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- Public Examination March- 2026, July - 2026 Question Papers are given with answers.

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Preface

Education is not the learning of facts.

It is rather training of the mind to think.

- **Albert Einstein**

Respected Principals, Correspondents, Head Masters / Head Mistresses, Teachers,

From the bottom of our heart, we at SURA Publications sincerely thank you for the support and patronage that you have extended to us for more than a decade.

It is in our sincerest effort we take the pride of releasing **SURA's Science Guide for 10th Standard**. This guide has been authored and edited by qualified teachers having teaching experience for over a decade in their respective subject fields. This Guide has been reviewed by a reputed Professor who is currently serving as Head of the Department in an esteemed College.

With due respect to Teachers, I would like to mention that this guide will serve as a teaching companion to qualified teachers. Also, this guide will be an excellent learning companion to students with exhaustive exercises and in-text questions in addition to precise answers for textual questions.

In complete cognizance of the dedicated role of Teachers, I completely believe that our students will learn the subject effectively with this guide and prove their excellence in Board Examinations.

I once again sincerely thank the Teachers, Parents and Students for supporting and valuing our efforts. God Bless all.

Subash Raj, B.E., M.S.

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Syllabus

MONTH	PHYSICS	CHEMISTRY	BIOLOGY	PRACTICAL	TOTAL UNITS
June	1	7	12, 13	1, 4, 8	4
July	2	8	14, 15	2, 5, 12	4
I MID TERM TEST (8 UNITS)					
August	3	9	16, 17	6, 9, 10, 13	4
September	4	0	18	3	2
QUARTERLY EXAM (14 UNITS)					
October	5	10	19, 20	7, 11, 14	4
November	6	11	21, 22	0	4
II MID TERM TEST (8 UNITS)					
December	0	0	23	0	
HALF YEARLY EXAM (FULL PORTION)					
January	FIRST REVISION TEST				
February	SECOND REVISION TEST				
March	THIRD REVISION TEST				

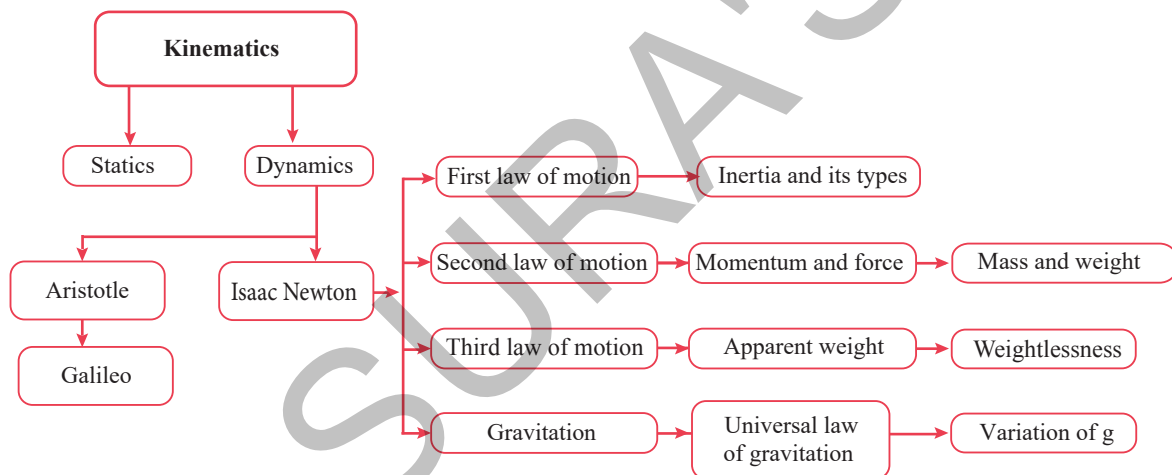
PHYSICS

UNIT

1

LAWS OF MOTION

CONCEPT MAP



MUST KNOW DEFINITIONS

Linear 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.
Like parallel forces	:	Two or more forces of equal or unequal magnitude acting along the same direction parallel to each other.
Unlike parallel forces	:	Two or more equal forces or unequal forces act along opposite directions parallel to each other.
Resultant Force	:	When several forces act simultaneously on the same body, then the combined effect of multiple forces can be represented by a single force, as resultant.
Moment of the couple	:	It is measured by the product of any one of the forces and the perpendicular distance between the line of action of two forces.

Impulse	: When a force F acts on a body for a period of time t , then the product of force and time is known as impulse.
Weight	: Weight is equal to gravitational force. Also weight (W) = mass $\times$ acceleration due to gravity. i.e $W = mg$
Mass	: The quantity of matter contained in the body. Its SI unit is kilogram (kg).
Inertial mass	: If mass is defined in association with force and inertia, it is termed as "inertial mass".
Gravitational mass	: When the mass of a body is defined in association with the gravitational field, it is termed as "gravitational mass".
Apparent weight	: Apparent weight is the weight of the body acquired due to the action of gravity and other external forces on the body.
Weightlessness	: Whenever a body or a person falls freely under the action of Earth's gravitational force alone, it appears to have zero weight.

FORMULAE

1.	Linear Momentum	$p = mv$
2.	Parallel forces are acting in the same direction	$F_{\text{net}} = F_1 + F_2$
3.	Parallel unequal forces are acting in the opposite direction	$F_{\text{net}} = F_1 - F_2$ (if $F_1 > F_2$) $F_{\text{net}} = F_2 - F_1$ (if $F_2 > F_1$)
4.	Parallel equal forces are acting in opposite directions in the same line of action ($F_1 = F_2$)	$F_{\text{net}} = F_1 - F_2$ $F_{\text{net}} = 0$ since ($F_1 = F_2$)
5.	Torque	$\tau = F \times d$
6.	Principle of moments	$F_1 \times d_1 = F_2 \times d_2$
7.	Moment of Couple	$M = F \times S$
8.	Force	$F = m \times a$
9.	Impulse	$J = \Delta P$
10.	Law of conservation of linear momentum	$m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$
11.	Newton's Universal law of gravitation	$F = \frac{Gm_1 m_2}{r^2}$ [$G = 6.674 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$]
12.	Acceleration due to gravity	$g = \frac{GM}{R^2}$
13.	Weight	$W = mg$
14.	Mass of the Earth	$M = \frac{gR^2}{G}$
15.	Acceleration	$a = \frac{v - u}{t}$

TEXTBOOK EVALUATION

I. CHOOSE THE CORRECT ANSWER :

1. Inertia of a body depends on ⊗ [April-'24]
 (a) weight of the object
 (b) acceleration due to gravity of the planet
 (c) mass of the object
 (d) Both a & b [Ans. (c) mass of the object]

2. Impulse is equals to [PTA-1; QY-'24]
 (a) rate of change of momentum
 (b) rate of force and time
 (c) change of momentum
 (d) rate of change of mass
 [Ans. (c) change of momentum]

3. Newton's III 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
 [Ans. (c) both a & b]

4. Plotting a graph for momentum on the Y-axis and time on X-axis. Slope of momentum-time graph gives
 (a) Impulsive force (b) Acceleration
 (c) Force (d) Rate of force
 [Ans. (c) Force]

5. In which of the following sport the turning of effect of force used? ⊗ [QY-2019]
 (a) swimming (b) tennis
 (c) cycling (d) hockey [Ans. (c) cycling]

6. The unit of 'g' is ms^{-2} . It can be also expressed as [QY-'23; HY-'24]
 (a) cms^{-1} (b) Nkg^{-1}
 (c) $\text{Nm}^2\text{kg}^{-1}$ (d) cm^2s^{-2} [Ans. (b) Nkg^{-1}]

7. One kilogram force equals to ⊗ [April-'25]
 (a) 9.8 dyne (b) $9.8 \times 10^4 \text{ N}$
 (c) $98 \times 10^4 \text{ dyne}$ (d) 980 dyne
 [Ans. (c) $98 \times 10^4 \text{ dyne}$]

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) 4 M (b) 2 M
 (c) M/4 (d) M [Ans. (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 [HY-'23; Mar.-'26]
 (a) decrease by 50% (b) increase by 50%
 (c) decrease by 25% (d) increase by 300%
 [Ans. (d) increase by 300%]

10. To project the rockets which of the following principle(s) is /(are) required? [GMQP-2019; Sep-2021; FRT & Aug.-'22; July-'24 & '25]
 (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 [Ans. (d) both a and c]

II. FILL IN THE BLANKS :

1. To produce a displacement _____ is required. [FRT-'22] [Ans. force/unbalanced force]
 2. Passengers lean forward when sudden brake is applied in a moving vehicle. This can be explained by _____. [Ans. inertia of motion]
 3. By convention, the clockwise moments are taken as _____ and the anticlockwise moments are taken as _____. [Ans. negative, positive]
 4. _____ is used to change the speed of car. [Ans. Gear or Torque]
 5. A man of mass 100 kg has a weight of _____ at the surface of the Earth. ⊗ [Ans. 980 N]

III. STATE WHETHER THE FOLLOWING STATEMENTS ARE TRUE OR FALSE CORRECT THE STATEMENT IF IT IS FALSE:

1. The linear momentum of a system of particles is always conserved.

Ans. False.

Correct Statement : In the absence of external force, the linear momentum of a system of particles is always conserved.

2. Apparent weight of a person is always equal to his actual weight.

Ans. False.

Correct Statement : Apparent weight of a person is not equal to his actual weight.

3. Weight of a body is greater at the equator and less at the polar region. ⊗

Ans. False.

Correct Statement : Weight of the body is **less** at equator, **more** at polar region.

4. Turning a nut with a spanner having a short handle is so easy than one with a long handle.

Ans. False.

Correct Statement : Turning a nut with a spanner having a **long handle** is so easy than one with a **short handle**.

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

Ans. False.

Correct Statement : When space station and astronauts have equal acceleration, they are under free fall condition, so both astronaut and space station are in the state of weightlessness.

IV. MATCH THE FOLLOWING : [PTA-1]

	Column I		Column II
(a)	Newton's I law	-	propulsion of a rocket
(b)	Newton's II law	-	Stable equilibrium of a body
(c)	Newton's III law	-	Law of force
(d)	Law of conservation of linear momentum	-	Flying nature of bird

Ans.

	Column I		Column II
(a)	Newton's I law	-	Stable equilibrium of a body
(b)	Newton's II law	-	Law of force
(c)	Newton's III law	-	Flying nature of bird
(d)	Law of conservation of linear momentum	-	propulsion of a rocket

V. ASSERTION AND REASONING :

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.

[Ans. (b) If both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.]

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. ⊗ [Ans. (c) Assertion is true, but the reason is false]

Hint: 'g' depends on the geometric radius of the Earth.

VI. ANSWER BRIEFLY :

1. Define inertia. Give its classification.

[Aug.-'22; April-'23; July-'26]

Ans. 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**'.

Classification:

- (i) Inertia of rest (ii) Inertia of motion
(iii) Inertia of direction

2. Classify the types of force based on their application. ⊗ [FRT & Aug.-'22]

Ans. (i) **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.

(ii) **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.

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.

Ans.

$$F_1 = 5 \text{ N}$$

$$F_2 = 15 \text{ N}$$

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

$$= 15 - 5 = 10$$

$$\text{Resultant force} = 10 \text{ N}$$

Resultant force of 10 N is acting in the direction of **F₂**, (i.e.) greater force.

4. Differentiate mass and weight. (⊗) [May-'22]

Ans. [QY-'24]

No	Mass	Weight
(i)	It is the quantity of matter contained in the body.	It is the gravitational force exerted on a body due to the gravity.
(ii)	It is a scalar quantity .	It is a vector quantity .
(iii)	SI unit is kg (kilogram)	SI unit is N (newton)
(iv)	Mass of a body remains the same at any point on the Earth.	Weight of a body varies from one place to another place on the Earth.
(v)	Measured using a physical balance.	Measured using a spring balance.

