PHYSICS**

**Laws of Motion**

**I. Choose the correct answer.**

**Self-Evaluation (Textual Questions)**

1. Inertia of a body depends on ..... .  
 (a) weight of the object (b) acceleration due to gravity of the planet  
 (c) mass of the object (d) both (a) & (b)
2. Impulse is equal to ..... .  
 (a) rate of change of momentum (b) rate of force and time  
 (c) change of momentum (d) rate of change of mass
3. Newton's third law is applicable ..... .  
 (a) for a body is at rest (b) for a body in motion  
 (c) both (a) & (b) (d) only for bodies with equal masses
4. Plotting a graph for momentum on the X-axis and time on Y-axis, slope of momentum-time graph gives ..... .  
 (a) Impulsive force (b) Acceleration (c) Force (d) Rate of force
5. In which of the following sport the turning of effect of force used?  
 (a) swimming (b) tennis (c) cycling (d) hockey
6. The unit of 'g' is  $m\ s^{-2}$ . It can be also expressed as ..... .  
 (a)  $cm\ s^{-1}$  (b)  $N\ kg^{-1}$  (c)  $N\ m^2\ kg^{-1}$  (d)  $cm^2\ s^{-2}$
7. One kilogram force equals to ..... .  
 (a) 9.8 dyne (b)  $9.8 \times 10^4\ N$  (c)  $98 \times 10^4\ dyne$  (d) 980 dyne
8. The mass of a body is measured on planet Earth as M kg. When it is taken to a planet of radius half that of the Earth then its value will be ..... kg.  
 (a) 4M (b) 2M (c) M/4 (d) M
9. If the Earth shrinks to 50% of its real radius its mass remaining the same, the weight of a body on the Earth will ..... .  
 (a) decrease by 50% (b) increase by 50%  
 (c) decrease by 25% (d) increase by 300%
10. To project the rockets which of the following principle(s) is / (are) required?  
 (a) Newton's third law of motion (b) Newton's law of gravitation  
 (c) Law of conservation of linear momentum  
 (d) Both (a) and (c)

**Other Important Questions**

11. The branch of physics that deals with the effect of force on bodies is ..... .  
 (a) Mechanics (b) Acoustics  
 (c) Thermodynamics (d) Relativity
12. What helps to measure the magnitude of force?  
 (a) Velocity (b) Acceleration (c) Inertia (d) Momentum
13. Unit of momentum in SI system is ..... .  
 (a) kg m (b)  $kg\ m\ s^{-2}$  (c)  $kg\ m\ s^{-1}$  (d)  $kg^2\ m\ s^{-2}$

14. Identify the vector quantity from the following.  
 (a) Mass (b) Potential (c) Force (d) All of these
15. Which is called the law of force?  
 (a) Newton's first law (b) Newton's second law  
 (c) Newton's third law (d) None of the above
16. SI unit of force is .....  
 (a) newton (b) kilogram (c) newton metre (d) kilogram metre
17. 1 kg f(force) is equal to .....  
 (a) 13.6 gm (b) 9.8 N (c) 980 dyne (d) 13.6 N
18. Mass of the Earth is equal to .....  
 (a) 9.8 kg (b) 10.2 kg (c) 6400 kg (d)  $5.972 \times 10^{24}$  kg
19. As we move to higher altitudes the value of 'g' .....  
 (a) increases (b) decreases (c) becomes zero (d) becomes infinity
20. At the centre of the Earth, the value of 'g' is .....  
 (a) maximum (b) minimum (c) zero (d) infinity
21. .... deals with the motion of bodies without considering the cause of motion.  
 (a) Mechanics (b) Statics (c) Kinematics (d) Kinetics
22. .... gives the definition of force as well as inertia.  
 (a) Newton's First Law (b) Newton's Second Law  
 (c) Newton's Third Law (d) All the above
23. Momentum is expressed as .....  
 (a) Mass  $\times$  Acceleration (b) Mass  $\times$  Velocity  
 (c) Mass  $\times$  Time (d)  $\frac{\text{Mass}}{\text{Velocity}}$
24. Unit of torque is .....  
 (a) Nm (b)  $\text{Nm}^2$  (c)  $\text{Nm}^{-1}$  (d)  $\text{Kgm}^2$
25. For a balanced force resultant force is .....  
 (a) infinity (b) less than zero (c) zero (d) greater than zero
26. Impulse is .....  
 (a) change in force (b) change in velocity  
 (c) change in momentum (d) change in torque
27. Rocket propulsion is based on .....  
 (a) Law of conservation of momentum (b) Newton's Second Law  
 (c) Newton's Third Law (d) Both (a) and (c)
28. Identify the correct relation.  
 (a)  $g = \frac{GM}{R^2}$  (b)  $G = \frac{gM}{R^2}$  (c)  $g = GMR^2$  (d)  $g = \frac{GR^2}{M}$
29. Mass of the earth is .....  
 (a)  $5.792 \times 10^{24}$  kg (b)  $5.972 \times 10^{24}$  kg (c)  $5.297 \times 10^{24}$  kg (d)  $5.927 \times 10^{24}$  kg
30. Apparent weight of a person under free fall is .....  
 (a) infinity (b) less than zero (c) zero (d) greater than zero

**ANSWERS**

- 
1. (a)    2. (c)    3. (c)    4. (d)    5. (c)    6. (b)    7. (c)    8. (c)  
 9. (increase by 4 times)    10. (d)    11. (a)    12. (d)    13. (c)    14. (c)    15. (b)    16. (a)  
 17. (b)    18. (d)    19. (b)    20. (c)    21. (c)    22. (a)    23. (b)    24. (a)    25. (c)    26. (c)  
 27. (d)    28. (a)    29. (b)    30. (c)
- 

**II. Fill in the blanks.**

**Self-Evaluation (Textual Questions)**

1. To produce a displacement ..... is required.
2. Passengers lean forward when sudden brake is applied in a moving vehicle. This can be explained by .....
3. By convention, the clockwise moments are taken as ..... and the anti-clockwise moments are taken as .....
4. .... is used to change the speed of car.
5. A man of mass 100 kg has a weight of ..... at the surface of the Earth.

**Other Important Questions**

6. .... deals with the bodies, which are at rest under the action of forces.
7. .... motion is force dependent.
8. .... law helps to measure the force.
9. .... is required to produce the acceleration of a body.
10. Gravitational unit of force in SI system is .....
11. .... is also equal to the magnitude of change in momentum.
12. The acceleration due to gravity on the surface of the Earth is .....
13. Below the surface of the Earth the value of 'g' .....
14. .... deals with the motion of bodies without considering the cause of motion.
15. Bodies of different size, shape and mass fall from a height in ..... reach the ground at the same time.
16. A body does not change its state during the period of time, then it is said to be at .....
17. A body changes its state, then it is said to be at .....
18. The resistance of a body to change its state is called .....
19. The product of mass and velocity of a moving body is .....
20. Momentum is a ..... quantity.
21. When a force of 1 N acts on a mass of 1 kg that is forced to move, the object moves with an acceleration of .....
22. In balanced force, the resultant force is equal to .....
23. The combined effect of multiple forces is balanced by a single force is called .....
24. The force which is equal to resultant but opposite in direction is called as .....
25. Like parallel forces are two forces that act along ..... direction.
26. Torque is a ..... quantity.
27. Unit of torque is .....
28. Two equal and unlike parallel force is called .....
29. If the object is rotated in clockwise direction, couple is .....

30. The algebraic sum of the moments in the clockwise direction is ..... to the algebraic sum moments in the anticlockwise.
31. 1 kg f equal to .....
32. 1 N is equal to .....
33. The momentum of massive object at rest is .....
34. The product of mass and velocity is known as .....
35. A body of mass 50 kg runs with a force of 100 N, then its acceleration would be .....
36. The force of gravitation is inversely related to .....
37. Weight of the body acquired due to gravity is .....
38. When a person falls freely under the action of gravity has .....
39. The apparent weight of an object ..... in an elevator while accelerating upward.
40. Everything in freely falling system, appears to be .....
41. When velocity of lift changes, apparent weight ..... from true weight.
42. Mass is the measure of .....
43. Weight is the measure of force of ..... on an object.
44. The unit of weight is .....
45. The unit of mass is .....
46. The weight of a 1 kg mass object on earth is .....
47. Astronauts are not floating but falling freely due to huge .....
48. .... force keeps the satellite in its orbit.
49. To study the dimensions of heavenly bodies ..... law is used.

**ANSWERS**

- |                                       |                      |                          |                             |
|---------------------------------------|----------------------|--------------------------|-----------------------------|
| 1. force                              | 2. inertia of motion | 3. positive, negative    | 4. Force                    |
| 5. 980 kg                             | 6. Statics           | 7. Violent motion        | 8. Newton's second law      |
| 9. Force                              | 10. kilogram force   | 11. Impulse              | 12. $9.8 \text{ m s}^{-2}$  |
| 13. decreases                         | 14. Kinematics       | 15. vacuum               | 16. rest                    |
| 17. motion                            | 18. inertia          | 19. momentum             | 20. vector                  |
| 21. $1 \text{ m s}^{-2}$              | 22. zero             | 23. resultant            | 24. equilibrant             |
| 25. same                              | 26. vector           | 27. Nm                   | 28. couple                  |
| 29. negative                          | 30. equal            | 31. 9.8 N                | 32. $1 \text{ kg m s}^{-2}$ |
| 33. zero                              | 34. momentum         | 35. $2 \text{ m s}^{-2}$ |                             |
| 36. square of distance between masses | 37. apparent weight  | 38. zero weight          |                             |
| 39. increases                         | 40. weightless       | 41. differs              | 42. matter                  |
| 43. gravity                           | 44. newton           | 45. kilogram             | 46. 9.8 N                   |
| 47. orbital velocity                  | 48. centripetal      | 49. gravitational        |                             |

**III. State whether the following statements are true or false. Correct the statement if it is false.**

**Self-Evaluation (Textual Questions)**

1. The linear momentum of a system of particles is always conserved.
2. Apparent weight of a person is always equal to his actual weight.
3. Weight of a body is greater at the equator and less at the polar region.
4. Turning a nut with a spanner having a short handle is so easy than one with a long handle.

5. There is no gravity in the orbiting space station around the Earth. So the astronauts feel weightlessness.

**Other Important Questions**

6. Kinetics deals with the motion of bodies without considering the cause of motion.  
 7. Newton's first law of motion gives the definition of force as well as inertia.  
 8. In a couple the line of action of the two forces coincide.  
 9. No external force is required to maintain the motion of a body moving with uniform velocity.  
 10. The velocity of the body will change when the net force acting on a body is not equal to zero.  
 11. The geometric radius of the Earth is minimum in the equatorial region.  
 12. Weight of a body is more at the poles than at the equatorial region.

**ANSWERS**

1. True 2. False 3. False 4. False 5. True 6. False 7. True 8. False  
 9. True 10. True 11. False 12. True

**Correct statements for the false statements:**

2. Apparent weight of a person is always not equal to his actual weight.  
 3. The geometric radius of the Earth is maximum in the equatorial region and minimum in the polar region. Hence the value of  $g$  is maximum in the polar region and minimum at the greater at the polar region.  
 4. Turning a nut with a spanner having a long handle is so easy than one with a short handle.  
 6. Kinematics deals with the motion of bodies without considering the cause of motion.  
 8. In a couple the line of action of the two forces does not coincide.  
 11. The geometric radius of the Earth is maximum in the equatorial region.

**IV. Match the following.**

**Self-Evaluation (Textual Questions)**

- (a) 1. Newton's first law - (i) Propulsion of a rocket  
 2. Newton's second law - (ii) Stable equilibrium of a body  
 3. Newton's third law - (iii) Law of force  
 4. Law of conservation of linear momentum - (iv) Flying nature of bird

**Other Important Questions**

- (b) 1. Study of moving bodies under the action of forces - (i) Unit of momentum in CGS system of unit  
 2. Natural Motion - (ii)  $6.674 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$   
 3.  $\text{g cm s}^{-1}$  - (iii) Dynamics  
 4. Nm - (iv)  $1.625 \text{ ms}^{-2}$   
 5. Dyne - (v) 980 dyne  
 6. 1 gf - (vi) CGS unit of force  
 7. 'G' in SI unit is - (vii) Force independent  
 8. 'g' in moon - (viii) Unit of torque and couple



- (c) 1. Compressing a spring & muscular force - (i) Unbalanced force  
 2. Electromagnetic force - (ii) Contact force  
 3. Tug of war - (iii) Non-contact force  
 4. Action of a lever - (iv) Unlike parallel forces
- (d) 1. Downward motion of the object with  $a \neq g$  - (i) Apparent weight equals to zero  
 2. Upward motion of the object with  $a \neq g$  - (ii) No loss; no gain  
 3. Downward motion of the object with uniform velocity  $a = 0$  - (iii) Apparent weight loss  
 4. Downward motion of the object with  $a = g$  - (iv) Apparent weight gain
- (e) 1. Moment of couple - (i)  $10^5$  dyne  
 2. Momentum - (ii)  $1.625 \text{ ms}^{-2}$   
 3. One Newton - (iii) 980 dyne  
 4. One gram force - (iv) Dyne cm  
 5. Acceleration due to gravity on the surface of the moon - (v)  $\text{gcm s}^{-1}$

**ANSWERS**

- 
- (a) 1. (ii) 2. (iii) 3. (iv) 4. (i)  
 (b) 1. (iii) 2. (vii) 3. (i) 4. (viii) 5. (vi) 6. (v) 7. (ii) 8. (iv)  
 (c) 1. (ii) 2. (iii) 3. (iv) 4. (i)  
 (d) 1. (iii) 2. (iv) 3. (ii) 4. (i)  
 (e) 1. (iv) 2. (v) 3. (i) 4. (iii) 5. (ii)
- 

**V. Assertion & Reasoning.**

**Self-Evaluation (Textual Questions)**

Mark the correct choice as

- (a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.  
 (b) If both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.  
 (c) Assertion is true, but the reason is false.  
 (d) Assertion is false, but the reason is true.

**1. Assertion :** The sum of the clockwise moments is equal to the sum of the anticlockwise moments.

**Reason :** The principle of conservation of momentum is valid if the external force on the system is zero.

**2. Assertion :** The value of 'g' decreases as height and depth increases from the surface of the Earth.

**Reason :** 'g' depends on the mass of the object and the Earth.

**Other Important Questions**

3. **Assertion:** A couple does not produce any translatory motion.  
**Reason :** In a couple the resultant force is zero.
4. **Assertion:** The velocity of the object remains constant as it falls down.  
**Reason :** The velocity of an object depends on the force acting on the object.
5. **Assertion:** Weight of a body varies from one place to another place on the Earth .  
**Reason :** Weight depends on the mass of the body.
6. **Assertion:** Apparent weight is not the same as the actual weight.  
**Reason :** Apparent weight is the weight of the body acquired due to the action of gravity and other external forces acting on the body.
7. **Assertion:** Astronauts are found to float in space ship.  
**Reason :** Space stations maintain zero gravity.

**ANSWERS**

1. (b)    2. (c)    3. (a)    4. (d)    5. (c)    6. (a)    7. (c)

**VI. Answer the following.**

**Self-Evaluation (Textual Questions)**

**1. Define inertia. Give its classification.**

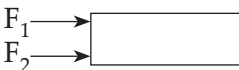
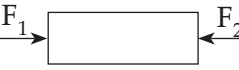
The inherent property of a body to resist any change in its state of rest or the state of uniform motion, unless it is influenced upon by an external unbalanced force, is known as 'inertia'. It is classified as

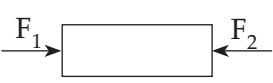
- (a) **Inertia of rest:** The resistance of a body to change its state of rest is called inertia of rest.
- (b) **Inertia of motion:** The resistance of a body to change its state of motion is called inertia of motion.
- (c) **Inertia of direction:** The resistance of a body to change its direction of motion is called inertia of direction.

**2. Classify the types of force based on their application.**

Based on the direction in which the forces is applied, they can be classified into two types as: (a) Like parallel forces and (b) Unlike parallel forces.

- (a) **Like parallel forces:** Two or more forces of equal or unequal magnitude acting along the same direction, parallel to each other are called like parallel forces.
- (b) **Unlike parallel forces:** If two or more equal forces or unequal forces act along opposite directions parallel to each other, then they are called unlike parallel forces. Action of forces are given in table.

Action of forces	Diagram	Resultant force ( $F_{net}$ )
Parallel forces are acting in the same direction.		$F_{net} = F_1 + F_2$
Parallel unequal forces are acting in opposite directions.		$F_{net} = F_1 - F_2$ (if $F_1 > F_2$ ) $F_{net} = F_2 - F_1$ (if $F_2 > F_1$ ) $F_{net}$ is directed along the greater force.

Parallel equal forces are acting in opposite directions in the same line of action ( $F_1 = F_2$ )		$F_{\text{net}} = F_1 - F_2 \quad (F_1 = F_2)$ $F_{\text{net}} = 0$
--	---	---

3. If a 5 N and a 15 N forces are acting opposite to one another. Find the resultant force and the direction of action of the resultant force.

$$F_{\text{net}} = F_2 - F_1 \quad (\text{if } F_2 > F_1)$$

$$= 15 - 5 = 10 \text{ N}$$

$F_{\text{net}}$  is directed along the greater force.

4. Differentiate mass and weight.

S. No.	Mass	Weight
(i)	Mass of a body is defined as the quantity of matter contained in the body.	Weight of a body is defined as the gravitational force exerted on it due to the Earth's gravity alone.
(ii)	Its SI unit is kilogram (kg).	Its SI unit is newton (N).
(iii)	Mass is a scalar quantity.	Weight is a vector quantity.

5. Define moment of a couple.

Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple. Rotating effect of a couple is known as moment of a couple.

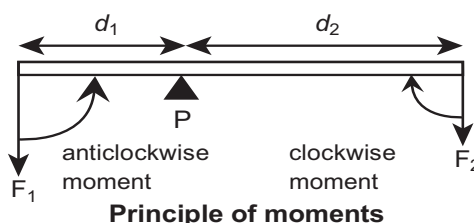
Moment of a couple = Force  $\times$  perpendicular distance between the line of action of forces

The unit of moment of a couple is newton metre (N m) in SI system and dyne cm in CGS system.