5. Define moment of a couple. [July-'24]Ans. (i) Rotating effect of a couple is known as **moment of a couple**.

(ii) It is measured by the product of any one of the forces and the perpendicular distance between the line of action of two forces.

(iii) Moment of a couple = Force × perpendicular distance between the line of action of forces, $M = F \times S$

Eg. Spinning of a top

6. State the principle of moments. [QY-'19 & '23]Ans. (i) 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 moments in clockwise direction is equal to the **algebraic sum of moments** in **anticlockwise direction**.(ii) Moment in clockwise direction = Moment in anticlockwise direction,
 $F_1 \times d_1 = F_2 \times d_2$ **7. State Newton's second law.** (⊗)

[GMQP-2019; May-'22; HY-'24]

Ans. (i) According to **Newton's second law**, "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**".(ii) $F = m \times a$ (**Force = mass × acceleration**)**8. Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?**

Ans. (i) The turning effect of a force depends upon the distance of the line of action of the applied force from the axis of rotation.

Moment of force = $F \times d$

(ii) Larger the perpendicular distance, lesser is the force required to turn the body. So spanner with long handle is preferred.

9. While catching a cricket ball the fielder lowers his hands backwards. Why? [FRT & QY-'24; Mar-'26]Ans. When the fielder pulls back his hands he experiences a **smaller force** for a **longer interval** of time to catch the ball, resulting in a lesser impulse on his hands.

$$\text{Force} = \frac{\text{change in momentum}}{\text{time}}$$

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

[July-'24]

Ans. 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.**VII. SOLVE THE GIVEN PROBLEMS :****1. Two bodies have a mass ratio of 3:4. The force applied on the bigger mass produces an acceleration of 12 ms^{-2} . What could be the acceleration of the other body, if the same force acts on it.****Given**

Mass ratio of two bodies is 3 : 4

So let's assume

Mass of smaller body = $m_1 = 3 \text{ kg}$ Mass of bigger body = $m_2 = 4 \text{ kg}$ Acceleration due to force applied by bigger body
 $= a_2 = 12 \text{ ms}^{-2}$ **To find :** Acceleration due to the same force on the smaller body = $a_1 = ?$ **Solution**

According to Newton's second law of motion.

$$F = m \times a$$

$$F_1 = m_1 a_1$$

$$F_1 = 3a_1$$

$$F_2 = m_2 a_2$$

$$F_2 = 4 \times 12 = 48 \text{ N}$$

As the force is equal

$$F_1 = F_2$$

$$3a_1 = 48$$

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

So acceleration due to the same force on the smaller body $a_1 = 16 \text{ ms}^{-2}$

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

Given

$$\begin{aligned}\text{Mass, } m &= 1 \text{ kg} \\ \text{Initial velocity, } u &= 10 \text{ ms}^{-1} \\ \text{Final velocity, } v &= -10 \text{ ms}^{-1}\end{aligned}$$

To find : Change in linear momentum
 $= m(v - u) = mv - mu$

Solution

$$\begin{aligned}\text{Momentum before collision} &= mu = (1 \times 10) \\ &= 10 \text{ kg ms}^{-1} \\ \text{Momentum after collision} &= mv \\ &= -(1 \times 10) \\ &= -10 \text{ kg ms}^{-1} \\ \text{Change in momentum } (\Delta p) &= mv - mu \\ \Delta p &= -10 - 10 \\ &= -20 \text{ kg ms}^{-1}\end{aligned}$$

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

$$\begin{aligned}\text{Force } F_1 &= 140 \text{ N} \\ \text{Length } L_1 &= 40 \text{ cm} = 40 \times 10^{-2} \text{ m} \\ \text{Force, } F_2 &= 40 \text{ N} \\ \text{Length, } L_2 &= ?\end{aligned}$$

To find : $F_1 \times L_1 = F_2 \times L_2$

Length of the spanner,

$$L_2 = \frac{F_1 \times L_1}{F_2}$$

Solution

$$\begin{aligned}L_2 &= \frac{140 \times 40 \times 10^{-2}}{40} \\ &= 140 \times 10^{-2} \text{ m}\end{aligned}$$

Length, $L_2 = 1.4 \text{ m}$

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

$$\begin{aligned}\text{The ratio of masses of two bodies is } M_1 : M_2 \\ \text{i.e. } 2 : 3\end{aligned}$$

$$\text{Mass of the smaller body, } M_1 = 2 \text{ kg}$$

$$\begin{aligned}\text{Mass of the bigger body } M_2 &= 3 \text{ kg} \\ \text{Radius of the smaller body, } R_1 &= 4 \text{ km} \\ \text{Radius of the bigger body, } R_2 &= 7 \text{ km} \\ \text{i.e. } R_1 : R_2 &= 4 : 7\end{aligned}$$

To find : $g_1 : g_2 = ?$

Solution

We know that

$$\begin{aligned}g &= \frac{GM}{R^2} \\ g_1 &= \frac{GM_1}{R_1^2} ; g_2 = \frac{GM}{R^2} \\ \frac{g_1}{g_2} &= \frac{\frac{GM_1}{R_1^2}}{\frac{GM_2}{R_2^2}} = \frac{M_1}{M_2} \times \frac{R_2^2}{R_1^2} \\ \frac{g_1}{g_2} &= \left(\frac{M_1}{M_2} \right) \left(\frac{R_2}{R_1} \right)^2 = \left(\frac{2}{3} \right) \left(\frac{7}{4} \right)^2 \\ \frac{g_1}{g_2} &= \frac{2}{3} \times \frac{7 \times 7}{4 \times 4} = \frac{49}{24}\end{aligned}$$

The ratio is, $g_1 : g_2 = 49 : 24$

VIII. ANSWER IN DETAIL.

1. What are the types of inertia? Give an example for each type. (OR) Explain the different types of inertia with an example for each type. [PTA-3; Aug. & FRT-'22; April-'24 Mar.-'26]

Ans. Inertia is of three types

- Inertia of rest.
 - Inertia of motion.
 - Inertia of direction.
- (i) **Inertia of rest :** The resistance of a body to **change its state of rest** is called **inertia of rest**.
Eg: When you vigorously shake the branches of a tree some of the leaves and fruit 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**.
Eg : An athlete runs some distance before jumping. Because, this will help him jump longer and higher.

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

Eg : When you make a sharp turn while driving a car, you tend to lean sideways.

2. State Newton's laws of motion.

[Sep-2021; FRT & Aug-'22; QY-'23; July-'26]

Hint: Physical law describes the relationship between a body and the forces.

Ans. (i) Newton's First law of motion: 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**.

(ii) Newton's Second law of motion:

✦ 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 force.

✦ This law helps us to measure the amount of force. So it is called as "law of force".

(iii) Newton's Third law of motion: [QY-'24]

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. [April-'23]

Ans. Newton's Second Law of motion :

"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."

(i) Let " m " be the mass of a moving body, moving along a straight line with an initial speed ' u '.

(ii) After a time interval of ' t ' second, the velocity of the body changes to ' v ' due to the impact of an unbalanced external force F .

(iii) Initial momentum of the body $\rightarrow P_i = mu$

(iv) Final momentum of the body $\rightarrow P_f = mv$

(v) Change in momentum $\rightarrow \Delta p = P_f - P_i$
 $= mv - mu$

By Newton's second law of motion,

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

$F \propto$ change in momentum / time

$F \propto (mv - mu) / t$

$F = k m (v - u) / t$

Here, k is the proportionality constant.

$k = 1$ in all system of units. Hence,

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

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

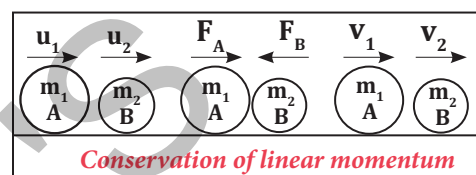
(vi) Hence, we have $F = m \times a$

Force = mass $\times$ acceleration

4. State and prove the law of conservation of linear momentum. [GMQP-2019; FRT & HY-'24]

Ans. Law 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" [April-'25]

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.

Force on body B due to A,

$$F_A = m_2 (v_2 - u_2) / t$$

Force on body A due to B,

$$F_B = m_1 (v_1 - u_1) / t$$

By Newton's III law of motion,

Action force = Reaction force

$$F_B = -F_A$$

$$\frac{m_1 (v_1 - u_1)}{t} = \frac{-m_2 (v_2 - u_2)}{t}$$

$$m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2 \text{ ----- (A)}$$

The above equation confirms **in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to sum of the momentum before collision.**

Hence the law of conservation of linear momentum is proved.

5. Describe rocket propulsion.

[PTA-4; Sep-2020; Aug-'22]

Hint: Rocket propulsion is the process that uses force to move a rocket off the ground into the atmosphere.

- Ans.** (i) Propulsion of rockets is based on **law of conservation of linear momentum** as well as **Newton's III law of motion**.
- (ii) Rockets are filled with a **fuel** (either liquid or solid) in the propellant tank.
- (iii) 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.
- (iv) To balance this momentum, an **equal and opposite reaction force** is produced in the combustion chamber, which makes the rocket project forward.
- (v) 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.
- (vi) The **mass** of the rocket **decreases with altitude**, results in the gradual increase in velocity of the rocket.
- (vii) 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.

[QY-2019; July-'23 & '25]

Ans. Universal law of gravitation:

- ✦ This law 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 **centers of these masses**.
- ✦ The direction of the force acts along the line **joining the masses**.

Derivation :

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

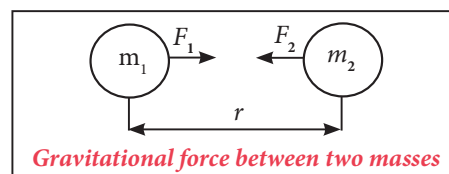
$$\begin{aligned} \text{Force } F &\propto m_1 \times m_2 \\ F &\propto 1/r^2 \end{aligned}$$

On combining the above two expressions,

$$F \propto \frac{m_1 \times m_2}{r^2}$$

$$F = \frac{Gm_1 \times m_2}{r^2} \text{ or } \frac{Gm_1 m_2}{r^2}$$

Where G is 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 of gravitation.**

[July-'24 & '25]

Hint: Newton's law of gravitation is applicable universally. So it is also called as universal law of gravitation.

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

IX. HOT QUESTIONS :

- 1. 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.**

Given

Mass of block 1, $m_1 = 8 \text{ kg}$

Mass of block 2, $m_2 = 2 \text{ kg}$

Total mass, $m = m_1 + m_2$

$$m = 8 + 2 \Rightarrow m = 10 \text{ kg}$$

Force, $F_1 = 15 \text{ N}$

To find : Force exerted on 2 kg, $F_2 = ?$

Solution

Force, $F_1 = \text{mass} \times \text{acceleration}$

$$F_1 = ma$$

$$F_1 = 10 \times a$$

$$a = \frac{F_1}{10} = \frac{15}{10} = 1.5 \text{ ms}^{-2}$$

Force exerted on m_2 (2 kg) is,

$$F_2 = m_2 a = 2 \times 1.5$$

$$F_2 = 3 \text{ N}$$

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 = 2:1)

Given

Kinetic energy of the truck = Kinetic energy of the bike

$$\frac{1}{2} m_t v_t^2 = \frac{1}{2} m_b v_b^2 \quad \dots\dots\dots ①$$

$$\text{Also, } m_t = 4m_b \quad \dots\dots\dots ②$$

Substituting ② in ①

$$\frac{1}{2} (4) m_b v_t^2 = \frac{1}{2} m_b v_b^2$$

$$4v_t^2 = v_b^2$$

$$v_t^2 = \frac{1}{4} v_b^2$$

$$v_t = \frac{1}{2} v_b \quad \dots\dots\dots ③$$

To find : Ratio of the momenta, i.e $m_t v_t : m_b v_b$

$$\frac{p_{\text{truck}}}{p_{\text{bike}}} = \frac{m_t v_t}{m_b v_b} = 4 \times \frac{1}{2} = \frac{2}{1} = 2 : 1$$

3. "Wearing helmet and fastening the seat belt is highly recommended for safe journey" Justify your answer using Newton's laws of motion. [QY-'24]

- Ans. (i)** While you are travelling in a bike or in a car, when a sudden brake is applied, the upper part of your body leans in the forward direction.
- (ii)** Similarly, when the vehicle is suddenly moves forward from rest, you lean backward. This is due to, any body would like to continue to be in its state of rest or the state of motion.

- (iii)** Newton's first law (law of inertia) applies here. So wearing helmet and seat belts while driving a car are highly recommended for a safe journey.

PTA Questions & Answers**1 MARK**

1. F be the force between the two bodies placed at a certain distance. If the distance between them is doubled, then the gravitational force F will be _____. [PTA-5]
 (a) 2F (b) F/2
 (c) F/4 (d) 4F **[Ans. (c) F/4]**
2. The force required to produce an acceleration of 1 cm s^{-2} on a body of mass 1 g is _____. [PTA-6]
 (a) 1 N (b) 10 dyne
 (c) 10^2 dyne (d) 1 dyne **[Ans. (d) 1 dyne]**

2 MARKS

1. Use the analogy to fill the blank [PTA-4]
 a) Opening a door: Moment of force, Opening a water tap: _____
Ans. Moment of a couple.
- b) pushing a bus by a group of people: Like parallel forces, Tug of war _____
Ans. Unlike parallel force.
2. A lift is moving downwards with an acceleration of 1.8 ms^{-2} . What is apparent weight realised by a man of mass 50kg? [PTA-1]

Given

$$\begin{aligned} \text{acceleration} &= 1.8 \text{ ms}^{-2} \\ \text{mass} &= 50 \text{ kg} \\ g &= 9.8 \text{ ms}^{-2} \end{aligned}$$

To find : Apparent weight, R = ?

Solution

$$\begin{aligned} \text{Formula: } R &= m(g - a) \\ R &= 50(9.8 - 1.8) = 50 \times 8 = 400 \\ R &= 400 \text{ N} \end{aligned}$$

3. Understand the assertion statement and the reason given and choose the correct choice. [PTA-2]

Assertion: When a person swims he pushes the water using the hands backwards and the water pushes the person in the forward direction.

Reason: For every action there is an equal and opposite reaction.

- a) Both the assertion and the reason are true and the reason is the correct explanation of the assertion.

- b) 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) Both the assertion and the reason are false.

Ans. a) Both the assertion and the reason are true and the reason is the correct explanation of the assertion.

4 MARKS

1. Why do apples weigh more at poles than at equator? [PTA-3]

- Ans. (i)** Acceleration due to gravity (g) is more at poles ($g = 9.8 \text{ ms}^{-2}$) than at equator ($g = 9.78 \text{ ms}^{-2}$). Further the weight of an object depends on ' g '.
(ii) So, the weight of the apple is more at the pole than at the equatorial region.

2. A force of 5 N applied on a body produces an acceleration 5 cm s^{-2} . Calculate the mass of the body. [PTA-5]

Given

$$\begin{aligned}\text{Force} &= 5 \text{ N} \\ \text{Acceleration} &= 5 \text{ cm s}^{-2} = 0.05 \text{ ms}^{-2}\end{aligned}$$

To find : Mass of the body = ?

Solution

$$\begin{aligned}F &= ma \\ 5 &= m(0.05) \\ m &= \frac{5}{0.05} = 100 \text{ kg}\end{aligned}$$

3. At what height from the centre of the earth surface, the acceleration due to gravity will be $1/4^{\text{th}}$ of its value on the surface of the earth. [PTA-6]

Given

Height from the centre of the Earth,

$$R' = R + h$$

The acceleration due to gravity at that height,

$$g' = g/4$$

Solution

$$\begin{aligned}g &= GM / R^2 \\ g' &= GM / R'^2 \\ \frac{g}{g'} &= \left(\frac{R'}{R}\right)^2 = \left(\frac{R+h}{R}\right)^2 \\ &= \left(1 + \frac{h}{R}\right)^2 \\ 4 &= \left(1 + \frac{h}{R}\right)^2\end{aligned}$$

$$2 = 1 + \frac{h}{R}$$

$$(or) \quad h = R$$

$$R' = 2R$$

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

7 MARKS

- 1. (i) Shock absorbers are used in luxury buses. why?**
(ii) A weight of a man is 686 N on the surface of the earth. Calculate the weight of the same person on moon. ('g' value of a moon is 1.625 ms^{-2})
(iii) Name the law of motion used in flying of birds. Give another example for the same law. [PTA-2]

Ans. (i)

- Luxury buses are fitted with springs and shock absorbers to reduce jerks while moving on uneven roads.
- A large force acting for a short period of time.
- Vehicle receives the sudden movement when it moves on the surfaces and receives impulsive force.
- To minimize this impact, shock absorbers are used in the luxury buses.

(ii) Given

Weight of a mass on earth = 686 N

$$9.8 \text{ N} = 1 \text{ kg in mass}$$

$$\text{Mass } m = W/g = \frac{686}{9.8} = 70 \text{ kg}$$

'g' value of a moon is 1.625 ms^{-2}

Solution

Weight = mass (m) $\times$ acceleration due to gravity (g)

$$m = 70 \text{ kg}$$

$$g = 1.625 \text{ ms}^{-2}$$

$$W = mg$$

$$W = 70 \times 1.625 = 113.75 \text{ N}$$

(iii) Newton's third law of motion.

Another Example: When a person swims, he pushes the water using his hands backwards (action), and the water pushes the swimmer in the forward direction (reaction).

2. A body of mass m is initially moving with a velocity u . When a force F acts on the body it picks up velocity v in t second so that the acceleration is a produced. Using this data derive the relation between the force, mass and acceleration. [PTA-5]

Ans. Initial momentum of the object $= mu$

Final momentum of the object $= mv$

The change in momentum

$$= mv - mu$$

$$= m(v - u) \quad \dots (1)$$

Rate of change of momentum

$$= \frac{\text{Change of momentum}}{\text{time}}$$

$$= \frac{m(v - u)}{t} \quad \dots (2)$$

According to Newton's second law of the motion, this is nothing but applied force.

$\therefore$ The applied force,

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

$$\text{Acceleration, } a = \frac{v - u}{t}$$

The applied force, $F \propto ma$

$$F = kma \quad (k = 1)$$

$$\therefore F = ma$$

Force acting on an object is a product of its mass and acceleration.

GOVERNMENT EXAM QUESTIONS & ANSWERS

1 MARKS

1. Force has : [FRT-'22]
(a) Magnitude only (b) Direction only
(c) Both direction and magnitude
(d) None of the above

[Ans. (c) Both direction and magnitude]

2. Unit of force in SI system is _____. [FRT-'22]
[Ans. Newton]

2 MARKS

1. Calculate the velocity of a moving body of mass 5 kg whose linear momentum is 2 kg ms^{-1} . [GMQP-2019]

Linear momentum = mass $\times$ velocity

$$\text{Velocity} = \frac{\text{linear momentum}}{\text{mass}} = \frac{2}{5} = 0.4 \text{ ms}^{-1}.$$

2. Write short notes on gears. [Sep-2020]

Ans. **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.

4 MARKS

1. Match the following : [FRT-'22]

List - I	List - II
(1) Newton's I law	- Passengers leaning sideways
(2) Newton's II law	- Stable equilibrium of a body
(3) Newton's III law	- Law of force
(4) Inertia of direction	- Flying nature of a bird
	- Falling of an object from upward to Earth

Ans.

List - I	List - II
(1) Newton's I law	- Stable equilibrium of a body
(2) Newton's II law	- Law of force
(3) Newton's III law	- Flying nature of bird
(4) Inertia of direction	- Passengers leaning sideways

2. Give any two examples for moment of a Couple. [QY-'24]

Ans. **Examples for moment of a couple** : Turning a tap, winding or unwinding a screw, spinning of a top

ADDITIONAL QUESTIONS & ANSWERS

CHOOSE THE CORRECT ANSWER

1 MARK

1. Physics that deals with the effect of force on bodies is _____.
(a) Kinematics (b) Dynamics
(c) Statics (d) **Mechanics**
2. _____ deals with the bodies which are at rest under the action of forces.
(a) **Statics** (b) Kinematics
(c) Dynamics (d) Mechanics

3. Study of moving bodies under the action of forces _____.
(a) Statics (b) Kinematics
(c) **Dynamics** (d) Mechanics
4. The act of cleaning a carpet by beating it with a stick is an example for inertia of _____.
(a) motion (b) direction
(c) **rest** (d) momentum
5. A luggage is usually tied with a rope on the roof of the buses due to _____.
(a) **inertia of motion**
(b) inertia of direction
(c) inertia of rest (d) momentum
6. The momentum of a heavy object at rest will be _____.
(a) large (b) infinity
(c) **zero** (d) small
7. Inertia is a _____.
(a) **property of matter**
(b) type of force (c) the speed of an object
(d) none of the above
8. The SI unit of force is _____.
(a) energy (b) joule
(c) **newton** (d) dyne
9. A & B are two objects with masses 100 kg & 75 kg respectively, then _____.
(a) both will have same inertia
(b) B will have more inertia
(c) **A will have more inertia**
(d) both will have less inertia
10. The physical quantity which is the measure of inertia is _____.
(a) density (b) weight
(c) force (d) **mass**
11. The sparks produced during sharpening a knife against a grinding wheel leaves the rim of the wheel tangentially. This is due to _____.
(a) inertia of rest (b) inertia of motion
(c) **inertia of direction**
(d) force applied
12. The law that gives a qualitative definition of force is _____.
(a) **Newton's I law** (b) Newton's II law
(c) Newton's III law (d) Law of gravitation
13. A body is said to be under balanced force when the resultant force applied on that body is _____.
(a) **zero** (b) infinite
(c) one (d) none
14. If equal or unequal forces act along opposite directions parallel to each other, then they are called _____ parallel forces.
(a) resultant (b) equilibrant
(c) like (d) **unlike**
15. The rotating or turning effect of a force is _____.
(a) momentum (b) **torque**
(c) couple (d) none
16. Acceleration of an object will increase as the net force increases depending on its _____.
(a) volume (b) **mass**
(c) shape (d) density
17. The physical quantity which is equal to rate of change of momentum is _____.
(a) displacement (b) acceleration
(c) **force** (d) impulse
18. An ice skater pushes harder with his leg muscles, he begins to move faster. This is an example of _____.
(a) Newton's I law (b) **Newton's II law**
(c) Newton's III law
(d) Law of conservation
19. You're riding a bike when suddenly you hit a large rock. The bike stops moving but you fly over the handle - bars. This is an example of _____.
(a) **Newton's I law** (b) Newton's II law
(c) Newton's III law (d) Law of conservation
20. When you paddle a canoe, the canoe goes forward. This is an example of _____.
(a) Newton's I law (b) Newton's II law
(c) **Newton's III law** (d) Law of conservation
21. The acceleration in a body is due to _____.
(a) balanced force (b) **unbalanced force**
(c) equilibrant (d) couple
22. When an object undergoes acceleration, _____.
(a) its speed always increase
(b) **a force always acts on it**
(c) its velocity always increases
(d) velocity always decreases