6. State the principle of moments.

The principle of moments states that when a number of like or unlike parallel forces act on a rigid body and the body is in equilibrium, then the algebraic sum of the moments in the clockwise direction is equal to the algebraic sum of the moments in the anticlockwise direction.

The principle of moments states that at equilibrium, the algebraic sum of the moments of all the individual forces about any point is equal to zero.



Moment in clockwise direction = Moment in anticlockwise direction

$$F_1 \times d_1 = F_2 \times d_2$$

7. State Newton's second law.

Newton's second law states that "the force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force".

8. Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?

A spanner with a long handle is preferred to tighten screws in heavy vehicles because the turning effect of a body depends upon the perpendicular distance of the line of action of the applied force from the axis of rotation. Larger the perpendicular distance, less is the force required to turn the body.

**9. While catching a cricket ball the fielder lowers his hands backwards. Why?**

While catching a cricket ball the fielder lowers his hands backwards. Hence he experiences a smaller force for a longer interval of time to catch the ball, resulting in a lesser impulse on his hands. As a result the ball does not hurt the fielder.

**10. How does an astronaut float in a space shuttle?**

Astronauts are not floating but falling freely around the earth due to their huge orbital velocity. Since space station and astronauts have equal acceleration, they are under free fall condition. Hence, both the astronauts and the space station are in the state of weightlessness.

**Other Important Questions**

**11. When two bodies of different masses are dropped from the same height, which body falls faster? Why?**

According to Galileo, two bodies of different masses, dropped from the same height, will touch the floor at the same time in the absence of air resistance.

Since the two objects are subject only to the force of gravity they will fall with the same acceleration and hence they will hit the ground at the same time.

**12. Define momentum.**

The product of mass and velocity of a moving body gives the magnitude of linear momentum. It acts in the direction of the velocity of the object.

$$p = m v$$

Its unit in SI system is  $\text{kg m s}^{-1}$  and in C.G.S system is  $\text{g cm s}^{-1}$ .

**13. State Newton's first law of motion.**

Newton's first law of motion states every body continues to be in its state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force.

**14. What is meant by resultant force?**

When several forces act simultaneously on the same body, then the combined effect of the multiple forces can be represented by a single force, which is termed as 'resultant force'. It is equal to the vector sum of all the forces.

**15. What is meant by equilibrant?**

If a system can be brought to equilibrium by applying another force, which is equal to the resultant force in magnitude, but opposite in direction. Such force is called as 'Equilibrant'.

**16. What is meant by moment of a force?**

The rotating or turning effect of a force about a fixed point or fixed axis is called moment of the force about that point or torque ( $\tau$ ).

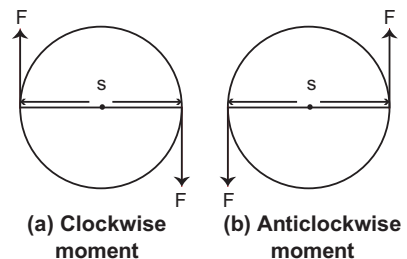
$$\tau = F \times d$$

Torque is a vector quantity. Its SI unit is N m.

**17. How do you measure the moment of the couple?**

Moment of a couple is measured by the product of any one of the forces and the perpendicular distance between the line of action of two forces. The turning effect of a couple is measured by the magnitude of its moment.

$$M = F \times S$$



By convention, the direction of moment of a force or couple is taken as positive if the body is rotated in the anti-clockwise direction and negative if it is rotate in the clockwise direction.

**18. What is meant by centripetal acceleration and force?**

In a uniform circular motion, the acceleration that is produced along the radius is called as centripetal acceleration. The force, which produces this acceleration is called as centripetal force.

**19. Define one newton.**

One newton is defined as the amount of force required for a body of mass 1 kg to produce an acceleration of  $1 \text{ m s}^{-2}$ ,  $1 \text{ N} = 1 \text{ kg m s}^{-2}$ .

**20. Define one dyne.**

One dyne is defined as the amount of force required for a body of mass 1 gram to produces an acceleration of  $1 \text{ cm s}^{-2}$ ,  $1 \text{ dyne} = 1 \text{ g cm s}^{-2}$ ; also  $1 \text{ N} = 10^5 \text{ dyne}$ .

**21. Define unit force.**

The amount of force required to produce an acceleration of  $1 \text{ m s}^{-2}$  in a body of mass 1 kg is called 'unit force'.

**22. Define impulsive force.**

A large force acting for a very short interval of time is called as 'Impulsive force'.

**23. What is meant by impulse? Give its unit.**

The product of force and time is known as 'impulse'. It is represented by 'J'

$$\text{Impulse, } J = F \times t$$

Impulse is also equal to the magnitude of change in momentum.

$$\Delta p = F \times t$$

Its unit is  $\text{kg m s}^{-1}$  or N s.

**24. Discuss the ways in which change in momentum can be achieved?**

Change in momentum can be achieved in two ways. They are:

- (i) a large force acting for a short period of time and
- (ii) a smaller force acting for a longer period of time.

**25. Why Automobiles are fitted with springs and shock absorbers?**

Automobiles are fitted with springs and shock absorbers to reduce jerks while moving on uneven roads.

**26. What is meant by acceleration due to gravity? Give its unit.**

If the acceleration of the body is due to the Earth's gravitational force, then it is called as 'acceleration due to the gravitational force of the Earth' or 'acceleration due to gravity of the Earth'. It is represented as 'g'. Its unit is  $\text{m s}^{-2}$ .

**27. What is meant by apparent weight?**

Apparent weight is the weight of the body acquired due to the action of gravity and other external forces acting on the body.

**28. Why does a person falling freely in a roller coaster or on a swing or in a vertical giant wheel feel an apparent weight loss?**

A person falling freely in a roller coaster or on a swing or in a vertical giant wheel moves down with an acceleration ( $a$ ) equal to the acceleration due to gravity ( $g$ ). This

motion is called as 'free fall'. Here, the apparent weight ( $R = m(g - g) = 0$ ) of the person is zero. Thus the person feels an apparent weight loss and weight gain when he moves up and down in such rides.

**29. Why astronauts are found floating in space?**

Astronauts are not floating but falling freely around the Earth due to their huge orbital velocity. Since space station and astronauts have equal acceleration, they are under free fall condition. Hence, both the astronauts and the space station are in the state of weightlessness.

**30. Discuss the effect of force on a body.**

Force is an external effort in the form of push or pull. It

- (i) produces or tries to produce the motion of a static body.
- (ii) stops or tries to stop a moving body.
- (iii) changes or tries to change the direction of motion of a moving body.

**31. Distinguish between balanced and unbalanced force.**

S. No.	Balanced Force	Unbalanced Force
(i)	The resultant force of all the forces acting on a body is equal to zero.	The resultant force is not equal to zero.
(ii)	The body is in equilibrium.	It causes the motion of the body.
(iii)	<b>Example:</b> Any body that is at rest.	<b>Example:</b> Drawing water from a well, force applied with a crow bar, forces on a weight balance, etc.

**32. A person of mass 60 kg stands on the surface of Earth. What could be his weight on the surface of the Earth and Moon?**

**Solution:** His weight on the surface of the Earth would be  $W = mg = 60 \times 9.8 = 588 \text{ N}$ .

If the same person goes to the surface of the Moon, he would weigh

$$W = 60 \times 1.625 = 97.5 \text{ N}$$

But, his mass remains the same (60 kg) on both the Earth and the Moon.

**VII. Solve the given problems.**

**Self-Evaluation (Textual Questions)**

1. Two bodies have a mass ratio of 3 : 4. The force applied on the bigger mass produces an acceleration of  $12 \text{ m s}^{-2}$ . What could be the acceleration of the other body, if the same force acts on it.

**Given data:**

Mass of two bodies,  $m_1 : m_2 = 3 : 4$ ;  $a_2 = 12 \text{ ms}^{-2}$ ;  $F_1 = F_2$

**Solution:**

$$F = ma$$

$$m_1 a_1 = m_2 a_2$$

$$3 \times a_1 = 4 \times 12$$

$$a_1 = \frac{48}{3} = 16 \text{ ms}^{-2}$$

2. A ball of mass 1 kg moving with a speed of  $10 \text{ m s}^{-1}$  rebounds after a perfect elastic collision with the floor. Calculate the change in linear momentum of the ball.

**Given data:**

Mass of ball ( $m$ ) = 1 kg; Velocity ( $u$ ) =  $10 \text{ ms}^{-1}$

Rebounding velocity ( $v$ ) =  $-10 \text{ ms}^{-1}$

Change in linear momentum = ?

**Solution:**

Initial momentum =  $mu = 1 \times 10 = 10$

Final momentum =  $mv = 1 \times (-10) = -10$

Change in momentum = Final momentum – Initial momentum

$$-10 - 10 = -20 \text{ kgms}^{-1}$$

3. A mechanic unscrew a nut by applying a force of 140 N with a spanner of length 40 cm. What should be the length of the spanner if a force of 40 N is applied to unscrew the same nut?

**Given data:**

Force = 140 N =  $F_1$

Length of the spanner = 40 cm =  $d_1$

Force = 40 N =  $F_2$

Length of the spanner ( $d_2$ ) = ?

**Solution:**

Moment of couple =  $\tau = F \times d$

$$F_1 \times d_1 = F_2 \times d_2 \Rightarrow 140 \times 40 = 40 \times d_2$$

$$d_2 = \frac{140 \times 40}{40} = 140 \text{ cm}$$

4. The ratio of masses of two planets is 2 : 3 and the ratio of their radii is 4 : 7. Find the ratio of their accelerations due to gravity.

**Given data:**

Masses of two planets,  $M_1 : M_2 = 2 : 3$

Ratio of their radii,  $r_1 : r_2 = 4 : 7$

Ratio of their acceleration due to gravity,  $g_1 : g_2 = ?$

**Solution:**

$$g = \frac{GM}{R^2}; \Rightarrow g_1 = \frac{GM_1}{R_1^2} \Rightarrow \frac{G \times 2}{4^2}; g_2 = \frac{GM_2}{R_2^2} \Rightarrow \frac{G \times 3}{7^2}$$

$$g_1 : g_2$$

$$\frac{2G}{16} : \frac{3G}{49} \Rightarrow \frac{1}{8} : \frac{3}{49}$$

$$g_1 : g_2 = 49 : 24$$

**Textual Solved Problems:**

5. Calculate the velocity of a moving body of mass 5 kg whose linear momentum is  $2.5 \text{ kg m s}^{-1}$ .

**Solution:** Linear momentum = mass  $\times$  velocity  $\Rightarrow$  Velocity = linear momentum/mass

$$V = 2.5/5 = 0.5 \text{ m s}^{-1}$$

6. A door is pushed, at a point whose distance from the hinges is 90 cm, with a force of 40 N. Calculate the moment of the force about the hinges.

**Solution:**

**Formula:** The moment of a force  $M = F \times d$

**Given:**  $F = 40 \text{ N}$  and  $d = 90 \text{ cm} = 0.9 \text{ m}$ .

Hence, moment of the force  $= 40 \times 0.9 = 36 \text{ N m}$ .

7. At what height from the centre of the Earth the acceleration due to gravity will be  $1/4^{\text{th}}$  of its value as at the Earth.

**Solution:**

**Data:** Height from the centre of the Earth,  $R' = R + h$

The acceleration due to gravity at that height,  $g' = g/4$

**Formula:**  $g = GM/R^2$

$$\frac{g}{g'} = \left(\frac{R'}{R}\right)^2 = \left(\frac{R+h}{R}\right)^2 = \left(1 + \frac{h}{R}\right)^2$$

$$4 = \left(1 + \frac{h}{R}\right)^2 \Rightarrow 2 = 1 + \frac{h}{R} \text{ or } h = R \Rightarrow R' = 2R$$

From the centre of the Earth, the object is placed at twice the radius of the Earth.

### VIII. Answer in detail.

#### Self-Evaluation (Textual Questions)

1. What are the types of inertia? Give an example for each type.

(i) **Inertia of rest:** The resistance of a body to change its state of rest is called inertia of rest.

**Example:** When we vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down.

(ii) **Inertia of motion:** The resistance of a body to change its state of motion is called inertia of motion.

**Example:** An athlete runs some distance before jumping.

(iii) **Inertia of direction:** The resistance of a body to change its direction of motion is called inertia of direction.

**Example:** When we make a sharp turn while driving a car, we tend to lean sideways. (Inertia of rest).

2. State Newton's laws of motion?

Newton's First Law of Motion states that "every body continues to be in its state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force".

Newton's Second Law of Motion states that "the force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force".

Newton's Third Law of Motion states that "for every action, there is an equal and opposite reaction. They always act on two different bodies".



### 3. Deduce the equation of a force using Newton's second law of motion.

Newton's Second Law of Motion states that "the force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force".

Let, ' $m$ ' be the mass of a moving body, moving along a straight line with an initial speed ' $u$ '. After a time interval of ' $t$ ', the velocity of the body changes to ' $v$ ' due to the impact of an unbalanced external force  $F$ .

Initial momentum of the body  $P_i = mu$

Final momentum of the body  $P_f = mv$

Change in momentum  $\Delta p = P_f - P_i = mv - mu$

By Newton's second law of motion,

Force,  $F \propto$  rate of change of momentum

$F \propto$  change in momentum / time

$$F \propto \frac{mv - mu}{t} \Rightarrow F = \frac{km(v - u)}{t}$$

Here,  $k$  is the proportionality constant.  $k = 1$  in all systems of units.

$$\text{Hence, } F = \frac{m(v - u)}{t}$$

Since, acceleration = change in velocity / time,  $a = (v - u)/t$ .

Hence, we have  $F = m \times a \Rightarrow$  Force = mass  $\times$  acceleration

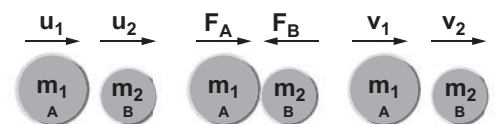
### 4. State and prove the law of conservation of linear momentum.

The law of conservation of linear momentum states that there is no change in the linear momentum of a system of bodies as long as no net external force acts on them.

Let us prove the law of conservation of linear momentum with the following illustration:

**Proof:** Let two bodies A and B having masses  $m_1$  and  $m_2$  move with initial velocity  $u_1$  and  $u_2$  in a straight line. Let the velocity of the first body be higher than that of the second body. *i.e.*,  $u_1 > u_2$ .

During an interval of time  $t$  second, they tend to have a collision. After the impact, both of them move along the same straight line with a velocity  $v_1$  and  $v_2$  respectively.



Conservation of linear momentum

Force on body B due to A,  $F_B = m_2 (v_2 - u_2)/t$

Force on body A due to B,  $F_A = m_1 (v_1 - u_1)/t$

By Newton's third law of motion,

Action force = Reaction force  $\Rightarrow F_A = -F_B$

$$m_1 (v_1 - u_1)/t = -m_2 (v_2 - u_2)/t$$

$$m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$$

The above equation confirms in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to the algebraic sum of the momentum before collision. Hence the law of conservation linear momentum is proved.

**5. Describe rocket propulsion.**

Propulsion of rockets is based on the law of conservation of linear momentum as well as Newton’s third law of motion. Rockets are filled with a fuel (either liquid or solid) in the propellant tank. When the rocket is fired, this fuel is burnt and a hot gas is ejected with a high speed from the nozzle of the rocket, producing a huge momentum. To balance this momentum, an equal and opposite reaction force is produced in the combustion chamber, which makes the rocket project forward.

While in motion, the mass of the rocket gradually decreases, until the fuel is completely burnt out. Since, there is no net external force acting on it, the linear momentum of the system is conserved. The mass of the rocket decreases with altitude, which results in the gradual increase in velocity of the rocket. At one stage, it reaches a velocity, which is sufficient to just escape from the gravitational pull of the Earth. This velocity is called escape velocity.

**6. State the universal law of gravitation and derive its mathematical expression**

Newton’s universal law of gravitation states that “every particle of matter in this universe attracts every other particle with a force. This force is directly proportional to the product of their masses and inversely proportional to the square of the distance between the centers of these masses. The direction of the force acts along the line joining the masses”.

Force between the masses is always attractive and it does not depend on the medium where they are placed.

Let,  $m_1$  and  $m_2$  be the masses of two bodies A and B placed  $r$  metre apart in space

Force  $F \propto m_1 \times m_2$

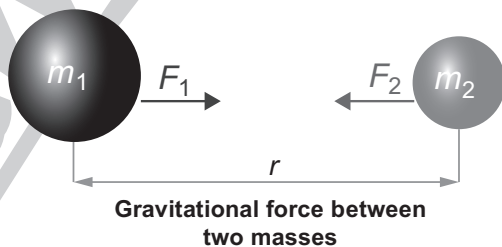
$F \propto 1/r^2$

On combining the above two expressions,

$$F \propto \frac{m_1 \times m_2}{r^2} \Rightarrow F = \frac{Gm_1m_2}{r^2} \dots$$

where  $G$  is the universal gravitational constant.

Its value in SI unit is  $6.674 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ .



**7. Give the applications of universal law gravitation.**

**Application of Newton’s law of gravitation:**

- (i) Dimensions of the heavenly bodies can be measured using the gravitation law. Mass of the Earth, radius of the Earth, acceleration due to gravity, *etc.* can be calculated with a higher accuracy.
- (ii) Helps in discovering new stars and planets.
- (iii) One of the irregularities in the motion of stars is called ‘Wobble’ lead to the disturbance in the motion of a planet nearby. In this condition the mass of the star can be calculated using the law of gravitation.
- (iv) Helps to explain that germination of roots is due to the property of geotropism which is the property of a root responding to the gravity.
- (v) Helps to predict the path of the astronomical bodies.

**Other Important Questions**

**8. List the concepts proposed by Galileo about force, motion and inertia of bodies.**

- (i) All earthly bodies is either in the state of rest or in the state of uniform motion.
- (ii) A body in motion will continue to be in the same state of motion as long as no external force is applied.

- (iii) The property of bodies to resist any change in their state when a force is applied is called 'inertia'.
- (iv) When dropped from a height in vacuum, bodies of different size, shape and mass fall at the same rate and reach the ground at the same time.

**9. Discuss the applications of torque.**

- (i) **Gears:** A gear is a circular wheel with teeth around its rim. It helps to change the speed of rotation of a wheel by changing the torque and helps to transmit power.
- (ii) **Seasaw:** While playing seasaw the heavier person lifts the lighter person. When the heavier person comes closer to the pivot point (fulcrum) the distance of the line of action of the force decreases. It causes less amount of torque to act on it. This enables the lighter person to lift the heavier person.
- (iii) **Steering Wheel:** A small steering wheel enables you to manoeuvre a car easily by transferring a torque to the wheels with less effort.

**10. Give examples for Newton's third law.**

Newton's third law states that "for every action, there is an equal and opposite reaction. They always act on two different bodies".

**Examples:** When birds fly they push the air downwards with their wings (Action) and the air pushes the bird upwards (Reaction).

When a person swims he pushes the water using the hands backwards (Action), and the water pushes the swimmer in the forward direction (Reaction).

When you fire a bullet, the gun recoils backward and the bullet is moving forward (Action) and the gun equalizes this forward action by moving backward (Reaction).

**11. Obtain the relation between g and G.**

Let,  $M$  be the mass of the Earth and  $m$  be the mass of the body. The entire mass of the Earth is assumed to be concentrated at its centre. The radius of the Earth is  $R = 6400$  km approximately. By Newton's law of gravitation, the force acting on the body is given by

$$F = \frac{GMm}{R^2} \dots (1)$$

Here, the radius of the body considered is negligible when compared with the Earth's radius. From Newton's second law of motion, the force acting on the body is given by the product of its mass and acceleration. Here, acceleration of the body is under the action of gravity. Hence  $a = g$ .

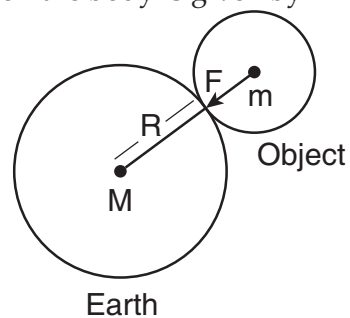
$$F = m a = mg$$

$$F = \text{weight} = mg \dots (2)$$

Comparing equations (1) and (2), we get

$$mg = \frac{GMm}{R^2} \dots (3)$$

$$\text{Acceleration due to gravity, } g = \frac{GM}{R^2} \dots (4)$$



**Relation between g and G**

**12. Illustrate the concept of apparent weight with an example.**

Apparent weight is the weight of the body acquired due to the action of gravity and other external forces acting on the body.

We can understand this from the following illustration:

Let us consider a person of mass  $m$ , who is travelling in lift. The actual weight of the person is  $W = mg$ , which is acting vertically downwards. The reaction force exerted by the lift's surface 'R', taken as apparent weight is acting vertically upwards.

Let us see different possibilities of the apparent weight 'R' of the person that arise, depending on the motion of the lift; upwards or downwards which are given in table.

Case 1: Lift is moving upward with an acceleration 'a'.	Case 2: Lift is moving downward with an acceleration 'a'.	Case 3: Lift is at rest.	Case 4: Lift is falling down freely.
$R - W = F_{\text{net}} = ma$ $R = W + ma$ $R = mg + ma$ $R = m(g + a)$	$W - R = F_{\text{net}} = ma$ $R = W - ma$ $R = mg - ma$ $R = m(g - a)$	Here, the acceleration is zero; $a = 0$ $R = W$ $R = mg$	Here, the acceleration is equal to $g$ $a = g$ $R = m(g - g)$
$R > W$	$R < W$	$R = W$	$R = 0$
Apparent weight is greater than the actual weight.	Apparent weight is lesser than the actual weight.	Apparent weight is equal to the actual weight.	Apparent weight is equal to zero.

**13. Explain the concept of weightlessness.**

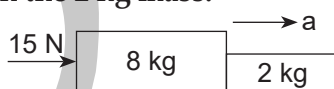
When a person in a lift moves down with an acceleration ( $a$ ) equal to the acceleration due to gravity ( $g$ ), this motion is called as 'free fall. Here, the apparent weight ( $R = m(g - g) = 0$ ) of the person is zero. This condition or state refers to the state of weightlessness.

The same effect takes place while falling freely in a roller coaster or on a swing or in a vertical giant wheel. We feel an apparent weight loss and weight gain when we are moving up and down in such rides.

**IX. HOT [Higher Order Thinking] questions.**

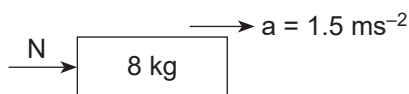
**Self-Evaluation (Textual Questions)**

- Two blocks of masses 8 kg and 2 kg respectively lie on a smooth horizontal surface in contact with one other. They are pushed by a horizontally applied force of 15 N. Calculate the force exerted on the 2 kg mass.



The above diagram pictures the question given. Since the two masses, a 8 kg block and 2 kg block are in contact they can be considered as a single system moving with the acceleration 'a'.

$$\begin{aligned} \vec{F}_{\text{ext}} &= m \vec{a} \\ \vec{F}_{\text{ext}} &= 15 \text{ N} \\ m &= 2 + 8 = 10 \text{ kg} \\ 15 &= 10a \\ \Rightarrow a &= \frac{15}{10} = 1.5 \text{ m s}^{-2} \end{aligned}$$



Consider the diagram for an 8 kg block.

Here the force, 'N' is applied by 8 kg block on 2 kg block. Applying Newton's second law on this block along the horizontal we get,  $N = 2 \times 1.5 = 3 \text{ N}$

Therefore the force between two block = 3 N

2. **A heavy truck and bike are moving with the same kinetic energy. If the mass of the truck is four times that of the bike, then calculate the ratio of their momenta. (Ratio of momenta = 1 : 2)**

Heavy truck and bike have same kinetic energy.

$$m_T = 4 m_B$$

$m_T \rightarrow$  mass of the truck

$m_B \rightarrow$  mass of the bike

The ratio of their momenta is ?

**Solution:**

$$\frac{1}{2} m_T v_T^2 = \frac{1}{2} m_B v_B^2 \Rightarrow m_T = 4m_B$$

$$\frac{1}{2} 4m_B v_T^2 = \frac{1}{2} m_B v_B^2$$

$$\frac{v_T^2}{v_B^2} = \frac{1}{4} \Rightarrow \frac{v_T}{v_B} = \frac{1}{2}$$

Ratio of their momenta,  $m_T v_T : m_B v_B$

$$4 m_B \frac{v_B}{2} : m_B v_B \Rightarrow 2 : 1$$

The ratio of their momenta = 2 : 1

3. **“Wearing helmet and fastening the seat belt is highly recommended for safe journey” Justify your answer using Newton’s laws of motion.**

“Wearing helmet and fastening the seat belt is highly recommended for safe journey”. Seat belts can help us understand the first law of motion because they show what happens to a body in motion once acted upon by an external force.

Imagine two people travelling in a car. When the car is in motion, people accelerate with the car and they move forward.

Now imagine that one person is wearing a seat belt and the other is not, when the car hits a wall. The car starts decelerating. The state of motion is changed. The person who is wearing a seat belt is physically strapped to the car. When the car accelerates, they accelerate. When it stops, they stop. But the person who is not wearing a seat belt, however, is not strapped to the car. So when the car stops, the person is not decelerated. They remain in motion until they go and hit the car windshield or the pavement. This is the physics behind many of the automobile accidents.

The same concept is applicable to wearing helmet also.

I. Choose the correct answer.

**Self-Evaluation (Textual Questions)**

- Which of the following has the smallest mass?  
 (a)  $6.023 \times 10^{23}$  atoms of He (b) 1 atom of He  
 (c) 2 g of He (d) 1 mole atoms of He
- Which of the following is a triatomic molecule?  
 (a) Glucose (b) Helium (c) Carbon dioxide (d) Hydrogen
- The volume occupied by 4.4 g of  $\text{CO}_2$  at S.T.P is .....  
 (a) 22.4 litre (b) 2.24 litre (c) 0.24 litre (d) 0.1 litre
- Mass of 1 mole of Nitrogen atom is .....  
 (a) 28 amu (b) 14 amu (c) 28 g (d) 14 g
- Which of the following represents 1 amu?  
 (a) Mass of a C – 12 atom (b) Mass of a hydrogen atom  
 (c)  $1/12^{\text{th}}$  of the mass of a C – 12 atom (d) Mass of O – 16 atom
- Which of the following statement is incorrect?  
 (a) One gram of C – 12 contains Avogadro's number of atoms.  
 (b) One mole of oxygen gas contains Avogadro's number of molecules.  
 (c) One mole of hydrogen gas contains Avogadro's number of atoms.  
 (d) One mole of electrons stands for  $6.023 \times 10^{23}$  electrons.
- The volume occupied by 1 mole of a diatomic gas at S.T.P is .....  
 (a) 11.2 litre (b) 5.6 litre (c) 22.4 litre (d) 44.8 litre
- In the nucleus of  ${}_{20}\text{Ca}^{40}$ , there are .....  
 (a) 20 protons and 40 neutrons (b) 20 protons and 20 neutrons  
 (c) 20 protons and 40 electrons (d) 40 protons and 20 electrons
- The gram molecular mass of oxygen molecule is .....  
 (a) 16 g (b) 18 g (c) 32 g (d) 17 g
- 1 mole of any substance contains ..... molecules.  
 (a)  $6.023 \times 10^{23}$  (b)  $6.023 \times 10^{-23}$  (c)  $3.0115 \times 10^{23}$  (d)  $12.046 \times 10^{23}$

**Other Important Questions**

- An example for Isotopes is .....  
 (a)  ${}_{17}\text{Cl}^{35}, {}_{17}\text{Cl}^{37}$  (b)  ${}_{17}\text{Cl}^{35}, {}_{17}\text{Cl}^{34}$  (c)  ${}_{17}\text{Cl}^{37}, {}_{17}\text{Cl}^{34}$  (d)  ${}_{17}\text{Cl}^{37}, {}_{17}\text{Cl}^{38}$
- The ratio of C,H,O in glucose is .....  
 (a) 6 : 12 : 6 (b) 6 : 6 : 12 (c) 12 : 6 : 6 (d) 6 : 6 : 6
- Pick out the incorrect statement .....  
 (a) Protons and electrons have considerable mass  
 (b) Mass of an atom is mainly contributed by its protons and neutrons  
 (c) Protons and neutrons are subatomic particles  
 (d) Sum of protons and neutrons is called Mass number

14. Assertion : The atomic mass of carbon is 12.01 amu and not 12.00 amu  
Reason : The natural abundance of C-12 and C-13 are 98.90% and 1.10%
- (a) A and R are correct, R explains the A  
(b) A is correct, R is wrong  
(c) A is wrong, R is correct  
(d) A and R are correct, R doesn't explain A.
15. The % of C in  $\text{CH}_4$  is .....  
(a) 75% (b) 25% (c) 70% (d) 30%
16. Which one of the following is the standard for atomic mass?  
(a)  ${}_1\text{H}^1$  (b)  ${}_6\text{C}^{12}$  (c)  ${}_6\text{C}^{14}$  (d)  ${}_8\text{O}^{16}$
17. One mole of  $\text{CO}_2$  contains .....  
(a)  $6.023 \times 10^{23}$  atoms of C (b)  $18.1 \times 10^{23}$  molecules of  $\text{CO}_2$   
(c)  $6.023 \times 10^{23}$  atoms of O (d) 3g atoms of  $\text{CO}_2$
18. The number of moles of  $\text{H}_2$  in 0.224 l of hydrogen gas at STP is .....  
(a) 1 (b) 0.1  
(c) 0.01 (d)  $0.001 \left( \frac{1}{22.4} \times 0.224 \right)$
19. The number of molecules in 16g of methane is .....  
(a)  $3.023 \times 10^{23}$  (b)  $6.023 \times 10^{23}$  (c)  $\frac{16}{6.023 \times 10^{23}}$  (d)  $\frac{6.023 \times 10^{23}}{3}$
20. The mass of one molecule of HI in grams is .....  
(a)  $2.125 \times 10^{-22}$  (b) 128 (c) 127 (d)  $6.02 \times 10^{-23}$
21. Molecular mass = .....  
(a) Vapour Density (b)  $2 \times$  Vapour Density  
(c)  $3 \times$  Vapour Density (d) Vapour Density/2
22. Match List I with List II using the correct code given below.
- | I                  | II                             |
|--------------------|--------------------------------|
| 1. Molar Volume    | (i) $6.023 \times 10^{23}$     |
| 2. Molecular mass  | (ii) Mass / atomic mass        |
| 3. Avogadro number | (iii) 22.4 l                   |
| 4. No. of Moles    | (iv) $2 \times$ Vapour Density |
- (a) 1. (i) 2. (iv) 3. (ii) 4. (iii) (b) 1. (ii) 2. (iii) 3. (iv) 4. (i)  
(c) 1. (iii) 2. (iv) 3. (i) 4. (ii) (d) 1. (iv) 2. (ii) 3. (iii) 4. (i)
23. Which of the following has highest mass?  
(a) 1 g atom of C (b) 1 mole atom of He  
(c) 2 g of He (d) 0.5 mole of  $\text{CH}_4$
24. Pick out the odd one out.  
(a)  $\text{CO}_2$  (b)  $\text{H}_2\text{SO}_4$  (c)  $\text{CH}_4$  (d)  $\text{C}_6\text{H}_{12}\text{O}_6$
25. One molecule of  $\text{H}_2\text{SO}_4$  is ..... times as heavy as  $\frac{1}{12^{\text{th}}}$  of the mass of Carbon-12.  
(a) 98 (b) 90 (c) 99 (d) 94

26. The values of standard temperature and pressure is .....  
 (a) 270.15 K, 1.00 atm (b) 273.15 K, 1.00 atm  
 (c) 270.15 K, 1.12 atm (d) 273.15 K, 1.89 atm
27. One mole of oxygen contains ..... atoms of oxygen and its gram atomic mass is .....  
 (a)  $6.023 \times 10^{23}$ , 16 g (b) 8, 16 g  
 (c)  $6.023 \times 10^{23}$ , 32 g (d) 16, 32 g
28. Mathematical expression of Avogadro law is .....  
 (a)  $V \propto n$  (b)  $V \propto \frac{1}{n}$  (c)  $V \propto n^2$  (d)  $V \propto \frac{1}{n^2}$
29. The Molar mass of  $\text{Ca}_3(\text{PO}_4)_2$  is .....  
 (a) 308 g (b) 306 g (c) 305 g (d) 310 g
30. The number of moles in 14 g of nitrogen gas is .....  
 (a) 0.1 mole (b) 0.8 mole (c) 0.5 mole (d) 0.6 mole

## ANSWERS

1. (b) 2. (c) 3. (b) 4. (d) 5. (c) 6. (a) 7. (c) 8. (b) 9. (c) 10. (a)  
 11. (a) 12. (a) 13. (a) 14. (a) 15. (a) 16. (b) 17. (a) 18. (c) 19. (b) 20. (b)  
 21. (b) 22. (c) 23. (a) 24. (a) 25. (a) 26. (b) 27. (a) 28. (a) 29. (a) 30. (c)

## II. Fill in the blanks.

**Self-Evaluation (Textual Questions)**

- Atoms of different elements having ..... mass number, but ..... atomic numbers are called isobars.
- Atoms of different elements having same number of ..... are called isotones.
- Atoms of one element can be transmuted into atoms of other element by .....
- The sum of the numbers of protons and neutrons of an atom is called its .....
- Relative atomic mass is otherwise known as .....
- The average atomic mass of hydrogen is ..... amu.
- If a molecule is made of similar kind of atoms, then it is called ..... atomic molecule.
- The number of atoms present in a molecule is called its .....
- One mole of any gas occupies ..... ml at S.T.P.
- Atomicity of phosphorus is .....

**Other Important Questions**

- The mass of the molecule of an element or compound is measured in ..... scale.
- The value of Avogadro's number is .....
- ..... is the smallest indivisible entity of matter.
- ${}_{17}\text{Cl}^{35}$  and  ${}_{17}\text{Cl}^{37}$  are .....
- Isotopes have same ..... but different .....
- The allotrope of oxygen is .....
- Relative molecular mass of sulphuric acid is .....
- One mole any gas at S.T.P occupies .....



19. Atoms of the same element may have different .....
20. The atomic mass of an element is expressed in grams is known as .....
21. Number of protons and number of electrons are always equal in .....
22. Atoms of same element has same number of .....
23. The molecule is made of similar kind of atoms is called .....
24. The molecule that consist of atoms of different elements are called ..... molecule.
25. The molecules contains more than two atoms are called ..... molecule.
26. The gram atomic mass of an element is expressed in .....
27. A compound is a ..... molecule.
28. STP means .....
29. One mole of oxygen contains ..... atoms of oxygen

**ANSWERS**

- |                                       |                            |                             |
|---------------------------------------|----------------------------|-----------------------------|
| 1. same, different                    | 2. neutrons                | 3. artificial transmutation |
| 4. mass number                        | 5. Standard atomic weight  | 6. 1.008                    |
| 7. homo                               | 8. atomicity               | 9. 22400                    |
| 11. C-12                              | 12. $6.023 \times 10^{23}$ | 13. Atom                    |
| 15. atomic number, mass number        | 16. ozone                  | 14. isotopes                |
| 18. 22.4 litres                       | 19. mass numbers           | 17. 98                      |
| 21. an atom                           | 22. protons                | 20. Gram Atomic Mass        |
| 24. heteroatomic                      | 25. polyatomic             | 23. homoatomic molecule     |
| 28. Standard Temperature and Pressure | 26. grams                  | 27. heteroatomic            |
|                                       | 29. $6.023 \times 10^{23}$ |                             |

**III. Match the following.****Self-Evaluation (Textual Questions)**

1. 8 g of  $O_2$  (i) 4 moles
2. 4 g of  $H_2$  (ii) 0.25 moles
3. 52 g of He (iii) 2 moles
4. 112 g of  $N_2$  (iv) 0.5 moles
5. 35.5 g of  $Cl_2$  (v) 13 moles

**ANSWERS**

1. (ii)    2. (iii)    3. (v)    4. (i)    5. (iv)

**IV. True or False: (If false give the correct statement)****Self-Evaluation (Textual Questions)**

1. Two elements sometimes can form more than one compound.
2. Noble gases are Diatomic.
3. The gram atomic mass of an element has no unit.
4. 1 mole of Gold and Silver contain same number of atoms.
5. Molar mass of  $CO_2$  is 42g.