23. A force of 20 N is acting on an object of mass 10 kg. The acceleration produced is _____.
(a) 1 ms^{-2} (b) **2 ms^{-2}**
(c) 20 ms^{-2} (d) 10 ms^{-2}
24. The physical quantity which is equal to change in momentum is _____.
(a) velocity (b) acceleration
(c) force (d) **impulse**
25. An example for a vector quantity is _____.
(a) speed (b) distance
(c) **momentum** (d) length
26. Impulse is equal to _____.
(a) ma (b) **Ft**
(c) mv (d) $\frac{v-u}{t}$
27. SI unit of impulse is _____.
(a) **Ns** (b) Ns^2
(c) kg ms^{-2} (d) $\text{kg m}^2\text{s}^{-2}$
28. Which of the following statements is not correct for an object moving along a straight path in an accelerated motion?
(a) its speed keeps changing
(b) its velocity always changes
(c) **it always goes away from the Earth**
(d) A force is always acting on it
29. When a ball is thrown up, the value of g will be _____.
(a) zero (b) +ve
(c) **-ve** (d) negligible
30. According to the Newton's III law of motion, action & reaction _____.
(a) always act on the same body
(b) have same magnitude & direction
(c) **always act in opposite directions**
(d) act on either body at normal to each other
31. A water tanker filled up to $\frac{2}{3}$ of its height is moving with a uniform speed, on sudden application of the brake, the water in the tank would _____.
(a) move backward (b) be unaffected
(c) rise upwards (d) **move forward**
32. The distance between two bodies becomes 6 times more than the usual distance, then force becomes _____.
(a) 36 times (b) 6 times
(c) 12 times (d) **$\frac{1}{36}$ times**
33. Newton's law of gravitation applies to
(a) small bodies only
(b) plants only
(c) **all bodies irrespective of their size**
(d) for solar system
34. A thief stole a box with valuable article of weight 'w' and jumped down a wall of height 'h'. Before he reached the ground he had experienced a load of
(a) $\frac{w}{2}$ (b) **zero**
(c) w (d) $2w$
35. Action of a lever is an example of ____ force.
(a) balanced (b) **unbalanced**
(c) parallel force (d) like parallel force
36. If the radius of the Earth were to shrink by one percent its mass remaining the same, the acceleration due to gravity on the Earth's surface would _____.
(a) decrease (b) remains unchanged
(c) **increase** (d) none of these
37. The force of gravitation between two bodies in the universe does not depend on _____.
(a) the distance between them
(b) the product of their masses
(c) **the sum of their masses**
(d) the gravitational constant
38. _____ stated that the natural state of all earthly bodies is at rest.
(a) **Aristotle** (b) Galileo
(c) Newton (d) Pluto
39. _____ deals with the bodies which are at rest under the action of forces.
(a) Kinetics (b) Kinematics
(c) Dynamics (d) **None of the above**
40. At the surface of Earth an object falling freely experiences an acceleration of _____.
(a) 9.4 ms^{-2} (b) 9.1 ms^{-1}
(c) **9.8 ms^{-2}** (d) 9.6 ms^{-2}
41. The magnitude of the weight is expressed in the units of
(a) displacement (b) mass (kg)
(c) **force (Newton)** (d) none

42. A lift of mass 1000 kg which is moving with an acceleration of 1 ms^{-2} in upward direction, then the tension developed in string which is connected to lift is _____.

- (a) 10,000 N (b) **10,800 N**
(c) 9800 N (d) 11000 N

Hint: $R > W$; $F = R - W \therefore R = mg + ma$

$$R = m(g + a) = 1000 (9.8 + 1) = 10,800 \text{ N}$$

43. The value of acceleration due to gravity on surface of the moon is _____ m s^{-2} .

- (a) 9.8 (b) 16.25
(c) 9.812 (d) **1.625**

44. Newton's law of _____ helps in discovering new stars and planets.

- (a) inertia (b) **gravitation**
(c) motion (d) linear momentum

45. The weight of an object in a satellite orbiting around the Earth is _____.

- (a) **zero** (b) actual weight
(c) less than the actual weight
(d) greater than the actual weight

46. The motion of falling bodies towards Earth is due to _____.

- (a) gravitational rotation
(b) weightless mass
(c) acceleration due to gravity
(d) **gravitational force**

47. Which quantity is zero at the centre of the Earth?

- (a) mass (b) **weight**
(c) both mass & weight
(d) none

48. What would happen, if the force of gravity disappears suddenly on Earth?

- (a) **All objects would move in a straight line along their existing direction of motion.**
(b) All object will float
(c) not possible
(d) cannot say

49. The acceleration due to gravity varies on Earth with

- (a) altitude (b) depth
(c) latitude (d) **all the above**

50. The CGS unit of force is _____.

- (a) Newton (b) Nm
(c) **dyne** (d) kg f

51. The apparent weight of a person moving upward in a lift is given by _____.

- (a) $R = W$ (b) $R = 0$
(c) **$R > W$** (d) $R < W$

52. If lift is accelerated in the upward direction, then the apparent weight of a body is ____.

- (a) **more than true weight**
(b) equal to the true weight
(c) less than true weight
(d) not equal to the true weight

53. The gravitational force between two objects becomes _____ when the masses of both objects are halved without altering the distance between them.

- (a) $\frac{f}{4}$ (b) $\frac{f}{2}$
(c) f (d) $2f$

FILL IN THE BLANKS

1. _____ deals with the motion of bodies without considering the cause of motion.

[Ans. Kinematics]

2. Kinetics deals with the motion of bodies considering the ____.

[Ans. cause of motion]

3. According to Aristotle, a moving body naturally comes to rest without any external force is termed as _____.

[Ans. natural motion]

4. If the body behaves contrary to their own natural state is called _____.

[Ans. violent motion]

5. According to Aristotle, when two bodies of different mass are dropped, the _____ falls faster.

[Ans. heavier]

6. Bodies of different size, shape and mass fall from a height in _____ reach the ground at the same time.

[Ans. vacuum]

7. A body does not change its state during the period of time, then it is said to be at _____.

[Ans. rest]

8. A body changes its state, then it is said to be in _____. **[Ans. motion]**
9. A sharp turn while driving a car, tend to lean sideways is due to _____. **[Ans. inertia of direction]**
10. Momentum is a _____ quantity. **[Ans. vector]**
11. An athlete can take a longer jump if he comes running from a distance compared to that when he jumps suddenly. This type of inertia is _____. **[Ans. inertia of motion]**
12. When a force of 1 N acts on a mass of 1 kg that is forced to move, the object moves with _____. **[Ans. an acceleration of 1 ms^{-2}]**
13. The acceleration in a body is due to _____. **[Ans. unbalanced force]**
14. When an object undergoes acceleration _____. **[Ans. a force always acts on it]**
15. Non - contact force is also known as _____ force. **[Ans. field]**
16. In balanced force, the resultant force is equal to _____. **[Ans. zero]**
17. The force which is equal to resultant but opposite in direction is called as _____. **[Ans. equilibrant]**
18. Torque is a _____ quantity. **[Ans. vector]**
19. Unit of torque is _____. **[Ans. Nm]**
20. Two equal and unlike parallel force is called _____. **[Ans. couple]**
21. If the object is rotated in clockwise direction, couple is _____. **[Ans. negative]**
22. The moment of a couple is the product of _____ and perpendicular distance between the forces. **[Ans. force]**
23. Steering wheel is based on the application of _____. **[Ans. torque]**
24. _____ helps to change the speed of the rotation. **[Ans. Gears]**
25. The algebraic sum of the moments in the clockwise direction is _____ to the algebraic sum moments in the anticlockwise. **[Ans. equal]**
26. The momentum of massive object at rest is _____. **[Ans. zero]**
27. The force of gravitation is inversely related to _____. **[Ans. square of distance between masses]**
28. When a person falls freely under the action of gravity has _____. **[Ans. zero weight]**
29. The apparent weight of an object _____ in an elevator while accelerating upward. **[Ans. increases]**
30. Everything in freely falling system, appears to be _____. **[Ans. weightless]**
31. When velocity of lift changes, apparent weight _____ from true weight. **[Ans. differs]**
32. Mass is the measure of _____. **[Ans. matter]**
33. Weight is the measure of force of _____ on an object. **[Ans. gravity]**
34. The unit of weight is _____. **[Ans. newton]**
35. The unit of mass is _____. **[Ans. kilogram]**
36. Mass which is associated with force and inertia is _____. **[Ans. inertial mass]**
37. The weight of a 1 kg mass object on Earth is _____. **[Ans. 9.8 N]**
38. Mass is associated with gravitational force is _____. **[Ans. gravitational mass]**
39. Astronauts are not floating but falling freely due to huge _____. **[Ans. orbital velocity]**
40. _____ force keeps the satellite in its orbit. **[Ans. Centripetal]**
41. To study the dimensions of heavenly bodies _____ law is used. **[Ans. gravitational]**
42. Mechanics is divided into _____ and _____. **[Ans. statics, dynamics]**
43. _____ is divided into kinematics and kinetics. **[Ans. Dynamics]**
44. _____ is also called as force independent. **[Ans. Natural motion]**
45. _____ is also called as force dependent. **[Ans. Violent motion]**
46. _____ measures the impact of force on a body. **[Ans. Linear momentum]**
47. Linear momentum acts in the direction of _____. **[Ans. velocity]**
48. Linear momentum measures the _____ on a body. **[Ans. impact of force]**
49. The unit of momentum in SI system is _____. **[Ans. kg m s^{-1}]**
50. The unit of momentum in C.G.S system is _____. **[Ans. g cm s^{-1}]**
51. _____ gives the definition of force as well as inertia. **[Ans. Newton's First Law]**
52. Force is an external effort in the form of _____ or _____. **[Ans. push, pull]**
53. _____ has both magnitude and direction. **[Ans. Force]**
54. _____ force is equal to the vector sum of all the forces. **[Ans. Resultant]**

55. Forces with resultant force _____ are called balanced forces. [Ans. equal to zero]
56. Forces with resultant force _____ are called unbalanced forces. [Ans. not equal to zero]
57. If the resultant force acting on a body is zero, then the body will be in _____. [Ans. equilibrium]
58. Two equal and unlike parallel forces applied simultaneously at two points constitute a _____. [Ans. couple]
59. Rotating effect of a couple is known as _____. [Ans. moment of a couple]
60. Turning a tap is an example of a _____. [Ans. couple]
61. The SI unit of moment of a couple is _____. [Ans. N m]
62. The C.G.S unit of couple is _____. [Ans. dyne cm]
63. The direction of moment of force or couple is taken as positive if the body is rotated in the _____ direction. [Ans. anti-clockwise]
64. The direction of moment of force or couple is taken as _____ if the body is rotated in the clockwise direction. [Ans. negative]
65. At equilibrium, the algebraic sum of the moments of all individual forces about any point is equal to _____. [Ans. zero]
66. Newton's second Law helps us to measure the _____. [Ans. amount of force]
67. The acceleration produced along the _____ is called centripetal acceleration. [Ans. radius]
68. The unit of force in C.G.S system is _____. [Ans. dyne]
69. A large force acting for a very short interval of time is called _____. [Ans. impulsive force]
70. Impulse is equal to magnitude of change in _____. [Ans. momentum]
71. A cricketer pulls his hands back while catching a ball to lower the _____ on his hands. [Ans. impulse]
72. The gravitational unit of force in SI system is _____. [Ans. kg f]
73. $1 \text{ g f} = \text{_____ dyne}$. [Ans. 980]
74. The _____ of a body does not change as long as no external force acts on it. [Ans. linear momentum]
75. Impulse is represented by _____. [Ans. J]
76. _____ is based on the law of conservation of linear momentum. [Ans. Propulsion of rockets]
77. The mass of a rocket decreases with _____. [Ans. altitude]
78. As the mass of a rocket decreases with altitude, its _____ increases. [Ans. velocity]
79. The velocity at which a rocket is able to escape from the _____ of the Earth is called escape velocity. [Ans. gravitational pull]
80. Force between the _____ is always attractive. [Ans. masses]
81. _____ does not depend on the medium in which it is placed. [Ans. Gravitational force]
82. The acceleration of a falling object is due to the Earth's _____ force. [Ans. gravitational]
83. The reaction force R exerted by lift's surface is known as _____. [Ans. apparent weight]
84. _____ 'R' of the person that arise, depending on the motion of the lift. [Ans. Apparent weight]
85. When lift is at rest, the apparent weight is _____ to actual weight. [Ans. equal]
86. The condition for lift falling down freely is _____. [Ans. apparent weight is zero]
87. The effect takes place while falling freely in roller coaster is _____. [Ans. weightlessness]
88. _____ law helps in discovering new stars and planets. [Ans. Newton's law of gravitation]
89. The mean value for acceleration due to gravity is taken as _____ ms^{-2} . [Ans. 9.8]
90. The acceleration due to gravity of the Earth is represented as _____. [Ans. g]
91. The SI unit of acceleration due to gravity is _____. [Ans. m s^{-2}]
92. The velocity of a falling body varies by _____ m s^{-1} for every 1 second. [Ans. 9.8]
93. Mass of the Earth is _____ kg. [Ans. 5.972×10^{24}]
94. Geometric radius of the Earth is _____ in the equatorial region. [Ans. maximum]
95. Geometric radius of the Earth is _____ in the polar region. [Ans. minimum]
96. The value of 'g' is maximum in the _____ region. [Ans. polar]
97. The value of 'g' is minimum in the _____ region. [Ans. equatorial]
98. The value of 'g' decreases with _____. [Ans. altitude]
99. The value of 'g' is zero at the _____. [Ans. centre of the Earth]