**ANSWERS**

1. True    2. False    3. False    4. True    5. False

**Correct statements for the false statements:**

- Noble gases are Monoatomic.
- The gram atomic mass of an element has unit g.
- Molar mass of CO<sub>2</sub> is 44g.

**V. Assertion & Reason type questions.**

**Self-Evaluation (Textual Questions)**

Answer the following questions using the data given below:

- A and R are correct, R explains the A.
- A is correct, R is wrong.
- A is wrong, R is correct.
- A and R are correct, R doesn't explain A.

1. **Assertion:** Atomic mass of aluminium is 27.

**Reason:** An atom of aluminium is 27 times heavier than 1/12th of the mass of the C-12 atom.

2. **Assertion:** The Relative Molecular Mass of Chlorine is 35.5 a.m.u.

**Reason:** The natural abundance of Chlorine isotopes are not equal.

**ANSWERS**

1. (b)    2. (c)

**VI. Answer the following.**

**Self-Evaluation (Textual Questions)**

1. **Define: Relative atomic mass.**

Relative atomic mass of an element is the ratio between the average mass of its isotopes to  $\frac{1}{12}$ th part of the mass of a carbon-12 atom. It is denoted as  $A_r$ . It is otherwise called "Standard Atomic Weight".

$$(A_r) = \frac{\text{Average mass of the isotopes of the element}}{\frac{1}{12} \text{th of the mass of one Carbon - 12 atom}}$$

2. Write the different types of isotopes of oxygen and its percentage abundance.

Isotope	Mass (amu)	% abundance
${}_8\text{O}^{16}$	15.9949	99.757
${}_8\text{O}^{17}$	16.9991	0.038
${}_8\text{O}^{18}$	17.9992	0.205

3. **Define: Atomicity.**

The number of atoms present in the molecule is called its 'atomicity'.

4. Give any two examples for hetrodiatomic molecules.

The two examples for hetrodiatomic molecules are HCl, HI

### 5. What is Molar volume of a gas?

One mole of any gas occupies 22.4 litre or 22400 ml at S.T.P. This volume is called as molar volume.

### 6. Find the percentage of nitrogen in ammonia.

Calculating the mass of 1 molecule of ammonia

$$\text{Mass} = (\text{Number of hydrogen atoms} \times \text{Mass of hydrogen atom}) + (\text{Number of nitrogen atoms} \times \text{Mass of nitrogen atoms})$$

$$\text{Mass} = (3 \times 1) + (1 \times 14) = 17$$

Calculating percentage by mass

$$\begin{aligned} \text{Percentage of mass of nitrogen} &= \frac{\text{Mass of nitrogen atom}}{\text{Mass of ammonia molecule}} \times 100 \\ &= \frac{14}{17} \times 100 = 82.3\%. \end{aligned}$$

### Other Important Questions

#### 7. Define Mass Number.

The sum of the number of protons and neutrons of an atom is called its Mass Number.

#### 8. Define amu.

Atomic mass unit is one-twelfth of the mass of a carbon-12 atom; an isotope of carbon, which contains 6 protons and 6 neutrons.

#### 9. Define Gram Atomic Mass.

If the atomic mass of an element is expressed in grams, it is called as Gram Atomic Mass.

#### 10. Define Average Atomic Mass.

The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.

#### 11. An element which exists as a mixture of 50% of an isotope having a mass of 9 amu, and 50% of another isotope having a mass of 10 amu. Calculate its average atomic mass.

$$\text{Average atomic mass} = (\text{Mass of 1st isotope} \times \% \text{ abundance of 1st isotope}) + (\text{Mass of 2nd isotope} \times \% \text{ abundance of 2nd isotope})$$

$$\begin{aligned} \text{Thus, for the given element the average atomic mass} &= \left(9 \times \frac{50}{100}\right) + \left(10 \times \frac{50}{100}\right) \\ &= 4.5 + 5 = 9.5 \text{ amu} \end{aligned}$$

#### 12. The natural abundance of C-12 and C-13 are 98.90% and 1.10% respectively. Calculate average of the atomic mass of carbon.

$$\begin{aligned} \text{Average atomic mass of carbon} &= \left(12 \times \frac{98.9}{100}\right) + \left(13 \times \frac{1.1}{100}\right) \\ &= (12 \times 0.989) + (13 \times 0.011) \\ &= 11.868 + 0.143 = 12.011 \text{ amu} \end{aligned}$$

**13. Define Molecule.**

A molecule is a combination of two or more atoms held together by strong chemical forces of attraction, *i.e.* chemical bonds.

**14. Explain the types of molecules.**

The molecules are of two types. They are homoatomic molecules and heteroatomic molecules. If the molecule is made of similar kind of atoms, then it is called homoatomic molecule. The molecule that consist of atoms of different elements is called heteroatomic molecule.

**15. Give two examples for homo and hetero diatomic molecules.**

The two examples for homo and hetero diatomic molecules are:

(i) Homo diatomic molecules *e.g.*  $F_2$ ,  $H_2$

(ii) Hetero diatomic molecules *e.g.* HI, CO

**16. Define atomicity.**

The number of atoms present in the molecule is called its 'atomicity'.

**17. Water is a heterotriatomic molecule. Justify.**

The water molecule ( $H_2O$ ) contains two hydrogen atoms and one oxygen atom. So its atomicity is three. It is a heterotriatomic molecule.

**18. Define RMM.**

The Relative Molecular Mass of a molecule is the ratio between the mass of one molecule of the substance to  $\frac{1}{12}^{\text{th}}$  mass of an atom of Carbon - 12.

**19. Define Gram Molecular Mass.**

If the molecular mass of a compound is expressed in grams, it is called Gram Molecular Mass.

**20. Give differences between Atom and Molecules.**

Atom	Molecule
An atom is the smallest particle of an element.	A molecule is the smallest particle of an element or compound.
Atom does not exist in free state except in a noble gas.	Molecule exists in free state.
Except some of noble gas, other atoms are highly reactive.	Molecules are less reactive.
Atom does not have a chemical bond.	Atoms in a molecule are held by chemical bonds.

**21. Define Mole.**

Mole (mole) is the amount of a substance that contains as many elementary entities (atoms, molecules, or other particles) as there are atoms in exactly 12 g (or 0.012 kg) of the carbon - 12 isotope.

**22. Write the four different modes of calculating the number of moles.**

Calculation of number of moles by different modes.

$$\begin{aligned} \text{Number of moles} &= \text{Mass} / \text{Atomic Mass} \\ &= \text{Mass} / \text{Molecular mass} \end{aligned}$$

$$= \text{Number of Atoms} / 6.023 \times 10^{23}$$

$$= \text{Number of Molecules} / 6.023 \times 10^{23}$$

**23. Calculate the Mass % of hydrogen in water.**

$$\text{Molar mass of H}_2\text{O} = 2(1) + 16 = 18 \text{ g}$$

$$\text{Mass \% of hydrogen} = \frac{2}{18} \times 100 = 11.11 \%$$

**24. Calculate the Mass % of oxygen in water.**

$$\text{Molar mass of H}_2\text{O} = 2(1) + 16 = 18 \text{ g}$$

$$\text{Mass \% of oxygen} = \frac{16}{18} \times 100 = 88.89 \%$$

**25. State Avogadro's law.**

The Avogadro's law states that "equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules".

**26. Give any two applications of Avogadro's law.**

**Applications of Avogadro's law:**

(i) It explains Gay-Lussac's law.

(ii) It helps in the determination of atomicity of gases.

**27. Define Isotopes.**

Two or more forms of an element having the same atomic number, but different mass number are called Isotopes ( $_{17}\text{Cl}^{35}$ ,  $_{17}\text{Cl}^{37}$ ).

**28. Define Isobars.**

Atoms of different elements having the same mass number, but different atomic number are called Isobars ( $_{18}\text{Ar}^{40}$ ,  $_{20}\text{Ca}^{40}$ ).

**29. Define Isotones.**

Atoms of different elements having the same number of neutrons, but different atomic number and different mass number are called Isotones. ( $_{6}\text{C}^{13}$ ,  $_{7}\text{N}^{14}$ ).

**30. Calculate the gram molar mass for glucose.**

The Gram molar mass for Glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) is

Atomic Mass of C = 12, O = 16, H = 1.

$$\text{C}_6\text{H}_{12}\text{O}_6 = 12 \times 6 + 1 \times 12 + 16 \times 6 = 72 + 12 + 96 = 180 \text{ g.}$$

**31. Calculate the number of moles in (i) 112 g of  $\text{N}_2$  (ii) 35.5 g of  $\text{Cl}_2$**

$$\text{No. of moles} = \frac{\text{Mass of the element}}{\text{Atomic Mass}}$$

$$(i) \quad \text{No. of moles} = \frac{112}{28} = 4 \text{ moles.}$$

$$(ii) \quad \text{No. of moles} = \frac{35.5}{70} = 0.5 \text{ moles.}$$

**VII. Answer in detail.**

**Self-Evaluation (Textual Questions)**

**1. Calculate the number of water molecule present in one drop of water which weighs 0.18 g.**

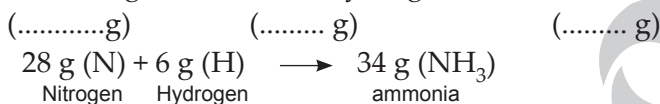
$$\text{Weight of water drop} = 0.18 \text{ g}$$

$$\begin{aligned} \text{No. of moles of water in the drop} &= \frac{\text{Mass of water}}{\text{Molar mass}} \\ &= \frac{0.18}{18} = 10^{-2} \text{ mole} \\ \text{No. of water molecules present} \\ \text{in 1 mole of water} &= 6.023 \times 10^{23} \\ \text{No. of water molecules present} \\ \text{in one drop of water} &= 6.023 \times 10^{23} \times 10^{-2} \\ &= 6.023 \times 10^{21} \end{aligned}$$



(The atomic mass of nitrogen is 14, and that of hydrogen is 1)

1 mole of nitrogen + 3 mole of hydrogen  $\rightarrow$  2 mole of ammonia



3. Calculate the number of moles in

(i) 27g of Al

Mass of Al = 27 g

Molar mass of Al = 26.982 g mol<sup>-1</sup>

$$\text{No. of moles} = \frac{\text{Mass}}{\text{Atomic Mass}} = \frac{27}{26.982} = 1.0006 \text{ mol} = 1 \text{ mole}$$

(ii)  $1.51 \times 10^{23}$  molecules of  $\text{NH}_4\text{Cl}$

$$\text{No. of moles} = \frac{\text{No. of Molecules of NH}_4\text{Cl}}{\text{Avogadro's number}} = \frac{1.51 \times 10^{23}}{6.023 \times 10^{23}} = \frac{1}{4} = 0.25 \text{ mole}$$

4. Give the salient features of "Modern atomic theory".

The salient features of "Modern atomic theory" are:

- (i) An atom is no longer indivisible (after the discovery of the electron, proton, and neutron).
- (ii) Atoms of the same element may have different atomic mass. (discovery of isotopes  $^{35}_{17}\text{Cl}$ ,  $^{37}_{17}\text{Cl}$ ).
- (iii) Atoms of different elements may have same atomic masses (discovery of Isobars  $^{40}_{18}\text{Ar}$ ,  $^{40}_{20}\text{Ca}$ ).
- (iv) Atoms of one element can be transmuted into atoms of other elements. In other words, atom is no longer indestructible (discovery of artificial transmutation).
- (v) Atoms may not always combine in a simple whole number ratio (E.g. Glucose  $\text{C}_6\text{H}_{12}\text{O}_6$  C:H:O = 6:12:6 or 1:2:1 and Sucrose  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  C:H:O = 12:22:11)
- (vi) Atoms is the smallest particle that takes part in a chemical reaction.
- (vii) The mass of an atom can be converted into energy ( $E = mc^2$ ).

5. Derive the relationship between Relative molecular mass and Vapour density.

The Relative Molecular Mass of a gas or vapour is the ratio between the mass of one molecule of the gas or vapour to mass of one atom of Hydrogen.

- (i) Vapour density is the ratio of the mass of a certain volume of a gas or vapour, to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure.

$$\text{Vapour Density (V.D.)} = \frac{\text{Mass of given volume of gas or vapour at S.T.P.}}{\text{Mass of the same volume of hydrogen}}$$

According to Avogadro's law, equal volumes of all gases contain equal number of molecules. Thus, let the number of molecules in one volume = n, then

$$\text{V.D. at S.T.P.} = \frac{\text{Mass of 'n' molecules of a gas or vapour at S.T.P.}}{\text{Mass of 'n' molecules of hydrogen}}$$

Cancelling 'n' which is common, you get

$$\text{V.D.} = \frac{\text{Mass of 1 molecules of a gas or vapour at S.T.P.}}{\text{Mass of 1 molecules of hydrogen}}$$

However, since hydrogen is diatomic

$$\text{V.D.} = \frac{\text{Mass of 1 molecules of a gas or vapour at S.T.P.}}{\text{Mass of 2 atoms of hydrogen}}$$

When you compare the formula of vapour density with relative molecular mass, they can be represented as

$$\text{V.D.} = \frac{\text{Mass of 1 molecules of a gas or vapour at S.T.P.}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

(Eqn 1)

$$\text{Relative molecular mass (hydrogen scale)} = \frac{\text{Mass of 1 molecule of a gas or vapour at S.T.P.}}{\text{Mass of 1 atom of hydrogen}}$$

(Eqn 2)

You can therefore substitute the above equation to an Eqn 1 and arrive at the following formula

$$\text{V.D.} = \frac{\text{Relative molecular mass}}{2}$$

Now on cross multiplication, you have  $2 \times \text{vapour density} = \text{Relative molecular mass of a gas}$ . (or)  $\text{Relative molecular mass} = 2 \times \text{Vapour density}$

#### Other Important Questions

#### 6. Differentiate Atom and Molecule.

Refer to VI-Q.No. 20.

#### 7. Explain Avogadro's law for the following reaction. $\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightarrow 2\text{HCl}_{(g)}$

In 1811 Avogadro framed a hypothesis based on the relationship between the number of molecules present in equal volumes of gases in different conditions.

The Avogadro's law states that "equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules" It follows that the volume of any given gas must be proportional to the number of molecules in it. If 'V' is the volume and 'n' is the number of molecules of a gas, then Avogadro law is represented, mathematically, as follows:

$$V \propto n$$

$$V = \text{constant} \times n$$

Thus, one litre (1 dm<sup>3</sup>) of hydrogen contains the same number of molecules as in one litre of oxygen, *i.e.* the volume of the gas is directly proportional to the number of molecules of the gas.

**Explanation:** Let us consider the reaction between hydrogen and chlorine to form hydrogen chloride gas



According to Avogadro's law 1 volume of any gas is occupied by "n" number of molecules. n molecules + n molecules  $\longrightarrow$  2n molecules

if n = 1 then



1 molecule of hydrogen chloride gas is made up of  $\frac{1}{2}$  molecule of hydrogen and  $\frac{1}{2}$  molecule of chlorine. Hence, the molecules can be subdivided. This law is in agreement with Dalton's atomic theory.

#### 8. Give the Applications of Avogadro's Law.

**Applications of Avogadro's law:**

- It explains Gay-Lussac's law.
- It helps in the determination of atomicity of gases.
- Molecular formula of gases can be derived using Avogadro's law.
- It determines the relation between molecular mass and vapour density.
- It helps to determine gram molar volume of all gases (*i.e.*, 22.4 litre at S.T.P)

#### VIII. Hot (Higher Order Thinking) Questions.

**Self-Evaluation (Textual Questions)**

1. Calcium carbonate is decomposed on heating in the following reaction.



(i) How many moles of Calcium carbonate are involved in this reaction?

Ans. One

(ii) Calculate the gram molecular mass of calcium carbonate involved in this reaction.



(iii) How many moles of CO<sub>2</sub> are there in this equation?