100. The motion of a body where the acceleration is equal to the acceleration due to gravity is called _____. [Ans. free fall]
101. _____ are said to be in a state of weightlessness. [Ans. Space stations]
102. Gears in vehicles, see saw and steering wheel are the application of _____. [Ans. torque]
103. _____ law is also called as law of force. [Ans. Newton's Second Law]
104. In circular motion, the acceleration produced along the radius is called as _____. [Ans. centripetal acceleration]
105. Impulse is also equal to the _____ of change in momentum. [Ans. magnitude]
106. Dimensions of _____ can be measured using gravitation law. [Ans. heavenly bodies]
107. One of the _____ in the motion of stars is called Wobble. [Ans. irregularities]
108. The product of _____ and _____ is called impulse. [Ans. force, time]
109. _____ is the weight of the body acquired due to the action of gravity and other external forces. [Ans. Apparent weight]
110. Aristotle stated that, the _____ of all Earthly bodies is at rest. [Ans. natural state]
111. According to Aristotle, when two different bodies of different mass are dropped from a height, the heavier body falls _____ than the lighter one. [Ans. faster]
112. At natural state, all earthly bodies are in a state of rest or in _____. [Ans. uniform motion]
113. When dropped from a height in vacuum, bodies of different size, shape and mass reach the ground at the _____. [Ans. same time]
114. A Tug of war is an example of a _____. [Ans. unlike parallel force]
115. When a body is in _____, it experiences balanced force. [Ans. equilibrium]
116. When the resultant force of a body is _____, then the body experiences unbalanced force. [Ans. not equal to zero]
117. Drawing water from a well is an example of _____. [Ans. unbalanced force]
118. The turning effect of applied force is _____ when the distance between the fixed edge and the point of application is more. [Ans. more]
119. The axis of a fixed edge about which the door is rotated is called _____. [Ans. axis of rotation]
120. When the net force acting on a body is not equal to zero then its _____ changes. [Ans. velocity]
121. The force which produces centripetal acceleration is called _____. [Ans. centripetal force]
122. The amount of force required to produce an acceleration of 1 m s^{-2} in a body of mass 1 kg called _____. [Ans. unit force]
123. Flying motion of birds in the air is an example of Newton's _____ Law of motion. [Ans. third]
124. The apparent weight of a person moving upward in a lift will be _____. [Ans. greater]
125. The apparent weight of a person moving in a lift will be equal to the actual weight, when the lift is at _____. [Ans. rest]
126. A body needs a _____ to move, or bring to rest or change its velocity. [Ans. push or pull]
127. In vacuum, two objects with a mass 1 kg and 2 kg are dropped from same height and they reach the ground at _____. [Ans. same time]
128. _____ stops or tries to stop a moving body. [Ans. Force]
129. Like parallel forces are acting in the _____. [Ans. same direction]
130. _____ forces act along opposite directions. [Ans. Unlike parallel]
131. If the resultant force is not equal to zero, then it causes the motion of the body due to _____. [Ans. unbalanced force]
132. Force on a weight balance is an example for _____. [Ans. balanced force]
133. Turning a tap, winding or unwinding a screw spinning of a top are example for _____. [Ans. couple]
134. _____ law always act on two different bodies only. [Ans. Newton's Third]
135. The algebraic sum of momentum after collision is numerically equal to algebraic sum of momentum before the collision in the absence of _____. [Ans. external force]
136. Every particle of matter in this universe _____ every other particle with a force. [Ans. attracts]
137. The value of 'g' _____ at all points on the surface of Earth. [Ans. not same]

138. The radius of Earth is _____. [Ans. 6378 km]

139. The mass of Earth is _____. [Ans. 5.972×10^{24} kg]

STATE WHETHER THE FOLLOWING STATEMENTS ARE TRUE OR FALSE.

CORRECT THE STATEMENT IF IT IS FALSE

- 1.** In the recoiling of a gun on firing, both the linear momentum and kinetic energy are conserved.

Ans. False.

Correct Statement : Only linear momentum is conserved. The total kinetic energy of the system is not conserved (it increases).

- 2.** The same change in linear momentum can be produced only by applying larger force for a longer period of time

Ans. False. **Correct Statement :** Change in linear momentum can be produced by applying larger force for a shorter time.

- 3.** In free fall under gravity, a body appears to be weightless.

Ans. True.

- 4.** The relation between absolute units of force on MKS and C.G.S system is $1 \text{ N} = 10^5 \text{ dyne}$.

Ans. True.

- 5.** Newton's first law defines force and inertia.

Ans. True.

- 6.** The unit of force and impulse is same.

Ans. False. **Correct Statement :** The unit of force is newton and the unit of impulse is Ns .

- 7.** Galileo suggested, that an external force is required to keep a body in uniform motion.

Ans. False.

Correct Statement : Aristotle suggested that an external force is required to keep a body in uniform motion.

- 8.** Forces of action and reaction never cancel each other as they are acting at different bodies.

Ans. True.

- 9.** Two bodies of different masses are allowed to fall freely from the same height, then both the bodies reach the Earth together.

Ans. True.

- 10.** A person's apparent weight inside the lift increases when lift is accelerated upward.

Ans. True.

- 11.** Newton's law of gravitation helps in discovering new stars and planets.

Ans. True.

- 12.** The value of 'g' is maximum at the equatorial region and minimum in the polar region.

Ans. False.

Correct Statement : The value of 'g' is **minimum at the equatorial** region and **maximum in the polar** region.

- 13.** Acceleration due to gravity can also be expressed

$$\text{as } g = \frac{GM}{R^2}.$$

Ans. True.

- 14.** $1 \text{ kg f} = 980 \text{ dyne}$

Ans. False.

Correct Statement : $1 \text{ kg f} = 9.8 \text{ N}$

- 15.** The velocity which is sufficient to just escape from the gravitational pull of the Earth is called variable velocity.

Ans. False.

Correct Statement : The velocity which is sufficient to just escape from the gravitational pull of the Earth is called **escape velocity**.

- 16.** The geometric radius of the Earth is maximum in the equatorial region and minimum in the polar region.

Ans. True

- 17.** The value of acceleration due to gravity on the surface of the moon is 3.625 ms^{-2} .

Ans. False.

Correct Statement: The value of acceleration due to gravity on the surface of the moon is **1.625 ms^{-2}** .

- 18.** Astronauts are not floating but falling freely around the Earth due to their huge centripetal acceleration.

Ans. False. **Correct Statement :** Astronauts are not floating but falling freely around the Earth due to their huge **orbital velocity**.

MATCH THE FOLLOWING**I.**

(a)	Principle of moments	-	(1)	Rotating force
(b)	Torque	-	(2)	$GM \frac{m}{R^2}$
(c)	Gravitational force	-	(3)	$F_B = -F_A$
(d)	Newton's III law	-	(4)	Sum of clockwise moments = sum of anticlockwise moments

[Ans. a-4, b-1, c-2, d-3]

II.

(a)	Statics	-	(1)	Force acting on moving bodies
(b)	Dynamics	-	(2)	Cause of motion
(c)	Kinematics	-	(3)	Not considering the cause of motion
(d)	Kinetics	-	(4)	Force acting on rest bodies

[Ans. a-4, b-1, c-3, d-2]

III.

(a)	Natural motion	-	(1)	Force independent
(b)	Violent motion	-	(2)	Push or Pull
(c)	Inertia	-	(3)	Dependent
(d)	Force	-	(4)	Inability to change its state

IV.

(a)	Moment of force	-	(1)	1 gram force
(b)	Two equal & unlike force	-	(2)	Torque
(c)	Principle of moments	-	(3)	Couple
(d)	980 dyne	-	(4)	$F_1 \times d_1 = F_2 \times d_2$

[Ans. a-2, b-3, c-4, d-1]

V.

(a)	Push or pull	-	(1)	Dynamics
(b)	Bodies at rest	-	(2)	Torque
(c)	Moving bodies	-	(3)	Statics
(d)	Steering wheel	-	(4)	force

[Ans. a-4, b-3, c-1, d-2]

VI.

	Quantity		Unit
(a)	Acceleration due to gravity	-	(1) $Nm^2 kg^{-2}$
(b)	Inertial mass	-	(2) N
(c)	Universal gravitational constant	-	(3) ms^{-2}
(d)	Weight	-	(4) kg

[Ans. a-3, b-4, c-1, d-2]

VII.

(a)	Impulse	-	(1) $5.972 \times 10^{24} kg$
(b)	Mass of Earth	-	(2) Nm
(c)	Linear momentum	-	(3) Ns
(d)	Torque	-	(4) $p=mv$

[Ans. a-3, b-1, c-4, d-2]

VIII.

	Column I		Column II
(a)	Galileo	-	(1) Cause of motion
(b)	Newton	-	(2) Mass energy relation
(c)	Aristotle	-	(3) Natural rest of moving body
(d)	Einstein	-	(4) Acceleration due to gravity is same for all objects.

[Ans. a-4, b-1, c-3, d-2]

IX.