Ans. One

#### IX. Solve the following problems.

**Self-Evaluation (Textual Questions)**

1. How many grams are there in the following?

(i) 2 moles of hydrogen molecule, H<sub>2</sub>

$$2 \times 2 = 4 \text{ g}$$

(ii) 3 moles of chlorine molecule, Cl<sub>2</sub>

$$3 \times 70 = 210 \text{ g}$$



(iii) 5 moles of sulphur molecule,  $S_8$

$$5 \times 256 = 1280 \text{ g}$$

(iv) 4 moles of phosphorous molecule,  $P_4$

$$4 \times 124 = 496 \text{ g}$$

2. Calculate the % of each element in calcium carbonate. (Atomic mass: C-12, O-16, Ca-40)

Given:

$$\text{Atomic mass of C} = 12$$

$$\text{Atomic mass of O} = 16$$

$$\text{Atomic mass of Ca} = 40$$



$$\text{Molar Mass CaCO}_3 = 40 + 12 + 3 \times 16 = 100 \text{ kg}$$

$$\% \text{ of Ca in CaCO}_3 = \frac{\text{Mass of Ca}}{\text{Molar Mass of CaCO}_3} = \frac{40}{100} \times 100 = 40 \%$$

$$\% \text{ of C in CaCO}_3 = \frac{\text{Mass of C}}{\text{Molar Mass of CaCO}_3} = \frac{12}{100} \times 100 = 12 \%$$

$$\% \text{ of O in CaCO}_3 = \frac{\text{Mass of O}}{\text{Molar Mass of CaCO}_3} = \frac{48}{100} \times 100 = 48 \%$$

3. Calculate the % of oxygen in  $Al_2(SO_4)_3$ . (Atomic mass: Al-27, O-16, S-32)

Given:

$$\text{Atomic mass of Al} = 27$$

$$\text{Atomic mass of O} = 16$$

$$\text{Atomic mass of S} = 32$$

$$\text{Molar Mass of Al}_2(\text{SO}_4)_3 = 2 \times 27 + 3 \times 32 + 12 \times 16$$

$$\text{Al} \rightarrow 2, \text{ S} \rightarrow 3, \text{ O} \rightarrow 12$$

$$= 54 + 96 + 192 = 342$$

$$\% \text{ of O} = \frac{192}{342} \times 100 = 56.14\%$$

4. Calculate the % relative abundance of B - 10 and B - 11, if its average atomic mass is 10.804 amu.

Given:

$$\text{Average Atomic mass of B-10 and B-11} = 10.804 \text{ amu}$$

$$\text{Average atomic mass} = (\text{Mass of 1st isotope} \times \% \text{ abundance of 1st isotope}) + \text{Mass of 2nd isotope} \times \% \text{ abundance of 2nd isotope}$$

$$10.804 = 10 \times x + 11 \times (1 - x)$$

$$10.804 = 10x + 11 - 11x$$

$$10.804 = -x + 11$$

$$\begin{aligned} -x &= 10.804 - 11 \\ -x &= -0.196 \\ x &= 0.20 \\ \therefore \text{B-11} \rightarrow 1 - x &= 1 - 0.20 \\ \text{B-11} &= 0.80 \end{aligned}$$

% of Relative abundance in B-10 = 20%

% of Relative abundance in B-11 = 80%

**Other Important Questions**

5. Under same conditions of temperature and pressure if you collect 3 litre of  $\text{O}_2$ , 5 litre of  $\text{Cl}_2$  and 6 litre of  $\text{H}_2$ ,

(i) Which has the highest number of molecules?

(ii) Which has the lowest number of molecules?

(i) 3 litre of  $\text{O}_2$

$$\begin{aligned} \text{Number of moles of } \text{O}_2 &= \frac{\text{Volume at STP}}{\text{Molar Volume}} \\ &= \frac{3}{22.4} = 0.1339 \text{ mole.} \end{aligned}$$

$$\begin{aligned} \text{No. of molecules of } \text{O}_2 &= \text{No. of moles of } \text{O}_2 \times \text{Avogadro number} \\ &= 0.1339 \times 6.023 \times 10^{23} \\ &= 0.8064 \times 10^{23} \text{ molecules of } \text{O}_2 \end{aligned}$$

(ii) 5 litre of  $\text{Cl}_2$

$$\text{No. of moles of } \text{Cl}_2 = \frac{5}{22.4} = 0.2232 \text{ moles.}$$

$$\begin{aligned} \text{No. of molecules of } \text{Cl}_2 &= 0.2232 \times 6.023 \times 10^{23} \\ &= 1.344 \times 10^{23} \text{ molecules of } \text{Cl}_2 \end{aligned}$$

(iii) 6 litre of  $\text{H}_2$

$$\text{No. of moles of } \text{H}_2 = \frac{6}{22.4} = 0.2678 \text{ mole.}$$

$$\begin{aligned} \text{No. of molecules of } \text{H}_2 &= 0.2678 \times 6.023 \times 10^{23} \\ &= 1.612 \times 10^{23} \text{ molecules of } \text{H}_2 \end{aligned}$$

(i) highest  $\rightarrow$  6 liters of  $\text{H}_2$

(ii) lowest  $\rightarrow$  3 liters of  $\text{O}_2$

**Solved Textbook Examples**

6. Boron naturally occurs as a mixture of boron-10 (5 protons + 5 neutrons) and boron-11 (5 protons + 6 neutrons) isotopes. The percentage abundance of B-10 is 20 and that of B-11 is 80. Then, the atomic mass of boron is calculated as follows:

$$\text{Atomic mass of boron} = \left(10 \times \frac{20}{100}\right) + \left(11 \times \frac{80}{100}\right)$$

$$\begin{aligned}
 &= (10 \times 0.20) + (11 \times 0.80) \\
 &= 2 + 8.8 \\
 &= 10.8 \text{ amu}
 \end{aligned}$$

7. **Relative molecular mass of sulphuric acid ( $\text{H}_2\text{SO}_4$ ) is calculated as follows: Sulphuric acid contains 2 atoms of hydrogen, 1 atom of sulphur and 4 atoms of oxygen.**

Therefore, Relative molecular mass of sulphuric acid

$$= (2 \times \text{mass of hydrogen}) + (1 \times \text{mass of sulphur}) + (4 \times \text{mass of oxygen})$$

$$= (2 \times 1) + (1 \times 32) + (4 \times 16) = 98$$

*i.e.*, one molecule of  $\text{H}_2\text{SO}_4$  is 98 times as heavy as  $\frac{1}{12^{\text{th}}}$  of the mass of a carbon - 12.

8. **Relative molecular mass of water ( $\text{H}_2\text{O}$ ) is calculated as follows: A water molecule is made of 2 atoms of hydrogen and one atom of oxygen.**

So, the relative molecular mass of water =  $(2 \times \text{mass of hydrogen}) + (1 \times \text{mass of oxygen})$

$$= (2 \times \text{mass of hydrogen}) + (1 \times \text{mass of oxygen})$$

$$= (2 \times 1) + (1 \times 16)$$

$$= 18$$

*i.e.*, one molecule of  $\text{H}_2\text{O}$  is 18 times as heavy as  $\frac{1}{12^{\text{th}}}$  of the mass of a carbon - 12.

9. **Find the mass percentage composition of methane ( $\text{CH}_4$ ).**

$$\text{Molar mass of } \text{CH}_4 = 12 + 4$$

$$= 16 \text{ g}$$

$$\text{Mass \% of carbon} = \frac{12}{16} \times 100 = 75 \%$$

$$\text{Mass \% of hydrogen} = \frac{4}{16} \times 100 = 25 \%$$

10. **Calculate the gram molar mass of the following. 1)  $\text{H}_2\text{O}$  2)  $\text{CO}_2$  3)  $\text{Ca}_3(\text{PO}_4)_2$**

**Solution:**

**1)  $\text{H}_2\text{O}$**

Atomic masses of H = 1, O = 16

$$\text{Gram molar mass of } \text{H}_2\text{O} = (1 \times 2) + (16 \times 1)$$

$$= 2 + 16$$

$$\text{Gram molar mass of } \text{H}_2\text{O} = 18 \text{ g}$$

**2)  $\text{CO}_2$**

Atomic masses of C = 12, O = 16

$$\text{Gram molar mass of } \text{CO}_2 = (12 \times 1) + (16 \times 2)$$

$$= 12 + 32$$

$$\text{Gram molar mass of } \text{CO}_2 = 44 \text{ g}$$

### 3) $\text{Ca}_3(\text{PO}_4)_2$

Atomic masses of Ca = 40, P = 30, O = 16.

$$\begin{aligned}\text{Gram molar mass of } \text{Ca}_3(\text{PO}_4)_2 &= (40 \times 3) + [30 + (16 \times 4)] \times 2 \\ &= 120 + (94 \times 2) \\ &= 120 + 188\end{aligned}$$

Gram molar mass of  $\text{Ca}_3(\text{PO}_4)_2 = 308 \text{ g}$

11. Calculate the number of moles in 46 g of sodium.

$$\begin{aligned}\text{Number of moles} &= \frac{\text{Mass of the element}}{\text{Atomic mass of the element}} \\ &= 46 / 23 \\ &= 2 \text{ moles of sodium}\end{aligned}$$

12. Calculate the number of moles in 5.6 litre of oxygen at S.T.P.

$$\begin{aligned}\text{Number moles} &= \frac{\text{Given volume of } \text{O}_2 \text{ at S.T.P}}{\text{Molar volume at S.T.P}} \\ \text{Number of moles of oxygen} &= \frac{5.6}{22.4} = 0.25 \text{ mole of oxygen}\end{aligned}$$

13. Calculate the number of moles of a sample that contains  $12.046 \times 10^{23}$  atoms of iron.

$$\begin{aligned}\text{Number of moles} &= \frac{\text{Number of atoms of iron}}{\text{Avogadro's number}} \\ &= 12.046 \times 10^{23} / 6.023 \times 10^{23} \\ &= 2 \text{ moles of iron}\end{aligned}$$

14. Calculate the mass of 0.3 mole of aluminium (Atomic mass of Al = 27).

$$\begin{aligned}\text{Number of moles} &= \frac{\text{Mass of Al}}{\text{Atomic mass of Al}} \\ \text{Mass} &= \text{No. of moles} \times \text{atomic mass} \\ \text{So, mass of Al} &= 0.3 \times 27 = 8.1 \text{ g}\end{aligned}$$

15. Calculate the mass of 2.24 litre of  $\text{SO}_2$  gas at S.T.P.

$$\text{Molecular mass of } \text{SO}_2 = 32 + (16 \times 2) = 32 + 32 = 64$$

$$\text{Number of moles of } \text{SO}_2 = \frac{\text{Given volume of } \text{SO}_2 \text{ at S.T.P}}{\text{Molar volume } \text{SO}_2 \text{ at S.T.P}}$$

$$\text{Number of moles of } \text{SO}_2 = \frac{2.24}{22.4} = 0.1 \text{ mole}$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molecular mass}}$$

Mass = No. of moles  $\times$  molecular mass

$$\text{Mass} = 0.1 \times 64$$

$$\text{Mass of } \text{SO}_2 = 6.4 \text{ g}$$

16. Calculate the mass of  $1.51 \times 10^{23}$  molecules of water.

$$\begin{aligned} \text{Molecular mass of H}_2\text{O} &= 18 \\ \text{Number of moles} &= \frac{\text{Number of molecules of water}}{\text{Avogadro's number}} \\ &= \frac{1.51 \times 10^{23}}{6.023 \times 10^{23}} \\ &= 1/4 \\ &= 0.25 \text{ mole} \\ \text{Number of moles} &= \frac{\text{Mass}}{\text{Molecular mass}} \\ 0.25 &= \text{mass} / 18 \\ \text{Mass} &= 0.25 \times 18 = 4.5 \text{ g} \end{aligned}$$

17. Calculate the mass of  $5 \times 10^{23}$  molecules of glucose.

$$\begin{aligned} \text{Molecular mass of glucose} &= 180 \\ \text{Mass of glucose} &= \frac{\text{Molecular mass} \times \text{number of particles}}{\text{Avogadro's number}} \\ &= \frac{(180 \times 5 \times 10^{23})}{6.023 \times 10^{23}} = 149.43 \text{ g} \end{aligned}$$

18. Calculate the number of molecules in 11.2 litre of  $\text{CO}_2$  at S.T.P.

$$\begin{aligned} \text{Number of moles of CO}_2 &= \frac{\text{Volume at S.T.P}}{\text{Molar volume}} \\ &= \frac{11.2}{22.4} = 0.5 \text{ mole} \\ \text{Number of molecules of CO}_2 &= \text{number of moles of CO}_2 \times \text{Avogadro's number} \\ &= 0.5 \times 6.023 \times 10^{23} \\ &= 3.011 \times 10^{23} \text{ molecules of CO}_2 \end{aligned}$$

19. Calculate the number of atoms present in 1 gram of gold (Atomic mass of Au = 198).

$$\begin{aligned} \text{Number of atoms of Au} &= \frac{\text{Mass of Au} \times \text{Avogadro's number}}{\text{Atomic mass of Au}} \\ \text{Number of atoms of Au} &= \frac{1}{198} \times 6.023 \times 10^{23} \\ \text{Number of atoms of Au} &= 3.042 \times 10^{21} \text{ g} \end{aligned}$$

20. Calculate the number of molecules in 54 gm of  $\text{H}_2\text{O}$ .

$$\text{Number of molecules} = \frac{(\text{Avogadro number} \times \text{Given mass})}{\text{Gram molecular mass}}$$

$$\begin{aligned} \text{Number of molecules of water} &= \frac{6.023 \times 10^{23} \times 54}{18} \\ &= 18.069 \times 10^{23} \text{ molecules} \end{aligned}$$

21. Calculate the number of atoms of oxygen and carbon in 5 moles of  $\text{CO}_2$ .

- 1 mole of  $\text{CO}_2$  contains 2 moles of oxygen
- 5 moles of  $\text{CO}_2$  contain 10 moles of oxygen

$$\begin{aligned} \text{Number of atoms of oxygen} &= \text{Number of moles of oxygen} \times \text{Avogadro's number} \\ &= 10 \times 6.023 \times 10^{23} \\ &= 6.023 \times 10^{24} \text{ atoms of Oxygen} \end{aligned}$$

- 1 mole of  $\text{CO}_2$  contains 1 mole of carbon
- 5 moles of  $\text{CO}_2$  contains 5 moles of carbon

$$\begin{aligned} \text{No. of atoms of carbon} &= \text{No. of moles of carbon} \times \text{Avogadro's number} \\ &= 5 \times 6.023 \times 10^{23} \\ &= 3.011 \times 10^{24} \text{ atoms of Carbon} \end{aligned}$$

**22. Calculate the volume occupied by 2.5 mole of  $\text{CO}_2$  at S.T.P**

$$\text{Number of moles of } \text{CO}_2 = \frac{\text{Given volume at S.T.P}}{\text{Molar volume at S.T.P}}$$

$$2.5 \text{ mole of } \text{CO}_2 = \frac{\text{Volume of } \text{CO}_2 \text{ at S.T.P}}{22.4}$$

$$\begin{aligned} \text{Volume of } \text{CO}_2 \text{ at S.T.P} &= 22.4 \times 2.5 \\ &= 56 \text{ litres.} \end{aligned}$$

**23. Calculate the volume occupied by  $3.011 \times 10^{23}$  of ammonia gas molecules.**

$$\begin{aligned} \text{Number of moles} &= \frac{\text{Number of molecules}}{\text{Avogadro's number}} \\ &= \frac{3.011 \times 10^{23}}{6.023 \times 10^{23}} \\ &= 2 \text{ moles} \end{aligned}$$

$$\begin{aligned} \text{Volume occupied by } \text{NH}_3 &= \text{number of moles} \times \text{molar volume} \\ &= 2 \times 22.4 \\ &= 44.8 \text{ litres at S.T.P} \end{aligned}$$

**24. Calculate the volume occupied by 14 g nitrogen gas.**

$$\begin{aligned} \text{Number of moles} &= 14 / 28 \\ &= 0.5 \text{ mole} \end{aligned}$$

$$\begin{aligned} \text{Volume occupied by } \text{N}_2 \text{ at S.T.P} &= \text{no. of moles} \times \text{molar volume} \\ &= 0.5 \times 22.4 = 11.2 \text{ litres.} \end{aligned}$$

**25. Calculation based on % composition. Calculate % of S in  $\text{H}_2\text{SO}_4$ .**

$$\begin{aligned} \text{Molar mass of } \text{H}_2\text{SO}_4 &= (1 \times 2) + (32 \times 1) + (16 \times 4) \\ &= 2 + 32 + 64 \\ &= 98 \text{ g} \end{aligned}$$

$$\% \text{ of S in } \text{H}_2\text{SO}_4 = \frac{\text{Mass of sulphur}}{\text{Molar mass of } \text{H}_2\text{SO}_4} \times 100$$

$$\% \text{ of S in } \text{H}_2\text{SO}_4 = \frac{32}{98} \times 100 = 32.65 \%$$

I. Choose the correct answer.

**Self-Evaluation (Textual Questions)**

- Casparian strips are present in the ..... of the root.  
(a) cortex (b) pith (c) pericycle (d) endodermis
- The endarch condition is the characteristic feature of .....  
(a) root (b) stem (c) leaves (d) flower
- The xylem and phloem arranged side by side on same radius is called .....  
(a) radial (b) amphivasal (c) conjoint (d) None of these
- Which is formed during anaerobic respiration?  
(a) Carbohydrate (b) Ethyl alcohol (c) Acetyl CoA (d) Pyruvate
- Kreb's cycle takes place in .....  
(a) chloroplast (b) mitochondrial matrix  
(c) stomata (d) inner mitochondrial membrane
- Oxygen is produced at what point during photosynthesis?  
(a) when ATP is converted to ADP (b) when CO<sub>2</sub> is fixed  
(c) when H<sub>2</sub>O is splitted (d) All of these

**Other Important Questions**

- Which of the following statements are correct with reference to monocot stem?  
(i) Protoxylem lacuna is present. (ii) Pith is absent.  
(iii) Pericycle is absent. (iv) Companion cells are absent.  
(a) (i), (ii) & (iii) only (b) (i) & (iii) only  
(c) (ii) & (iv) only (d) (iii) & (iv) only
- The types of vascular bundle seen in ferns is .....  
(a) collateral (b) concentric (c) bicollateral (d) amphicribal
- Bicollateral vascular bundles are seen in the members of .....  
(a) Malvaceae (b) Cucurbitaceae (c) Solanaceae (d) Musaceae
- The hypodermis of ..... is made up of sclerenchymatous cells.  
(a) dicot stem (b) dicot root (c) monocot stem (d) monocot root
- Lateral roots originate from .....  
(a) cortex (b) pericycle (c) endodermis (d) pith
- Palisade parenchyma is present in .....  
(a) roots (b) fruit (c) stem (d) leaves
- The vascular bundle of dicot leaf is surrounded by .....  
(a) sclerenchyma (b) parenchyma (c) collenchyma (d) chlorenchyma
- The important functions of casparian strips is to .....  
(a) conduct water and minerals to xylem.  
(b) conduct water from cortex to xylem.  
(c) provide mechanical strength to plant.  
(d) prevent re-entry of water into cortex from xylem.

15. Isobilateral leaf is present in ..... .  
 (a) grass (b) cucurbita (c) sunflower (d) bean
16. The caspian strips are found in the endodermis of ..... .  
 (a) dicot stem (b) dicot root (c) monocot stem (d) dicot leaf
17. The vascular bundle with protoxylem facing towards centre of the stem is ..... .  
 (a) exarch (b) endarch (c) tetrach (d) polyarch
18. Palisade parenchyma contains ..... .  
 (a) carotenoid (b) starch (c) chlorophyll (d) lipids
19. The word Plant Anatomy was coined by ..... .  
 (a) Calvin (b) Nehemiah Grew (c) Krieb (d) Hill
20. The passage cells are found in endodermis of ..... .  
 (a) dicot stem (b) monocot stem (c) dicot root (d) dicot leaf
21. The protoxylem lacunae is present in the vascular bundle of ..... .  
 (a) dicot root (b) monocot root (c) dicot stem (d) monocot stem
22. The vascular bundles are 'V' or 'Y' shaped in ..... .  
 (a) dicot root (b) monocot root (c) dicot stem (d) monocot stem
23. The outermost layer of the stele is ..... .  
 (a) endodermis (b) pericycle (c) rhizodermis (d) hypodermis
24. Tissues are ..... .  
 (a) group of cells which are similar in origin and functions  
 (b) group of organs which are similar in origin and function  
 (c) cells which are similar in function but not in origin  
 (d) group of cells which are not similar in origin and functions
25. Plant tissues are divided into meristamatic and permanent tissue on which of the following basis?  
 (a) Whether the plant is a dicot or a monocot.  
 (b) Whether the cells formed are capable of dividing or not.  
 (c) Position (d) Origin
26. Branch of botany dealing with the internal organisation of plants is called ..... .  
 (a) Cytology (b) Physiology (c) Anatomy (d) Ecology
27. Stomata are the component of ..... tissue system.  
 (a) Epidermal (b) Ground (c) Conducting (d) Vascular
28. The distinguishing feature of open vascular bundles is presence of ..... .  
 (a) cambium (b) xylem (c) pericycle (d) endodermis
29. The central most portion of the stem of dicotyledon plants is occupied by ..... .  
 (a) vascular bundle (b) pericycle (c) pith (d) cortex
30. The bulliform cells are found in the ..... .  
 (a) monocot stem (b) dicot root (c) monocot leaves (d) dicot stem
31. Formation of ATP during electron transport chain is known as ..... .  
 (a) dephosphorylation (b) photophosphorylation  
 (c) oxidative phosphorylation (d) substrate level phosphorylation
32. Energy currency of the cell is ..... .  
 (a) ADP (b) ATP (c) NADH<sub>2</sub> (d) FADH<sub>2</sub>



33. Glycolysis occurs in ..... .  
 (a) mitochondria (b) ribosome (c) chloroplast (d) cytoplasm
34. The photosynthetic pigments are located in ..... .  
 (a) cristae (b) cisternae (c) thylakoid (d) stroma
35. Light reactions was first explained by ..... .  
 (a) Hill (b) Arnoide (c) P. Mitchell (d) Calvin
36. Bio synthetic reaction was first explained by ..... .  
 (a) Hill (b) F. Grew (c) Melvin Calvin (d) Kolliku
37. What are the products of respiration?  
 (a)  $O_2$ ,  $H_2O$ , energy (b)  $CO_2$  and energy  
 (c)  $CO_2$ ,  $H_2O$  and energy (d)  $H_2O$  and  $CO_2$
38. End product of anaerobic respiration is ..... .  
 (a) Pyruvic acid (b) Lactic acid (c) ATP & NADP (d) Glycose
39. The mitochondria was first discovered ..... .  
 (a) 1857 (b) 1957 (c) 1886 (d) 1987
40. Which is located on the inner membrane of the mitochondria?  
 (a) Glycolysis (b) Krebs cycle  
 (c) Electron transport chain (d) Fermentation
41. Which of the following is tennis racket shaped particles?  
 (a) Peroxisome (b) Cristae (c) Oxysome (d) Matrix
42. In which organelle does Krebs cycle take place?  
 (a) Mitochondrial (b) Cytoplasm  
 (c) Nucleosome (d) Mitochondrial matrix

### ANSWERS

1. (d) 2. (b) 3. (c) 4. (b) 5. (b) 6. (c) 7. (a) 8. (d) 9. (b) 10. (c)  
 11. (b) 12. (d) 13. (b) 14. (d) 15. (a) 16. (b) 17. (b) 18. (c) 19. (b) 20. (c)  
 21. (d) 22. (c) 23. (a) 24. (b) 25. (b) 26. (c) 27. (a) 28. (a) 29. (c) 30. (c)  
 31. (c) 32. (b) 33. (c) 34. (c) 35. (a) 36. (c) 37. (b) 38. (b) 39. (a) 40. (c)  
 41. (c) 42. (d)

### II. Fill in the blanks.

#### Self-Evaluation (Textual Questions)

- Cortex lies between .....
- Xylem and phloem occurring on the same radius constitute a vascular bundle called .....
- Glycolysis takes place in .....
- The source of  $O_2$  liberated in photosynthesis is .....
- ..... is ATP factory of the cells.

#### Other Important Questions

- Trichomes and root hairs are ..... outgrowth.
- ..... helps in absorption of water and minerals.
- The chief water conducting element is .....
- Conjoint vascular bundles are classified into ..... and .....

10. The cambium is responsible for .....
11. The innermost layer of the cortex is .....
12. Casparian strips are made up of .....
13. When the cambium is absent, the vascular bundle is .....
14. The skull shaped vascular bundles are seen in .....
15. The palisade parenchyma involved in .....
16. Sclerenchyma provide ..... to plant.
17.  $6\text{CO}_2 + 12\text{H}_2\text{O} \xrightarrow[\text{chlorophyll}]{\text{light}}$  .....
18. The site of photosynthesis is .....
19. The light reaction was discovered by .....
20. In light independent reaction, the bio synthetic pathway is ..... step.
21. Any one internal factors that affect photosynthesis is .....
22. The mitochondria were first discovered by .....
23. The energy currency of the cell is .....
24. The oxysomes are involved in ..... synthesis.
25. The process of splitting of glucose is known as .....
26. Glucose converted into lactate by .....
27. Dark reaction takes place in ..... of chloroplast.
28. The ..... type of respiration takes place in the presence of oxygen.
29. The end products of light reaction ..... and .....
30. The chief food conducting element is .....

### ANSWERS

- |  |                             |                      |
|--|-----------------------------|----------------------|
| 1. Epidermis and Endodermis  | 2. conjoint                 | 3. cytoplasm         |
| 4. $\text{H}_2\text{O}$ (water)  | 5. Mitochondria             | 6. epidermal         |
| 8. xylem   | 9. collateral, bicollateral | 10. secondary growth |
| 11. endodermis   | 12. suberin                 | 13. closed           |
| 15. photosynthesis   | 16. mechanical support      | 14. monocot system   |
| 17. $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{H}_2\text{O} + 6\text{O}_2 \uparrow$ | 18. chloroplast             | 19. Robin Hill       |
| 20. second   | 21. hormones                | 22. Kolliker         |
| 24. ATP  | 25. glycolysis              | 23. ATP              |
| 28. aerobic  | 29. ATP, $\text{NADPH}_2$   | 27. stroma           |
|  | 30. phloem                  |                      |

**III. State whether the following statements are true or false. Correct the statement if it is false:**

**Self-Evaluation (Textual Questions)**

1. Phloem tissue is involved in the transport of water in plant.
2. The waxy protective covering of a plant is called as cuticle.
3. In monocot stem cambium is present in between xylem and phloem.
4. Palisade parenchyma cells occur below upper epidermis in dicot root.
5. Mesophyll contains chlorophyll.
6. Anaerobic respiration produces more ATP than aerobic respiration.

**Other Important Questions**

7. The Plant Anatomy is the study of external structure of plants.

8. Cambium is responsible for longitudinal growth.
9. Hypodermis is the innermost layer of the cortex.
10. In dicot stem the vascular bundles are arranged in the form of ring.
11. In dicot leaf the lower epidermis contain numerous stomata.
12. The yellow colored plastids are leucoplast.
13. Primary pigments are reactant centre.
14. Mitochondria is otherwise called ATP factory of the cell.
15.  $C_6H_{12}O_6; 6O_2 \rightarrow 6CO_2 + 6O_2 + ATP$ .
16. The respiration without oxygen is known as anaerobic respiration.

**ANSWERS**

1. False 2. True 3. False 4. True 5. True 6. False 7. False 8. False  
 9. False 10. True 11. True 12. False 13. True 14. True 15. False 16. True

**Correct statements for the false statements:**

1. Xylem tissue is involved in the transport of water in plant.
3. In monocot stem cambium is absent in between xylem and phloem.
6. Anaerobic respiration produces less ATP than aerobic respiration.
7. The Plant Anatomy is the study of internal structure of plants.
8. Cambium is responsible for secondary growth.
9. Endodermis is the innermost layer of the cortex.
12. The yellow colored plastids are chromoplast.
15.  $C_6H_{12}O_6; 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$ .

**IV. Match the following.**

**Self-Evaluation (Textual Questions)**

- |                    |   |                            |
|--------------------|---|----------------------------|
| (a) 1. Amphicribal | - | (i) <i>Dracaena</i>        |
| 2. Cambium         | - | (ii) Translocation of food |
| 3. Amphivasal      | - | (iii) Fern                 |
| 4. Xylem           | - | (iv) Secondary growth      |
| 5. Phloem          | - | (v) Conduction of water    |

**Other Important Questions**

- |                                 |   |                              |
|---------------------------------|---|------------------------------|
| (b) 1. Nehemiah Grew            | - | (i) Plant tissue system      |
| 2. Sachs                        | - | (ii) Bio synthetic system    |
| 3. Robin Hill                   | - | (iii) Mitochondria           |
| 4. Calvin                       | - | (iv) TCA cycle               |
| 5. Kolliker                     | - | (v) Light reaction           |
| 6. Krieb                        | - | (vi) Father of Plant Anatomy |
| (c) 1. Polyarch                 | - | (i) Mitochondria             |
| 2. Skull shaped vascular bundle | - | (ii) Monocot root            |
| 3. Chloroplast                  | - | (iii) Monocot stem           |
| 4. ATP factory                  | - | (iv) Mechanical support      |
| 5. Sclerenchyma                 | - | (v) Photosynthesis           |

## ANSWERS

- (a) 1. (iii) 2. (iv) 3. (i) 4. (v) 5. (ii)  
(b) 1. (vi) 2. (i) 3. (v) 4. (ii) 5. (iii) 6. (iv)  
(c) 1. (ii) 2. (iii) 3. (v) 4. (i) 5. (iv)

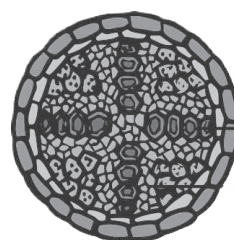
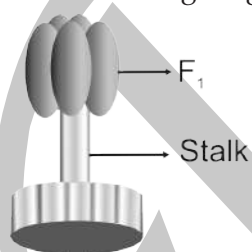
### V. Answer in a sentence.

#### Self-Evaluation (Textual Questions)

1. What is collateral vascular bundle?
2. Where does the carbon that is used in photosynthesis come from?
3. What is the common step in aerobic and anaerobic pathway?
4. Name the phenomenon by which carbohydrates are oxidized to release ethyl alcohol.

#### Other Important Questions

5. Name the tissue which conducts water and minerals to different parts of the body.
6. Give one example for Amphivasal and Amphicribal.
7. Name the type of vascular bundle, present in plant cucurbita.
8. Where are the photosynthetic pigments located in the chloroplast?
9. Expand ATP and NADP.
10. Name the pigment that act as reactant centre.
11. Name the gas released as a byproduct during photosynthetic process.
12. If the proto xylem lies next to phloem what kind of arrangement of xylem would you call it?
13. What part of the plant would show the following: Radial, Polyarch and well developed pith.
14. What are the cells that make the leaves curl in plants during water stress?
15. Name the pigments which are present in almost all photosynthetic groups.
16. What are the components in ground tissue system?
17. What is the other name of endodermis?
18. Expand ADP and NAD.
19. Name the following diagram.
20. Name the following vascular bundle.



## ANSWERS

1. Xylem lies towards the centre and phloem lies towards the periphery. When cambium is present in collateral bundles, it is called open. e.g. dicot stem and collateral bundle without cambium is called closed. e.g. monocot stem.
2. Atmosphere (air) 3. Glycolysis
4. Anaerobic respiration or Fermentation process 5. Xylem
6. Dracaena and Ferns 7. Bicollateral 8. Thylakoids

9. Adenosine Tri Phosphate, Nicotinamide Dinucleotide Phosphate  
 10. Chlorophyll a      11. Oxygen      12. Exarch      13. Monocot root  
 14. Bulliform cells      15. Chlorophyll a      16. Parenchyma, Collenchyma, Sclerenchyma  
 17. Starch sheath  
 18. Adenine Dinucleotide Phosphate, Nicotinamide Adenine Dinucleotide  
 19. Oxysomes      20. Xylem tetrach-dicot root

## VI. Short answer questions

### Self-Evaluation (Textual Questions)

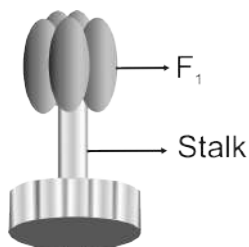
#### 1. Give an account on vascular bundle of dicot stem.

Vascular bundles are conjoint, collateral, endarch and open. They are arranged in the form of a ring around the pith.

#### 2. Write a short note on mesophyll.

Mesophyll is the ground tissue that is present between both epidermal layers. Mesophyll is not differentiated into palisade and spongy parenchyma. The cells are irregularly arranged with inter-cellular spaces. These cells contain chloroplasts.

#### 3. Draw and label the structure of oxysomes.



#### 4. Name the three basic tissue system in flowering plants.

The basic three tissue system in plants are:

- (i) Dermal or Epidermal tissue system
- (ii) Ground tissue system
- (iii) Vascular tissue system

#### 5. What is photosynthesis and where in a cell does it occur?

Photosynthesis is the process in which carbon dioxide combines with water in the presence of sunlight and chlorophyll to form carbohydrates. During this process oxygen is released as a byproduct. Photosynthesis occurs in green parts of the plant such as leaves, stems and floral buds.

#### 6. What is respiratory quotient?

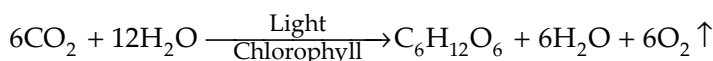
Respiratory quotient is the ratio of volume of carbon dioxide liberated and the volume of oxygen consumed during respiration. It is expressed as

$$RQ = \frac{\text{Volume of CO}_2 \text{ liberated}}{\text{Volume of O}_2 \text{ consumed}}$$

#### 7. Why should the light dependent reaction occur before the light independent reaction?

Photosynthetic pigments absorb the light energy and convert it into chemical energy ATP and NADPH<sub>2</sub>.

#### 8. Write the reaction for photosynthesis?



Carbon dioxide + Water → Glucose + water + oxygen

### Other Important Questions

#### 9. What is Plant Anatomy?

Plant anatomy is the study of internal structure of plants.

#### 10. Define tissues.

Tissues are the group of cells that are similar or dissimilar in structure and origin, but perform similar function.

#### 11. What are the two types of tissues present in the plants?

(i) Meristamatic tissue and (ii) Permanent tissue.

#### 12. State the functions of epidermal tissue system?

Functions of epidermal tissue system are:

- (i) Epidermis protects the inner tissues.
- (ii) Stomata helps in transpiration.
- (iii) Root hairs help in absorption of water and minerals.

#### 13. What are the different tissue present in between epidermis and vascular tissue?

(i) Cortex, (ii) Endodermis, (iii) Pericycle, (iv) Pith.

#### 14. What is a vascular bundle?

Vascular tissue system consists of xylem and phloem tissues. They are present in the form of bundles called vascular bundles.

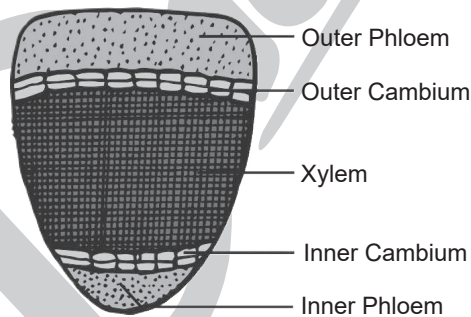
#### 15. What are the different types of vascular bundles?

There are three different types of vascular bundles namely (i) Radial, (ii) Conjoint, (iii) Concentric.

#### 16. What is an Amphicribral vascular bundle?

**Amphicribral:** Vascular bundle is Phloem surrounds xylem. e.g. Ferns.

#### 17. Draw the diagram of bicollateral vascular bundle and label the parts.



**Conjoint, Bicollateral Vascular bundle**

#### 18. What is xylem?

Xylem conducts water and minerals to different parts of the plant.

#### 19. What is exarch and endarch condition?

**Endarch:** Protoxylem lies towards the centre and metaxylem lies towards the periphery. e.g. stem.

**Exarch:** Protoxylem lies towards the periphery and metaxylem lies towards the centre. e.g. roots.

**20. What is piliferous layer?**

Epiblema is the outermost layer. Cuticle and stomata are absent. Unicellular root hairs are present. It is also known as Rhizodermis or Piliferous layer.

**21. Define stele.**

**Stele:** All tissues inner to endodermis constitute stele. It includes pericycle and vascular bundle.

**22. What are called casparian strips?**

Endodermis is the innermost layer of cortex. The cells are barrel - shaped, closely packed, and show band like thickenings on their radial and inner tangential walls called casparian strips.

**23. What is meant by pericycle?**

**Pericycle:** Inner to endodermis lies a single layer of pericycle. It is the site of origin of lateral roots.

**24. Write any two differences between vascular bundles in monocot root and dicot root.**

S. No.	Monocot root	Dicot root
(i)	Xylem is polyarch.	Xylem is tetrach.
(ii)	The conjunctive tissue is made up of sclerenchyma.	Conjunctive tissue is made up of parenchyma.

**25. Give two differences between hypodermis and endodermis.**

S. No.	Hypodermis	Endodermis
(i)	Hypodermis is the outermost zone of cortex.	Endodermis is the innermost layer of cortex.
(ii)	It is multilayered.	It is single layered.
(iii)	It is present in the stems of dicot and monocot.	It is present in both stem and root of dicots.