(a)	Rocket propulsion	-	(1) Stars
(b)	Astronauts	-	(2) linear momentum
(c)	Wobble	-	(3) Weightlessness
(d)	Tug of war	-	(4) unbalanced force
(e)	Action of a lever	-	(5) unlike parallel force

[Ans. a-2, b-3, c-1, d-5, e-4]

ASSERTION AND REASON

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

1. **Assertion:** A rocket moves forward by pushing the surrounding air backwards.
Reason: It drives the necessary thrust to move forward, according to Newton's third law.
[Ans. (d) Assertion is false but reason is true]
2. **Assertion:** No force is required to move a body uniformly along a straight line.
Reason: Because $F = ma = m(0) = 0$.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
3. **Assertion:** A force of 1 kg force produces an acceleration of 1 m/s^2 in a body of mass 1 kg.
Reason: $a = F/m$
[Ans. (d) Assertion is false but reason is true]
4. **Assertion:** The net force acting on a body is zero.
Reason: The body is moving uniformly along a straight line.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
5. **Assertion:** Action and reaction forces balance each other.
Reason: Both forces act always on two different bodies.
[Ans. (d) Assertion is false but reason is true.]
6. **Assertion:** If Earth suddenly stops rotating, the value 'g' would increase at places away from the poles.
Reason: 'g' depends on the distance between two objects.
[Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion]
7. **Assertion:** If a pendulum is suspended in a lift and lift is falling freely, then its time period becomes infinite.
Reason: Free falling body has acceleration equal to acceleration due to gravity.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
Hint: $a = g$; $T = 2\pi \sqrt{\frac{l}{g-a}}$ $T = \infty$
8. **Assertion:** The ratio of inertial mass to gravitational mass is equal to one.
Reason: The inertial mass & gravitational mass of a body are equivalent.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
Hint: Both are scalar & measured in same unit.
9. **Assertion:** Like forces equal in magnitude simultaneously act on a body leads translatory or rotatory motion.
Reason: Act in the same direction of action of force leads translatory ; acting tangent to the body leads rotatory.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
10. **Assertion:** The impact of a force is more if the velocity and mass of the body is more.
Reason: The linear momentum measures the impact of a force on a body.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
11. **Assertion:** Propulsion of rocket is based on escape velocity.
Reason: Velocity which is sufficient to escape from Earth's gravitational pull is called escape velocity.
Hint: Propulsion of rockets is based on the law of conservation of linear momentum.
[Ans. (d) Assertion is false, but reason is true]
12. **Assertion:** Gravitational force exerted on a body is weight.
Reason: Acceleration due to gravity for Earth is 9.8 ms^{-2} .
[Ans. (b) Both assertion and reason are true, but reason is not the correct explanation of assertion]
13. **Assertion:** Astronauts are not floating but falling freely around the Earth due to their huge orbital velocity.
Reason: Astronauts and space-station have equal acceleration, they are under free fall condition.
[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]

USE THE ANALOGY TO FILL IN THE BLANK

1. Unit of linear force : N :: Unit of torque : ____
Ans. Nm
2. Unit of force in CGS is 1 dyne = 1 g cm s⁻² ::
 Unit of force in SI is 1 N = ____
Ans. 10⁵ dyne
3. Inertia : Moment of inertia :: _____ :
 Moment of force
Ans. Force
4. Natural motion : Force independent ::
 Violent motion : _____
Ans. Force dependent

5. Opening a pen cap : _____ :: Opening the door : moment of force

Ans. Moment of couple

6. Clockwise moment : negative, :: Anti - clockwise moment : _____

Ans. Positive

7. $R = m(g - a)$: $R < W$:: _____ : $R = W$

Ans. $R = mg$

8. Statics : rest :: Dynamics : _____

Ans. motion

9. Law of inertia : Newton's 1 law :: Law of force : _____

Ans. Newton's II law

10. Upward motion : $R > W$:: Downward motion : _____

Ans. $R < W$

VERY SHORT ANSWERS

2 MARKS

1. Bodies of larger mass need greater effort to put them in motion. Why?

Ans. According to Newton's II law, $F = ma$.

For given acceleration a , if m is large, F should be more i.e., greater force.

2. A constant force F acts on a truck over a distance s and for a time t . What is the momentum gained by the truck?

Ans. Momentum gained by the truck = Force $\times$ time.
i.e., impulse = $F \times t$.

3. A force of 1 N acts on a body of mass 1 g. Calculate the acceleration produced in the body.

Given : $F = 1 \text{ N}$; $m = 1 \text{ g} = 10^{-3} \text{ kg}$.

Ans. $F = ma \Rightarrow a = \frac{F}{m} = \frac{1}{10^{-3}} = 10^3 \text{ ms}^{-2}$.

4. If a force is acting on a moving body perpendicular to the direction of motion, then what will be its effect on the speed of the body?

Ans. There is no change in speed. E.g. Forces acting on a body in circular motion.

5. If the net force acting on a body be zero, then will the body remain necessarily in rest position?

Ans. No, the body may be in uniform motion along a straight line.

6. A lift is accelerated upward. What is apparent weight of a person inside the lift?

Ans. The apparent weight will increase.

7. When will be the force exerted by the floor of an elevator on the foot of a person standing there be more than the weight of the person?

Ans. If the elevator is

(i) going down and slowing down and

(ii) going up and speeding up.

8. Action and reaction forces do not balance each other. Why?

Ans. This is because forces of action & reaction act always on the different bodies.

9. When a ball of 0.5 kg mass moving with a speed of 20 ms^{-1} rebounds after striking normally a perfectly elastic wall. Find the change in momentum.

Ans. Change in linear momentum = $m(v - u)$

$$\Delta P = 0.5(-20 - 20)$$

$$= -20 \text{ kg m s}^{-1}$$

magnitude 20 kg m s^{-1}

10. Thief jumps from roof of a house with a box of weight W on his head. What will be the weight of the box as experienced by the thief during jump?

Ans. Weight of the box during jump $W = m(g - a)$.
 $= m(g - g) = 0$.

11. Why does a gun recoil when a bullet is fired?

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

12. A brinjal vendor sells his brinjal using a beam balance in an elevator. Will he gain more if the elevator is accelerating up?

Ans. No. A beam balance compares two masses; both pans experience the same apparent-weight change, so the reading is unaltered.

13. Which law is used in geotropism?

Ans. Newton's law of gravitation.

14. A boy puts a heavy box of mass M on his head and jumps down from the top of a multi-storeyed building to the ground. How much is the force exerted by the box on his head during his free fall? Does the force of gravity increase during the fall?

Ans. During a free fall, the force exerted by the box on the boy's head is zero, and the force of gravity acting on the box remains constant.

15. What is meant by natural motion?

Ans. According to Aristotle, a moving body naturally comes to rest without any external influence of the force. Such motions are termed as "**natural motion**".

16. What is equilibrant?

Ans. A system can be brought to equilibrium by applying another force, which is equal to the resultant force in magnitude, but opposite in direction.

17. What is Torque? (or) moment of force?

Ans. 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 (τ).

18. Write the convention rule of couple.

Ans. (i) By convention, direction of moment of a force or couple is taken as positive if the object is rotated in anti-clockwise direction.
(ii) It is negative if it rotates the object in clockwise direction.

19. What is the use of Steering Wheel?

Ans. A small steering wheel helps to manoeuvre a car easily by transferring a torque to the wheels with less effort.

20. Define 1 newton (N).

Ans. The amount of force required for a body of mass 1 kg produces an acceleration of 1 m s^{-2} ;
 $1 \text{ N} = 1 \text{ kg m s}^{-2}$.

21. Define 1 dyne.

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

22. What is Unit force?

Ans. The amount of force required to produce an acceleration of 1 ms^{-2} on a body of mass 1 kg is called "**unit force**".

23. What is Impulsive force?

Ans. Large force acting for very short interval of time is called as "**Impulsive force**".

24. Define impulse.

Ans. When a force F acts on a body for a period of time t, then the product of force and time is known as 'impulse'. It is represented by 'J'.

SHORT ANSWERS

4 MARKS

1. An athlete runs a certain distance before taking a long jump. Why?

Ans. (i) This is due to inertia of motion.
(ii) This is because velocity acquired by running is added to the velocity of the athlete at the time of jump.
(iii) Hence he can jump over a longer distance.

2. What is Mechanics? Explain its branches.

Ans. Mechanics: Branch of physics that deals with the effect of force on bodies.

Branches : It is divided into two branches, namely, statics and dynamics.

(i) **Statics :** It deals with the bodies which are at rest under the action of forces.
(ii) **Dynamics:** It is the study of moving bodies under the action of forces. Dynamics is further divided as follows:

Kinematics : It deals with the motion of bodies without considering the cause of motion.

Kinetics : It deals with the motion of bodies considering the cause of motion.

3. When is a body said to be in rest and motion?

Ans. (i) When an object does not change its state during period of time, then it is said to be in the state of "rest".
(ii) When an object changes its state during a period of time, then it is said to be in the state of "motion".

4. What is resultant force?

Ans. (i) When several forces act simultaneously on the same object, then the combined effect of multiple forces can be represented by a single force, which is termed as **resultant force**.
(ii) It is equal to vector sum (adding the magnitude of the forces with their direction) of all the forces.

5. How can you measure torque?

Ans. It is measured by the product of any one of the forces (F) and the perpendicular distance between the fixed point or the fixed axis and the line of action of the force. $\tau = F \times d$.

6. Define Linear Momentum.

Ans. (i) 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.

(ii) Linear momentum = mass $\times$ velocity
 $p = mv$

7. Distinguish between balanced and unbalanced force.

Ans.

	Balanced Force	Unbalanced force
(i)	If the resultant force of all the forces acting on a body is equal to zero, then the body will be in equilibrium. Such forces are called balanced forces.	If the resultant force is not equal to zero, then it causes the motion of the body due to unbalanced forces.
(ii)	Eg : Forces on a weight balance	Eg : Action of a lever.

8. Handle in a door is always placed at the edge of door. Why?

Ans. The door can be easily opened or closed if we apply the force at a point far away from the fixed edge.

- (i)** In this case, the effect of the force we apply is to rotate the door about the fixed edge.
- (ii)** This rotational effect of the applied force is more about the 'axis of rotation' when the distance between the fixed edge and the point of application of force is more.

9. What is Gravitational unit of force?

Ans. In the SI system of units, gravitational unit of force is kilogram force, represented by kg f. In the CGS system its unit is gram force, represented by g f.

- (i)** $1 \text{ kgf} = 1 \text{ kg} \times 9.8 \text{ m s}^{-2} = 9.8 \text{ N}$;
- (ii)** $1 \text{ gf} = 1 \text{ g} \times 980 \text{ cm s}^{-2} = 980 \text{ dyne}$

10. Take two eggs and drop them from a certain height one by one. Drop one egg onto a concrete floor and another one onto a cushion pillow. What changes do you notice?

When the egg is dropped onto a concrete floor, it breaks. But, the egg dropped onto the cushion pillow does not break. Can you explain why?

Ans. (i) **Egg dropped on concrete :** A large force acts for a short period of time on concrete, causing breakage.

Egg dropped on cushion pillow : A smaller force acting for a longer period.

- (ii)** In this activity for the egg dropped to a cushion pillow, the time of interaction of force is large and makes the magnitude of force small.
- (iii)** So, it does not break. When the same egg is dropped onto a concrete floor, the time of interaction is very short and hence the force becomes large, which breaks the egg.
- (iv)** Such a force is known as "impulsive force".

11. What is meant by Weightlessness?

Ans. (i) When the person in a lift moves down with an acceleration (a) equal to the acceleration due to gravity (g), i.e., when $a = g$, this motion is called as 'free fall'.

(ii) Here, the apparent weight ($R = m(g - g) = 0$) of the person is zero.

12. Give more examples for the cases in which the time of action of force is made large to have less force?

- Ans. (i)** Fragile items like glass crockery etc., are wrapped in straw or paper strips in boxes for shipment to avoid breakage.
- (ii)** Chalks are packed with husks in between to reduce impact forces while transportation.
- (iii)** Automobiles are fitted with springs and shock absorbers to reduce jerk while moving in uneven roads.

13. Give examples for the cases in which the time of action of force is very short to have a large force?

- Ans. (i)** Striking a hammer on a nail.
- (ii)** Hitting cricket ball with the bat.
- (iii)** We get hurt more while we slip down on a concrete floor than on a mud floor.

- (iv) Both the floors experience same amount of change in momentum. But in concrete floor the large amount of force acts in shorter interval of time. So it hurts more.

14. If 25 N of force is used to compress a spring, then how much reactive force exerted by spring?

Ans. Reactive force by spring = - 25 N.

When a force of 25 N is used to compress a spring, then same amount of force will be exerted by the spring in the opposite direction. This is according to Newton's III law of motion. i.e., For every action there is an equal and opposite reaction.

15. Is it possible to open the cap of pen with one hand? Give reason.

Ans. (i) Yes, it is possible. Two equal & opposite forces are required to produce required amount of torque. Two fingers can be used.

(ii) Rotational motion produced by a single finger is less than two fingers producing equal & opposite forces.