**26. Write any two differences between open vascular bundle and closed vascular bundle.**

S. No.	Open vascular bundle	Closed vascular bundle
(i)	When cambium is present in between xylem and phloem.	There is no cambium present in between xylem and phloem.
(ii)	Vascular bundles are open.	Vascular bundles are closed.
(iii)	Secondary growth is present.	Secondary growth is absent.

**27. What are passage cells?**

Endodermis cells which are opposite to the protoxylem elements are, a thin walled cells without casparian strips. These cells are called passage cells. Through which water and minerals are transported from cortex to xylem elements.

**28. What is a protoxylem lacuna?**

In monocot stem, the mature vascular bundle, the lower most protoxylem disintegrates and form a cavity. This is called protoxylem lacuna.

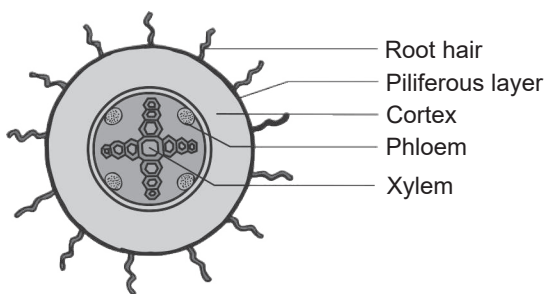
29. Write any two differences between the cortex of dicot stem and the cortex of the dicot root.

**Cortex of the dicot root:** It is a multilayered large zone made of thin-walled parenchymatous cells with intercellular spaces. It stores food and water.

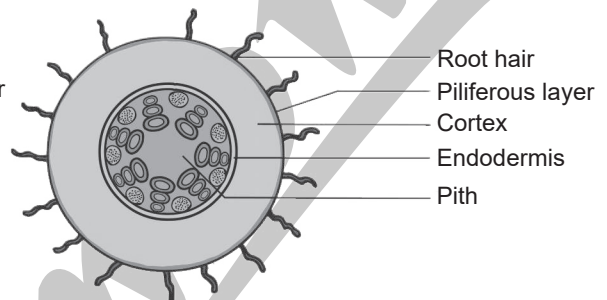
**Cortex of the dicot stem:** It is divided into three regions:

- (i) **Hypodermis:** It consists of 3-6 layers of collenchyma cells. It gives mechanical support.
- (ii) **Middle cortex:** It is made up of few layers of chlorenchyma cells. It is involved in photosynthesis due to the presence of chloroplast.
- (iii) **Inner cortex:** It is made up of few layers of parenchyma cells. It helps in gaseous exchange and stores food materials.

30. Draw and label the ground plan of (a) Dicot root and (b) Monocot root.



Ground plan of Dicot root



Ground plan of Monocot root

31. Differentiate bundle sheath from bundle cap.

S. No.	Bundle sheath	Bundle cap
(i)	Bundle sheath is present in monocot stem and dicot leaf.	Bundle cap is present in dicot stem.
(ii)	Each vascular bundle is surrounded by a sheath of sclerenchyma fibre called bundle sheath.	The patch of sclerenchyma cells occurs outside the phloem in each vascular bundle.

32. Differentiate palisade from spongy parenchyma.

S. No.	Palisade parenchyma	Spongy parenchyma
(i)	It is found just below the upper epidermis.	It is found below the palisade parenchyma tissue.
(ii)	The cells are elongated. These cells have more number of chloroplasts.	Cells are almost spherical or oval and are irregularly arranged.
(iii)	The cells do not have intercellular spaces and they take part in photosynthesis.	Cells have intercellular spaces. It helps in gaseous exchange.

33. Write the differences between dicot and monocot leaf.

S. No.	Dicot Leaf	Monocot Leaf
(i)	Dorsiventral leaf.	Isobilateral leaf.
(ii)	Mesophyll is differentiated into palisade and spongy parenchyma.	Mesophyll is not differentiated into palisade and spongy parenchyma.



**34. Name two epidermal outgrowth.**

Trichomes and root hairs are the epidermal outgrowths.

**35. What are stomata?**

Epidermis is the outer most layer. It has many minute pores called stomata.

**36. What is bulliform cells?**

Some cells of upper epidermis are large and thin walled. They are known as bulliform cells.

**37. Define plastid.**

Plastids are double membrane bound organelles found in plants and some algae. They are responsible for preparation and storage of food.

**38. What are the different types of plastids?**

There are three types of plastids:

- (i) Chloroplast - green coloured plastids
- (ii) Chromoplast - yellow, red, orange coloured plastids
- (iii) Leucoplast - colourless plastids

**39. What are the functions of chloroplast?**

(i) Photosynthesis (ii) Storage of starch (iii) Synthesis of fatty acids (iv) Storage of lipids (v) Formation of chloroplasts.

**40. What is a photo system?**

Reaction centres (Chl. a) and the accessory pigments (harvesting centre) together are called photosystems.

**41. What are reaction centre and harvest centre?**

Chlorophyll a is the primary pigment that traps solar energy and converts it into electrical and chemical energy. Thus it is called the reaction centre. Other pigments such as chlorophyll b and carotenoids are called accessory pigments or harvesting centre as they pass on the absorbed energy to chlorophyll a (Chl. a) molecule.

**42. What is calvin cycle?**

During Dark reaction  $\text{CO}_2$  is reduced into carbohydrates with the help of light generated ATP and  $\text{NADPH}_2$ . This is also called calvin cycle and is carried out in the absence of light. In Calvin cycle the inputs are  $\text{CO}_2$  from the atmosphere and the ATP and  $\text{NADPH}_2$  produced from light reaction.

**43. What are the factors that affects photosynthesis?**

(a) **Internal Factors:** (i) Pigments (ii) Leaf age (iii) Accumulation of carbohydrates (iv) Hormones.

(b) **External Factors:** (i) Light (ii) Carbon dioxide (iii) Temperature (iv) Water (v) Mineral elements.

**44. Write any two differences between light and dark reactions.**

S. No.	Light reactions	Dark reactions
(i)	Reaction need light.	Reaction take place in absence of light.
(ii)	It occurs in thylakoid membrane of chloroplast.	It occurs in stroma of chloroplast.

**45. What is chlorophyll?**

Chloroplasts are green plastids containing green pigment called chlorophyll.

**46. Define stroma.**

Matrix present inside to the membrane is called stroma. It contains DNA, 70 S ribosomes and other molecules required for protein synthesis.

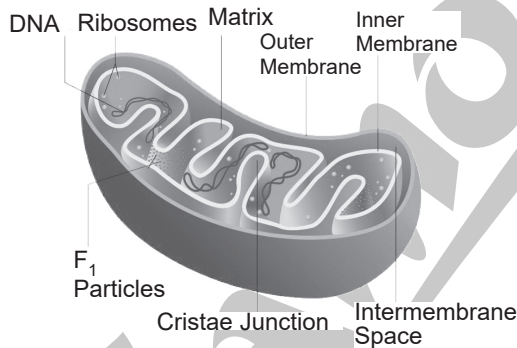
**47. What are thylakoids?**

Thylakoids consist of thylakoid membrane that encloses thylakoid lumen. Thylakoids forms a stack of disc like structures called a grana (singular-granum).

**48. What are called fret channels?**

Some of the thylakoids are arranged in the form of discs stacked one above the other. These stacks are termed as grana, they are interconnected to each other by membranous lamellae called Fret channels.

**49. Draw and label the structure of mitochondria.**



**Structure of Mitochondria**

**50. Why mitochondria are called as "Power house of the cell"?**

Mitochondria (singular: mitochondrion) are organelles within eukaryotic cells that produce adenosine triphosphate (ATP) which form the energy currency of the cell. For this reason, the mitochondria are referred to as the "Power house of the cell".

**51. Name the substances that found in mitochondria.**

Mitochondria contain 60-70% protein, 25-30% lipids, 5-7% RNA and small amount of DNA and minerals.

**52. What is cristae?**

The inner mitochondrial membrane gives rise to finger like projections called cristae. These cristae increase the inner surface area (fold in inner membrane) of the mitochondria to hold variety of enzymes.

**53. What is an oxysome?**

The inner mitochondrial membrane bear minute regularly spaced tennis racket shaped particles known as oxysomes ( $F_1$  particle). They are involved in ATP synthesis.

**54. What are the functions of mitochondria?**

**Functions of mitochondria:**

- Mitochondria is the main organelle of cell respiration. They produce a large number of ATP molecules. So they are called as power houses of the cell or ATP factory of the cell.

- It helps the cells to maintain normal concentration of calcium ions.
- It regulates the metabolic activity of the cell.

**55. What is an oxidative phosphorylation?**

NADH<sub>2</sub> and FADH<sub>2</sub> molecules formed during glycolysis and Krebs's cycle are oxidised to NAD<sup>+</sup> and FAD<sup>+</sup> to release the energy via electrons. The electrons, as they move through the system, release energy which is trapped by ADP to synthesize ATP. This is called oxidative phosphorylation.

**56. Write the overall reaction of aerobic respiration.**



**57. Differentiate Krebs's cycle and Glycolysis.**

S. No.	Krebs's cycle	Glycolysis
(i)	It takes place in matrix of mitochondria.	It takes place in cytoplasm.
(ii)	It occurs in aerobic respiration only.	It occurs in both aerobic and anaerobic respiration.
(iii)	Pyruvic acid completely converted into CO <sub>2</sub> and H <sub>2</sub> O.	Glucose converts into two molecules of pyruvic acid.
(iv)	It is connected with oxidative phosphorylation.	It is not connected with oxidative phosphorylation.

**58. Write the overall equation for anaerobic respiration.**



**59. What is Krebs's cycle?**

**Krebs's cycle:** This cycle occurs in mitochondria matrix. At the end of glycolysis, two molecules of pyruvic acid enter into mitochondria. The oxidation of pyruvic acid into CO<sub>2</sub> and water takes place through this cycle. It is also called Tricarboxylic Acid Cycle (TCA).

**60. Write down the formula for respiratory quotient?**

$$RQ = \frac{\text{Volume of CO}_2 \text{ liberated}}{\text{Volume of O}_2 \text{ consumed}}$$

**61. Define ETC.**

**Electron Transport Chain:** This is accomplished through a system of electron carrier complex called electron transport chain (ETC) located on the inner membrane of the mitochondria.

**62. Identify X and Y and its functions.**



X - Cristae enzymes;

Y - F<sub>1</sub> particle oxysome involved in ATP synthesis

## VII. Long answer questions.

### Self-Evaluation (Textual Questions)

1. Differentiate the following. (a) Monocot root and Dicot root (b) Aerobic and Anaerobic respiration.

(a) Differences between Dicot root and Monocot root.

S. No.	Tissues	Dicot root	Monocot root
(i)	Number of Xylem	Tetrarch	Polyarch
(ii)	Cambium	Present (During secondary growth only), Vascular bundle open.	Absent, Secondary growth vascular bundle closed.
(iii)	Secondary Growth	Present	Absent
(iv)	Pith	Absent	Present

(b) Differences between Aerobic respiration and Anaerobic respiration.

S. No.	Aerobic respiration	Anaerobic respiration
(i)	Oxygen is required.	Oxygen is not required.
(ii)	End products are CO <sub>2</sub> and H <sub>2</sub> O.	End products are lactic acid or alcohol.
(iii)	More ATP molecules are released.	Less ATP molecules are released.
(iv)	It occurs in cytoplasm and mitochondria.	It occurs only in cytoplasm.

2. Describe and name three stages of cellular respiration that aerobic organisms use to obtain energy from glucose.

Aerobic respiration is the type of cellular respiration in which organic food is completely oxidized with the help of oxygen into carbon dioxide, water and energy. It occurs in most plants and animals.



**Stages of Aerobic respiration:**

(a) **Glycolysis (Glucose splitting):** It is the breakdown of one molecule of glucose (6 carbon) into two molecules of pyruvic acid (3 carbon). Glycolysis takes place in cytoplasm of the cell. It is the first step of both aerobic and anaerobic respiration.

(b) **Kreb's Cycle:** This cycle occurs in mitochondria matrix. At the end of glycolysis, 2 molecules of pyruvic acid enter into mitochondria. The oxidation of pyruvic acid into CO<sub>2</sub> and water takes place through this cycle. It is also called Tricarboxylic Acid Cycle (TCA).

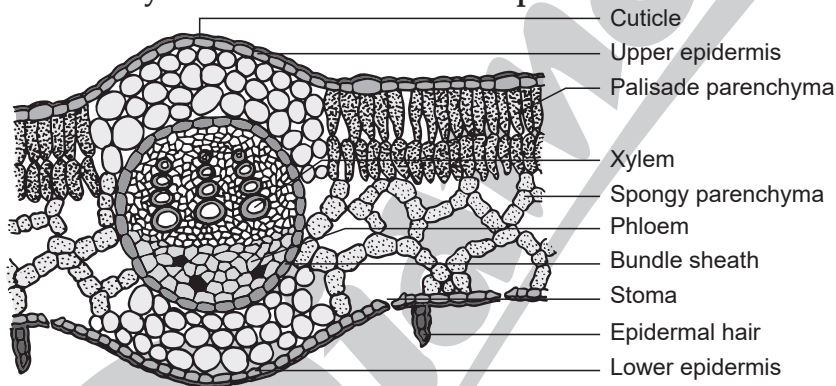
(c) **Electron Transport Chain:** This is accomplished through a system of electron carrier complex called electron transport chain (ETC) located on the inner membrane of the mitochondria. NADH<sub>2</sub> and FADH<sub>2</sub> molecules formed during glycolysis and Krebs cycle are oxidised to NAD<sup>+</sup> and FAD<sup>+</sup> to release the energy via electrons. The electrons, as they move through the system, release energy which is trapped by ADP to synthesize ATP. This is called oxidative phosphorylation. In this process, O<sub>2</sub> the ultimate acceptor of electrons gets reduced to water.

3. How does the light dependent reaction differ from the light independent reaction? What are the end products and reactants in each? Where does each reaction occur within the chloroplast?

S. No.	Light dependent reaction	Light independent reaction
(i)	The reactions takes place in the presence of light.	The reactions takes place in the absence of light.
(ii)	It occurs in thylakoid membrane.	It occurs in stroma.
(iii)	This was discovered by Robin Hill.	This was discovered by Melvin Calvin.
(iv)	Reactants are Sunlight, $H_2O$ , $NADP^+$ , ADP.	Reactants are $ATP$ , $NADPH^+$ , $CO_2$ , RUBP.
(v)	End products are $O_2$ , $ATP$ , $NADPH$ .	End products are $NADP$ , $ATP$ , Organic compounds.

**Other Important Questions**

4. Draw the anatomy of dicot leaf and label the parts.



Transverse section of Dicot leaf

5. Describe the primary structure of dicot stem (sunflower). [OR] Draw and label the transverse section of dicot stem.

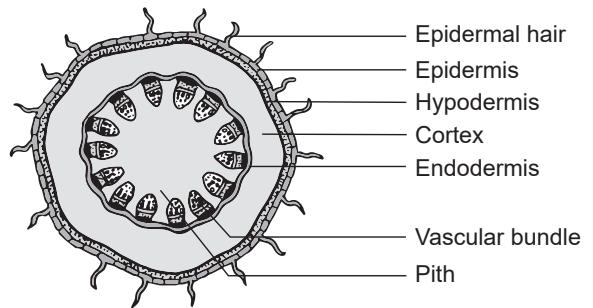
The transverse section of a dicot stem reveals the following structures.

**Epidermis:** It is the outermost layer. It is made up of single layer of parenchyma cells, its outer wall is covered with cuticle. It is protective in function.

**Cortex:** It is divided into three regions:

(i) **Hypodermis:** It consists of 3 - 6 layers of collenchyma cells. It gives mechanical support.

(ii) **Middle cortex:** It is made up of few layers of chlorenchyma cells. It is involed in photosynthesis due to the presence of chloroplast.



Ground plan

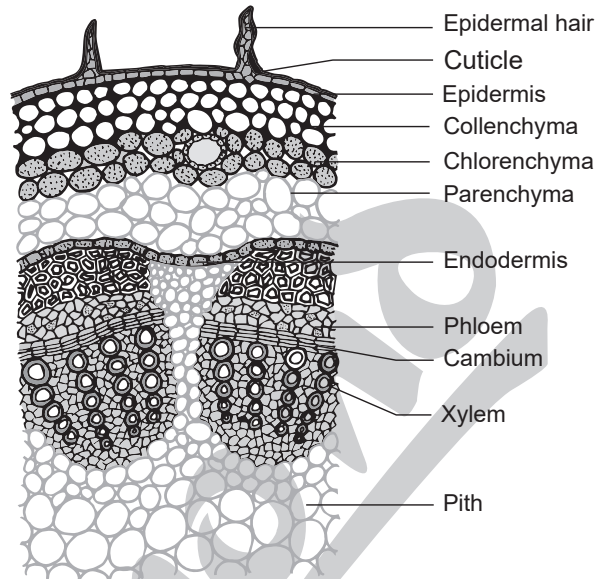
**(iii) Inner cortex:** It is made up of few layers of parenchyma cells. It helps in gaseous exchange and stores food materials. Endodermis is the inner most layer of cortex it consists of a single layer of barrel shaped cells, these cells contain starch grains. So it is also called starch sheath.

**Stele:** The central part of the stem inner to endodermis is known as stele. It consists of pericycle, vascular bundle and pith.

**(i) Pericycle:** It occurs between vascular bundle and endodermis. It is multilayered, parenchymatous with alternating patches of sclerenchyma.

**(ii) Vascular bundle:** Vascular bundles are conjoint, collateral, endarch and open. They are arranged in the form of a ring around the pith.

**(iii) Pith:** The large central parenchymatous zone with intercellular spaces is called pith. It helps in the storage of food materials.



A sector enlarged  
Transverse section of Dicot stem

**6. Describe the internal structure of dicot root (Bean). [OR] Draw and label the transverse section of dicot root.**

A thin transverse section of dicot root shows the following structures.