16. Classify the following things into like parallel and unlike parallel forces (Dragging water from well, force applied to crow bar, weight balance, turning pen cap)

Ans. Dragging water from well - Unlike parallel forces

Force applied to crow bar - Unlike parallel forces

Weight balance - Like parallel forces

Turning pen cap - Unlike parallel forces

17. What happens to the weight of a person while he goes from polar region to equator?

Ans. (i) The value of g is maximum in polar region and minimum at the equator region.

(ii) Since weight $W = mg$, as g varies, the weight of the person is more at poles than at the equator region.

NUMERICAL PROBLEMS

1. Weight of a person inside the lift while at rest is 50 N. What is the weight he feels when lift moves up with an acceleration of 9.8 ms^{-2} .

Ans. $R = m(g + a)$ ($R \rightarrow$ Apparent weight)

$$mg = 50 \text{ N}$$

$$ma = 50 \text{ N}$$

$$R = mg + ma = 50 + 50$$

$$R = 100 \text{ N}$$

Here Apparent weight (R) is greater than the actual weight $mg (=W)$

2. A 20g bullet moving at 300 m/s stops after penetrating 2 cm of bone. Calculate the average retarding force acting on the bullet.

Given

$$\text{Mass of the bullet, } m = 20 \times 10^{-3} \text{ kg}$$

$$\text{Initial velocity, } u = 300 \text{ m/s}$$

$$\text{Final velocity, } v = 0$$

$$\text{Distance, } s = 2 \text{ cm} = 2 \times 10^{-2} \text{ m}$$

To find : Average retarding force acting on the bullet, $F = ?$

Solution

Using equations of motion,

$$v^2 = u^2 + 2as$$

$$0 = (300)^2 + 2(a) \times 2 \times 10^{-2}$$

$$a = -\frac{(300)^2}{4 \times 10^{-2}} = -\frac{9 \times 10^4}{4 \times 10^{-2}}$$

$$a = -2.25 \times 10^6 \text{ m/s}^2$$

Average force,

$$F = ma$$

$$= 20 \times 10^{-3} \times -2.25 \times 10^6$$

$$F = -45 \times 10^3 = -4.5 \times 10^4 \text{ N}$$

The negative sign indicates that the force is resistive (acting against the direction of motion), but the magnitude of the force exerted by the bullet is $4.5 \times 10^4 \text{ N}$.

3. A bullet of mass 50 g moving with a speed of 300 ms^{-1} is brought to rest in 1s. Find the impulse and the force.

Given

$$\text{Mass of the bullet, } m = 50 \times 10^{-3} \text{ kg}$$

$$\text{Initial speed of the bullet, } u = 300 \text{ m/s}$$

$$\text{Final speed, } v = 0$$

$$\text{time, } t = 1 \text{ s}$$

To find : (i) Impulse (of a force), $J = ?$
(ii) Force, $F = ?$

Solution

$$\begin{aligned} \text{(i) Impulse, } J &= \text{Change in momentum} \\ &= m(v - u) \\ &= 50 \times 10^{-3} [0 - 300] \\ &= -15 \text{ Ns} \end{aligned}$$

$$\begin{aligned} \text{(ii) Impulse} &= F \times t \\ -15 &= F \times 1 \text{ s} \\ F &= \frac{-15}{1} = -15 \text{ N} \end{aligned}$$

4. A cricket ball of mass 25 g moving with a speed of 12 ms^{-1} is hit by a bat so that the ball is turned back with a velocity of 20 ms^{-1} . Calculate the impulse received by the ball?

Given

$$\begin{aligned} \text{Mass of the ball, } m &= 25 \text{ g} \\ &= 25 \times 10^{-3} \text{ kg} \\ \text{Initial speed of the ball, } u &= 12 \text{ ms}^{-1} \\ \text{Final speed of the ball, } v &= -20 \text{ ms}^{-1} \\ [\text{-ve sign indicates backward direction}] \end{aligned}$$

To find : Impulse, $J = ?$

Solution

$$\begin{aligned} \text{Impulse} &= \text{Change in linear momentum} \\ J &= m(v - u) \\ &= 25 \times 10^{-3} (-20 - 12) \\ &= 25 \times 10^{-3} (-32) \\ &= -800 \times 10^{-3} \\ J &= -0.8 \text{ Ns.} \end{aligned}$$

5. Calculate the mass of a body weighing 100 dyne. $g = 10 \text{ m/s}^2$

Given

$$\begin{aligned} \text{Weight, } W &= 100 \text{ dyne} \\ \text{Acceleration due to gravity, } g &= 10 \text{ m/s}^2 \\ g &= 1000 \text{ cm/s}^2 \end{aligned}$$

To find : Mass of the body, $m = ?$

Solution

$$\begin{aligned} W &= mg; \quad m = \frac{W}{g} \\ m &= \frac{100 \text{ dyne}}{1000 \text{ cm/s}^2} = \frac{1}{10} \text{ g} \\ \text{Mass, } m &= 0.1 \text{ g} \end{aligned}$$

6. A cricket ball of mass 100 g moving with a speed of 20 ms^{-1} is brought to rest by a player. Find the change in momentum of the ball.

Ans.

$$\begin{aligned} \text{Mass} &= 100 \text{ g} = 0.1 \text{ kg}; \\ \text{Initial speed } u &= 20 \text{ ms}^{-1} \\ \text{Final velocity } v &= 0 \\ \text{Change in momentum} &= ? \\ mv - mu &= (0.1 \times 0) - (0.1 \times 20) \end{aligned}$$

Change in momentum = -2 kg ms^{-1}

7. A sphere of mass 20 kg moving with a velocity 40 ms^{-1} collides with another sphere of mass 15 kg which is at rest. After collision they move with the same velocity. Find that velocity.

Given

$$\begin{aligned} \text{Mass of the first body, } m_1 &= 20 \text{ kg} \\ \text{Mass of the second body, } m_2 &= 15 \text{ kg} \\ \text{Initial velocity of first body, } u_1 &= 40 \text{ ms}^{-1} \\ \text{Initial velocity of second body, } u_2 &= 0 \\ (\text{Second body is at rest initially}) \\ \text{Final velocity of the first body, } v_1 &= \text{Final velocity of the second body, } v_2 \\ \text{i.e., } v_1 &= v_2 = v \end{aligned}$$

To find : $v = ?$

Solution

$$\begin{aligned} \text{According to law of conservation of momentum,} \\ m_1 u_1 + m_2 u_2 &= m_1 v_1 + m_2 v_2 \\ m_1 u_1 + m_2 u_2 &= (m_1 + m_2) v \\ 20 \times 40 + 15 \times 0 &= (20 + 15) v \\ 800 &= 35 v \\ \text{Velocity, } v &= \frac{800}{35} = 22.86 \text{ ms}^{-1} \end{aligned}$$

8. A force of 200 dyne acts on a body of mass 10 g for 5 s. What will be the velocity of the body if it starts from rest? Express in SI unit.

Ans.

$$\begin{aligned} \text{Force, } F &= 200 \text{ dyne} \\ \text{Mass } m &= 10 \text{ g} \\ t &= 5 \text{ s} \\ \text{Acceleration, } a &= \frac{F}{m} \Rightarrow a = \frac{200}{10} = 20 \text{ cm/s}^2 \\ \text{Velocity } v &= at \Rightarrow v = 20 \times 5 = 100 \text{ cm/s} \\ \text{In SI unit } v &= 100 \times 10^{-2} \text{ ms}^{-1} \text{ (or) } 1 \text{ ms}^{-1} \\ v &= 1 \text{ ms}^{-1} \end{aligned}$$

9. A force of 60 N acts on a body for 10 s. What is the change in momentum?

Ans. Impulse = Change in momentum
 $F = 60 \text{ N}; t = 10 \text{ s}$
 Change in momentum = Force $\times$ time
 $= 60 \times 10$

Change in momentum = 600 Ns

10. A body of mass 2 kg moving with uniform velocity of 40 ms^{-1} collides with another body at rest. If two bodies move together with a velocity of 20 ms^{-1} . Find the mass of the other body.

Given

Mass of first body, $m_1 = 2 \text{ kg}$
 Initial velocity of first body, $u_1 = 40 \text{ ms}^{-1}$
 Initial velocity of second body, $u_2 = 0$
 Final velocity of first body,
 $v_1 =$ Final velocity of the second body, v_2
 i.e., $v_1 = v_2 = 20 \text{ ms}^{-1}$

To find : Mass of second body, $m_2 = ?$

Solution

According to law of conservation of momentum,

$$\begin{aligned} m_1 u_1 + m_2 u_2 &= m_1 v_1 + m_2 v_2 \\ m_1 u_1 + m_2 u_2 &= v_1 m_1 + m_2 v_2 \\ 2 \times 40 + m_2 \times 0 &= 20 \times 2 + 20 \times m_2 \\ 80 &= 40 + 20 m_2 \\ 20 m_2 &= 40 \Rightarrow \\ m_2 &= \frac{40}{20} = 2 \text{ kg} \end{aligned}$$

Mass of second body, $m_2 = 2 \text{ kg}$

11. A force of 10 kg weight acting on an object of mass for 2 s gives to it a velocity of 10 ms^{-1} . What is the mass of an object in kg?
 $[g = 9.8 \text{ ms}^{-2}]$

Given

Force, $F = 10 \text{ kg wt} = 10 \times 9.8 = 98 \text{ N}$
 Time, $t = 2 \text{ s}$; Velocity, $v = 10 \text{ ms}^{-1}$

To find : Mass $m = ?$

$$F = ma; a = \frac{v}{t}$$

Solution

$$\begin{aligned} a &= \frac{10}{2} = 5 \text{ ms}^{-2} \\ \therefore m &= \frac{F}{a} = \frac{98}{5} = 19.6 \text{ kg} \\ m &= 19.6 \text{ kg} \end{aligned}$$

12. A 2000 kg car traveling at 20 ms^{-1} hits concrete wall and stops in 0.05 s. What magnitude of impulse did the wall exert on the car?

Given

Mass of the car $m = 2000 \text{ kg}$
 Speed of the car $v = 20 \text{ ms}^{-1}$
 Time $t = 0.05 \text{ s}$

To find : Impulse = ?

$$\text{Impulse} = F \times t; \text{ Force} = m \times a$$

Solution

$$a = \frac{v}{t} = \frac{20}{0.05} = 400 \text{ ms}^{-2}$$

$$F = ma \Rightarrow 2000 \times 400 = 8 \times 10^5 \text{ N}$$

$$\begin{aligned} \text{Impulse} &= F \times t \Rightarrow 8 \times 10^5 \times 0.05 \\ &= 4 \times 10^4 \text{ N s} \end{aligned}$$

The magnitude of impulse exerted by the wall on the car = $4 \times 10^4 \text{ Ns}$

13. The masses of two planets are in the ratio 1 : 2 and their radii are in the ratio 1 : 2. Find the ratio of the acceleration due to gravity on the planets.

Given

Ratio of mass of two planets = $M_1 : M_2 = 1 : 2$

Ratio of radius of the planets = $R_1 : R_2 = 1 : 2$

To find : Ratio of acceleration due to gravity on the planets, $g_1 : g_2 = ?$

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

$$\text{constant } G = 6.674 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

Solution

$$g_1 = \frac{GM_1}{R_1^2}; g_2 = \frac{G(2M_1)}{(2R_1)^2}$$

$$\frac{g_1}{g_2} = \frac{GM_1}{R_1^2} \times \frac{4R_1^2}{G.2M_1} = \frac{2}{1}$$

$$g_1 : g_2 = 2 : 1$$

14. A pistol fired a bullet of mass 50 g triggered with a speed 250 ms^{-1} penetrated into a wooden plank comes to rest at 1 ms. Find the impulse and average force offered by the planks.