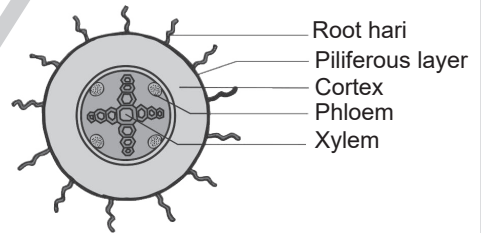
**(i) Epiblema:** It is the outermost layer. Cuticle and stomata are absent. Unicellular root hairs are present. It is also known as Rhizodermis or Piliferous layer.

**(ii) Cortex:** It is a multilayered large zone made of thin-walled parenchymatous cells with intercellular spaces. It stores food and water.

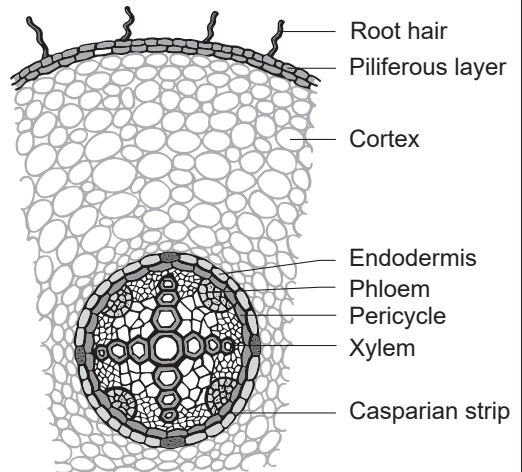
**(iii) Endodermis:** It is the innermost layer of cortex. The cells are barrel-shaped, closely packed, and show band like thickenings on their radial and inner tangential walls called casparian strips. It helps in the movement of water and dissolved salts from cortex into xylem.

**(iv) Stele:** All tissues inner to endodermis constitute stele. It includes pericycle and vascular bundle.

**(a) Pericycle:** Inner to endodermis lies a single layer of pericycle. It is the site of origin of lateral roots.



Ground plan



Transverse section of Dicot root

(b) **Vascular bundle:** It is radial. Xylem is exarch and tetrach. The tissue present between xylem and phloem is called conjunctive tissue. In dicot root, it is made up of parenchyma.

(c) **Pith:** Young root contains pith whereas in old root pith is absent.

7. Explain the anatomy of monocot stem (Maize). [OR] Draw and label the transverse section of monocot stem.

A transverse section of monocot stem reveals the following structures.

(i) **Epidermis:** It is the outermost layer. It is made up of single layer of parenchyma cells. It is covered with thick cuticle. Multicellular hairs are absent and stomata are also less in number.

(ii) **Hypodermis:** It is made up of few layers of sclerenchyma cells interrupted by chlorenchyma. Sclerenchyma provides mechanical support to plant.

(iii) **Ground tissue:** The entire mass of parenchyma cells next to hypodermis and extending to the centre is called ground tissue. It is not differentiated into endodermis, cortex, pericycle and pith.

(iv) **Vascular Bundle:** Vascular bundles are skull shaped and scattered in the ground tissue. Vascular bundles are conjoint, collateral, endarch and closed. Each vascular bundle is surrounded by few layer of sclerenchyma cells called bundle sheath.

(a) **Xylem:** It consists of metaxylem and protoxylem. Xylem vessels are arranged in V or Y shape. In mature vascular bundle, the lower most protoxylem disintegrates and form a cavity. This is called protoxylem lacuna.

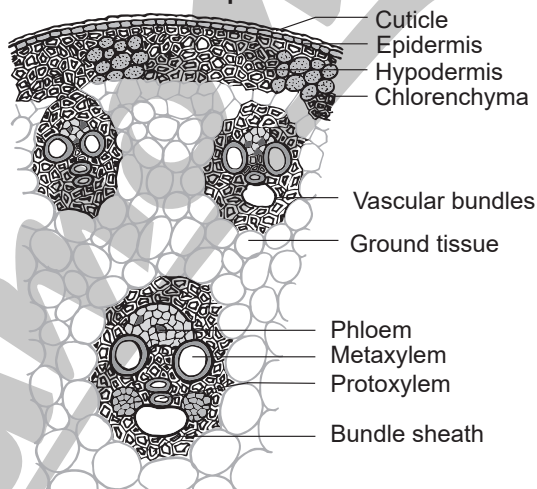
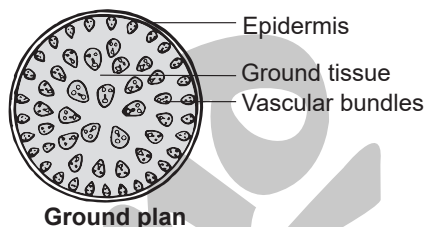
(b) **Phloem:** It consists of sieve tube elements and companion cells. Phloem parenchyma, and phloem fibers are absent.

(v) **Pith:** Pith is not differentiated in monocot stems.

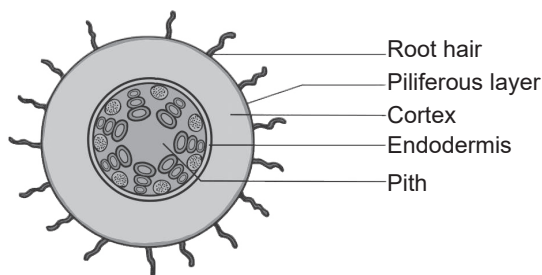
8. Describe the internal structure of monocot root (Maize). [OR] Draw and label the parts of transverse section of monocot root.

A thin transverse section of monocot root, shows the following characteristic features.

(i) **Epiblema or Rhizodermis:** It is the outermost layer of the root, and is made up of single layer of thin walled, parenchymatous cell. Stomata and cuticle are absent. The root hair helps in absorption of water and minerals from the soil. This layer also protects the inner tissues.



Transverse section of Monocot stem



Ground plan

(ii) **Cortex:** It is multilayered large zone, composed of parenchymatous cells with intercellular spaces. It stores water and food material.

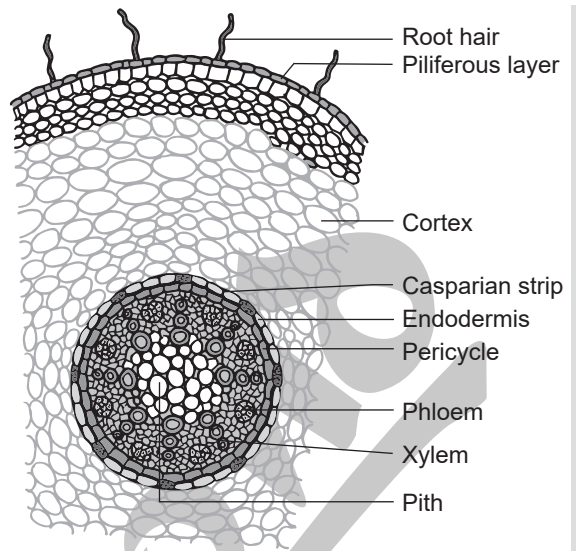
(iii) **Endodermis:** It is the innermost layer of cortex with characteristic casparian strips and passage cells. Casparian strips are band like thickening made of suberin.

(iv) **Stele:** All the tissues inner to endodermis constitute stele. It includes pericycle, vascular tissues and pith.

(a) **Pericycle:** It is a single layer of thin walled cells. The lateral roots originate from this layer.

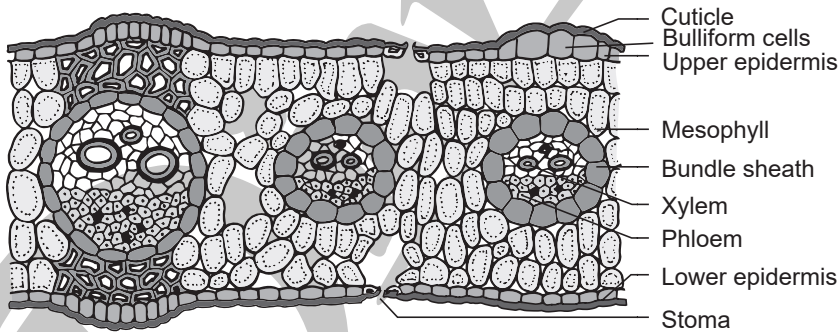
(b) **Vascular tissues:** It consists of many patches of xylem and phloem arranged radially. The xylem is exarch and polyarch. The conjunctive tissue is made up of sclerenchyma.

(c) **Pith:** It is present at the center. It is made up of parenchyma cells with intercellular spaces. It contains abundant amount of starch grains. It stores food.



**Transverse section of Monocot root**

**9. Describe the anatomy of isobilateral leaf with a labelled diagram.**



**Transverse section of Monocot leaf**

The transverse section of a monocot leaf reveals the following structures.

(i) **Epidermis:** Monocot leaf has upper and lower epidermis. Epidermis is made up of parenchyma cells. Cuticle is present on the outer wall stomata are present on both upper and lower epidermis. Some cells of upper epidermis are large and thin walled they are known as bulliform cells.

(ii) **Mesophyll:** It is the ground tissue that is present between both epidermal layers. Mesophyll is not differentiated into palisade and spongy parenchyma. The cells are irregularly arranged with inter-cellular spaces. These cells contain chloroplasts.

(iii) **Vascular bundles:** Large number of vascular bundles are present, some of which are small and some are large. Each vascular bundle is surrounded by parenchymatous bundle sheath. Vascular bundles are conjoint, collateral and closed. Xylem is present towards upper epidermis and phloem towards lower epidermis.



**10. Tabulate the different types of tissue system, components and its functions.**

S.No.	Tissue System	Components	Functions
(i)	Dermal Tissue System	Epidermis and Periderm (in older stems and roots)	<ul style="list-style-type: none"> <li>• Protection</li> <li>• Prevention of water loss</li> </ul>
(ii)	Ground Tissue System	Parenchyma tissue Collenchyma tissue Sclerenchyma tissue	<ul style="list-style-type: none"> <li>• Photosynthesis</li> <li>• Food storage</li> <li>• Regeneration</li> <li>• Support</li> <li>• Protection</li> </ul>
(iii)	Vascular Tissue System	Vascular tissues - Xylem tissue - Phloem tissue	<ul style="list-style-type: none"> <li>• Transport of water and minerals</li> <li>• Transport of food</li> </ul>

**11. Distinguish the anatomy of dicot stem and monocot stem.**

S. No.	Tissues	Dicot stem	Monocot stem
(i)	Hypodermis	Collenchymatous	Sclerenchymatous
(ii)	Ground tissue	Differentiated into cortex, endodermis, pericycle and pith	Undifferentiated
(iii)	Vascular bundles	<ul style="list-style-type: none"> <li>• Less in number</li> <li>• Uniform in size</li> <li>• Arranged in a ring</li> <li>• Open</li> <li>• Bundle sheath absent</li> </ul>	<ul style="list-style-type: none"> <li>• Numerous</li> <li>• Smaller near periphery, bigger in the centre</li> <li>• Scattered</li> <li>• Closed</li> <li>• Bundle sheath present</li> </ul>
(iv)	Secondary growth	Present	Mostly absent
(v)	Pith	Present	Absent
(vi)	Medullary rays	Present	Absent

**12. Describe the vascular tissue system.**

The vascular tissue system consists of xylem and phloem tissues. They are present in the form of bundles called vascular bundles. Xylem conducts water and minerals to different parts of the plant. Phloem conducts food materials to different parts of the plant. There are three different types of vascular bundles namely (i) Radial, (ii) Conjoint, (iii) Concentric.

(i) **Radial Bundles:** Xylem and phloem are present in different radii alternating with each other. e.g. roots.

(ii) **Conjoint bundles:** Xylem and phloem lie on the same radius. There are two types of conjoint bundles.

(a) **Collateral:** Xylem lies towards the centre and phloem lies towards the periphery. When cambium is present in collateral bundles, it is called open. e.g. dicot stem and collateral bundle without cambium is called closed. e.g. monocot stem.

(b) **Bicollateral:** In this type of bundle, the phloem is present on both outer and inner side of xylem. e.g. *Cucurbita*

(iii) **Concentric Bundles:** Vascular bundle in which xylem completely surrounds the phloem or viceversa is called concentric vascular bundle. It is of two types:

1. **Amphivasal:** Xylem surrounds phloem. e.g. *Dracaena*

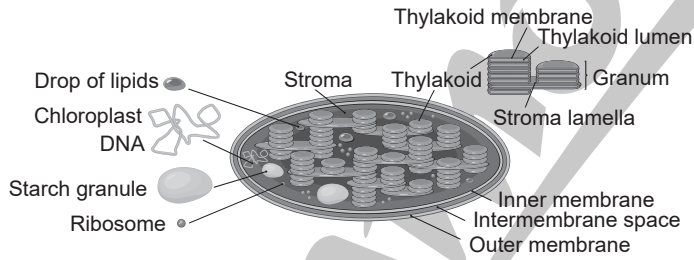
2. **Amphicribal:** Phloem surrounds xylem. e.g. *Ferns*

**Endarch:** Protoxylem lies towards the centre and metaxylem lies towards the periphery. e.g. stem.

**Exarch:** Protoxylem lies towards the periphery and metaxylem lies towards the centre. e.g. roots.

13. Explain the structure of chloroplast. [OR] Draw a neat labelled diagram of chloroplast.

**Structure of chloroplast:** Chloroplasts are green plastids containing green pigment called chlorophyll. Chloroplasts are oval shaped organelles having a diameter of 2-10 micrometer and a thickness of 1-2 micrometer.



**Ultrastructure of chloroplast**

(i) **Envelope:** Chloroplast envelope has outer and inner membranes which is separated by intermembrane space.

(ii) **Stroma:** Matrix present inside to the membrane is called stroma. It contains DNA, 70 S ribosomes and other molecules required for protein synthesis.

(iii) **Thylakoids:** It consists of thylakoid membrane that encloses thylakoid lumen. Thylakoids forms a stack of disc like structures called a grana (singular-granum).

(iv) **Grana:** Some of the thylakoids are arranged in the form of discs stacked one above the other. These stacks are termed as grana, they are interconnected to each other by membranous lamellae called Fret channels.

14. Explain the structure of mitochondria with a neat labelled diagram.

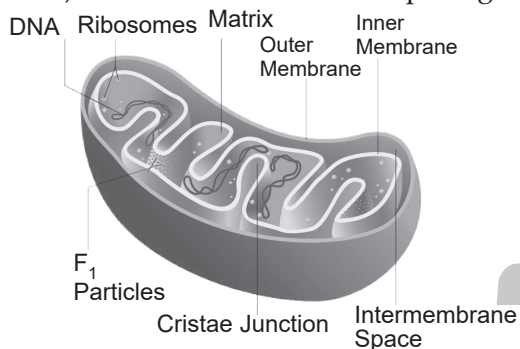
Inner mitochondrial membrane is semi permeable membrane and regulates the passage of materials into and out of the mitochondria. It is rich in enzymes and carrier proteins. It consists of 80% proteins and lipids.

**Cristae:** The inner mitochondrial membrane gives rise to finger like projections called cristae. These cristae increase the inner surface area (fold in inner membrane) of the mitochondria to hold variety of enzymes.

**Oxysomes:** The inner mitochondrial membrane bear minute regularly spaced tennis racket shaped particles known as oxysomes ( $F_1$  particle). They involve in ATP synthesis.

**Mitochondrial matrix:** It is a complex mixture of proteins and lipids. Matrix contains enzymes for Krebs cycle, mitochondrial ribosomes(70 S), tRNAs and mitochondrial DNA.

**Mitochondrial Membranes:** It consists of two membranes called inner and outer membrane. Each membrane is 60-70 Å thick. Outer mitochondrial membrane is smooth and freely permeable to most small molecules. It contains enzymes, proteins and lipids. It has porin molecules (proteins) which form channels for passage of molecules through it.



**Structure of Mitochondria**

15. Describe in detail how ATP and NADPH<sub>2</sub> are formed during photo chemical reaction.

(i) **Light dependent photosynthesis (Hill reaction\Light reaction):** This was discovered by Robin Hill (1939). This reaction takes place in the presence of light energy in thylakoid membranes (grana) of the chloroplasts. Photosynthetic pigments absorb the light energy and convert it into chemical energy ATP and NADPH<sub>2</sub>. These products of light reaction move out from the thylakoid to the stroma of the chloroplast.

(ii) **Light independent reactions (Biosynthetic phase):** The second steps (dark reaction or biosynthetic pathway) is carried out in the stroma. During this reaction CO<sub>2</sub> is reduced into carbohydrates with the help of light generated ATP and NADPH<sub>2</sub>. This is also called as Calvin cycle and is carried out in the absence of light. In Calvin cycle the inputs are CO<sub>2</sub> from the atmosphere and the ATP and NADPH<sub>2</sub> produced from light reaction.

**VIII. Higher Order Thinking Skills(HOTS).**

**Self-Evaluation (Textual Questions)**

1. The reactions of photosynthesis make up a biochemical pathway. A) What are the reactants and products for both light and dark reactions. B) Explain how the biochemical pathway of photosynthesis recycles many of its own reactions and identify the recycled reactants.

A.	Light reaction	Dark reaction
<b>Reactants</b>	Sunlight, H <sub>2</sub> O, NADP <sup>+</sup> , ADP.	ATP, NADPH, CO <sub>2</sub> , RUBP.
<b>Products</b>	O <sub>2</sub> , ATP, NADPH	NADP <sup>+</sup> , ADP, Organic compounds.

B. ADP/ATP, NADP<sup>+</sup>/NADPH and electrons are recycled during photosynthesis. RUBP which reacts with CO<sub>2</sub> in the Calvin cycle is regenerated at each turn of the cycle.

2. **Where do the light dependent reaction and the Calvin cycle occur in the chloroplast?**  
Thylakoid and Stroma.

**Other Important Questions**

3. **Why large number of stomata are present at the lower side of the epidermis in dicot leaf?**

The number of stomata greater on the lower surface of a leaf because it is more often in the shade which means evaporation will not take place as much.

4. **Of what value is the study of plant anatomy?**

To study of internal structure of plants help to classify and understand the differences and similarities of the plants.

5. **How would you know that the source of oxygen in photosynthesis is water and not carbondioxide?**

Plants do not converts the  $\text{CO}_2$  into  $\text{O}_2$ ,  $\text{CO}_2$  converts into sugar molecules. So the source of oxygen is water.

*Didamoni*