Given

Mass, $m = 50 \text{ g} = 50 \times 10^{-3} \text{ kg}$
 Final speed, $v = 0$
 Initial speed, $u = 250 \text{ ms}^{-1}$
 Time, $t = 1 \text{ ms} = 10^{-3} \text{ s}$

To find : $J = F \times t = ?$ Average force, $F = ma = ?$

Solution

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

$$F = \frac{m(v - u)}{t} = \frac{50 \times 10^{-3} [0 - 250]}{1 \times 10^{-3} \text{ s}}$$

$$F = -12500 = -1.25 \times 10^4 \text{ N}$$

$$J = F \times t = -1.25 \times 10^4 \times 10^{-3}$$

$$J = -12.5 \text{ Ns}$$

- 15. Force of 50 N acts perpendicular on a body, which is fixed at a point O. The distance of point of action of force from O is 5 cm. Find the moment of force.**

Given Force, $F = 50 \text{ N}$; Distance, $d = 5 \text{ cm}$

To find : moment of force $= F \times d$

Solution

$$\begin{aligned} \text{Moment of force,} &= 50 \times 5 \times 10^{-2} \\ &= 250 \times 10^{-2} = \mathbf{2.5 \text{ Nm}} \end{aligned}$$

- 16. Calculate the force of gravitation between two bodies of mass 50 kg and 10 kg respectively placed 10 m apart. If their distance increased by 100 % then find the change in percentage of force. (New force is 75% less than the original force)**

Given

$$\text{Mass of body 1, } m_1 = 50 \text{ kg}$$

$$\text{Mass of body 2, } m_2 = 10 \text{ kg}$$

$$\text{Distance, } R = 10 \text{ m}$$

Universal gravitation

$$\text{constant, } G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

To find : Force of gravitation, $F = \frac{Gm_1m_2}{R^2}$

Solution

$$F = \frac{6.67 \times 10^{-11} \times 50 \times 10}{10^2}$$

$$\text{Force, } F = \mathbf{33.35 \times 10^{-11} \text{ N}}$$

Doubling r gives $F' = F/4 = 8.3375 \times 10^{-11} \text{ N}$,
i.e. the force decreases by 75%.

LONG ANSWERS

7 MARKS

- 1. What are the concepts proposed by Galileo?**

Ans. (i) The natural state of all earthly bodies is either the state of rest or 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) When force is applied on bodies, they resist any change in their state. This property of bodies 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.

2. Give the application of torque.

- Ans. (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) **Seesaw :** 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.

3. Give examples for Newton's third law.

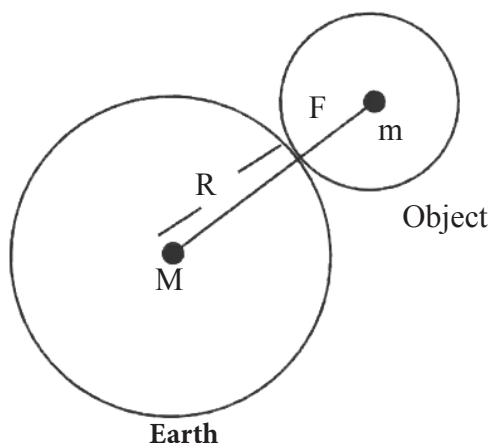
- Ans. (i)** When birds fly, they push the air downwards by their wings (Action).
- (ii) The air pushes the bird upwards (Reaction).
- (iii) When a person swims, he pushes the water using hands backwards (Action), the water pushes the swimmer in forward direction (Reaction).
- (iv) Rockets expel gas at high velocity (Action). The downward moving gas pushes the rocket in upward direction (Reaction).
- (v) When we fire a bullet, the gun recoils back, Bullet is moving forward (action). The gun equalise this forward action by moving backward (reaction).

4. Derive the Relation between g and G .

- Ans. (i)** Let, M be the mass of the Earth and m be the mass of the object.
- (ii) The entire mass of the Earth is assumed to be concentrated at its centre. The radius of the Earth is $R (= 6378 \text{ km} \approx 6400 \text{ km})$.

- (iii) By Newton's law of gravitation, the force acting on the object is given by

$$F = G M m / R^2 \quad \dots (A)$$



Relation between g and G

- (iv) According to Newton's second law, the force acting on the object is given by the product of its mass and acceleration. Here acceleration of the body is under the action of gravity hence $a = g$.

$$F = ma = mg$$

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

Comparing equations (A) and (B), we get

$$mg = G M m / R^2$$

Acceleration due to gravity

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

HIGHER ORDER THINKING (HOTS)

1. Why is the recoil of a heavy gun on firing not so strong as of a light gun using the same cartridges?

Ans. Recoil velocity of a gun $\propto \frac{1}{m}$. So light rifle recoils with large velocity than a heavy rifle.

2. If a body moves with uniform velocity, what is the net force acting on a body?

Ans. If a body moves with uniform velocity, the acceleration of body is zero.

$\therefore$ net force acting on the body is zero.

$$F = ma \quad [a = 0]$$

3. Meteors are shooting stars. They completely burn out while they hit Earth's atmosphere. Apply impulse concept to explain their burning action.

Ans. A shooting star is a small piece of rock that hits Earth's atmosphere. It heats up due to friction with and compression of the air in the atmosphere. They enter with very high speeds. When it strikes with high speed in short duration (i.e. impulse $J = F \times t = \Delta p$) causes burning.

4. A rocket with a lift-off mass 20,000 kg is blasted upwards with an initial acceleration of 50 ms^{-2} . Calculate the initial thrust (Force) of the blast.

Ans. Given

Initial mass of the rocket, $m = 20,000 \text{ kg}$

Initial acceleration, $a = 50 \text{ ms}^{-2}$

(Upward direction)

Let initial thrust of the blast be T

To find : $T = mg + ma$

Solution

$$T = m(g + a)$$

$$= 20,000 (9.8 + 50)$$

$$T = 2 \times 10^4 \times 59.8$$

Initial thrust,

$$T = 119.6 \times 10^4 \text{ N}$$

$$T = 1.196 \times 10^6 \text{ N}$$

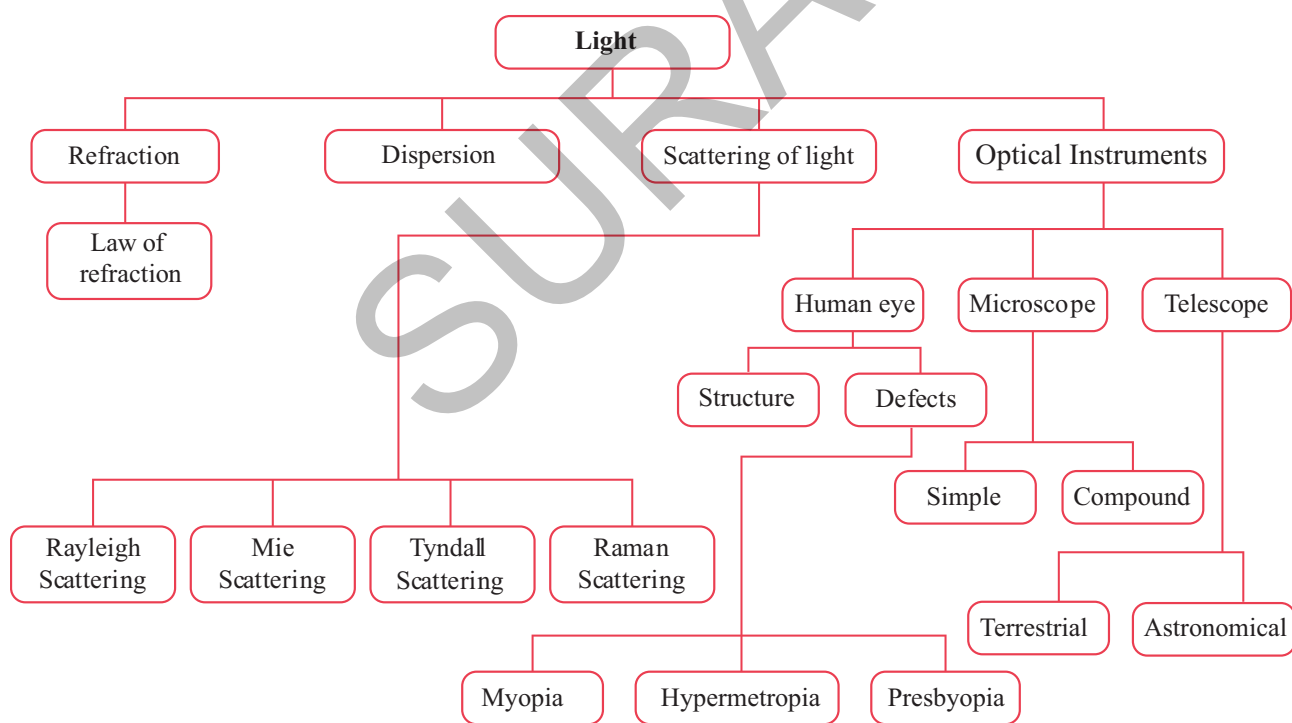


UNIT

2

OPTICS

CONCEPT MAP



MUST KNOW DEFINITIONS

Refraction	:	When a ray of light travels from one transparent medium into another obliquely, the path of light undergoes deviation. This deviation of ray of light is called refraction.
First Law of refraction	:	The incident ray, the refracted ray of light and the normal to the refracting surface all lie in the same plane.
Refractive index	:	The ratio of speed of light in vacuum to the speed of light in a medium.
Dispersion of light	:	When a beam of white light or composite light is refracted through any transparent media such as glass or water, it is split into its component colours.
Scatterer	:	Scattering is the phenomenon by which a beam of light is redirected in many different directions when it interacts with a constituent particle of the medium. The interacting particle of the medium is called as scatterer .
Elastic scattering	:	If the energy of incident beam of light and scattered light beam are the same, then the scattering is called elastic scattering.
Inelastic scattering	:	If the energy of incident beam of light and scattered beam of light are not the same, the scattering is called inelastic scattering.
Rayleigh scattering law	:	The amount of scattering of light is inversely proportional to the fourth power of the wavelength.
Mie scattering	:	Mie scattering takes place when the diameter of the scatterer is similar to or larger than the wavelength of the incident light. It is also an elastic scattering.
Tyndall scattering	:	The scattering of light rays by the colloidal particles in the colloidal solution.
Raman scattering	:	The interaction of light ray with the particles of pure liquids or transparent solids, which leads to a change in wavelength or frequency.

FORMULAE

Velocity of light	$C = v\lambda$	Power of lens	$P = \frac{1}{f}$
Snell's law	$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$	Lens maker's formula	$\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$
Rayleigh's Scattering Law	$S \propto \frac{1}{\lambda^4}$	The focal length of the required concave lens for myopia	$f = \frac{xy}{x - y}$
lens formula	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$	The focal length of the required convex lens for hypermetropia	$f = \frac{dD}{d - D}$
Magnification	$m = \frac{h'}{h} = \frac{v}{u}$		

TEXTBOOK EVALUATION

I. CHOOSE THE CORRECT ANSWER :

1. The refractive index of four substances A, B, C and D are 1.31, 1.43, 1.33, 2.4 respectively. The speed of light is maximum in $\otimes$ [FRT-'22]

(a) A (b) B
(c) C (d) D [Ans. (a) A]

2. Where should an object be placed so that a real and inverted image of same size is obtained by a convex lens [May-'22]

(a) f (b) 2f
(c) infinity (d) between f and 2f [Ans. (b) 2f]

3. A small bulb is placed at the principal focus of a convex lens. When the bulb is switched on, the lens will produce [PTA-3]

(a) a convergent beam of light
(b) a divergent beam of light
(c) a parallel beam of light
(d) a coloured beam of light [Ans. (c) a parallel beam of light]

4. Magnification of a convex lens is $\otimes$ [April-'23; Mar.-'26]

(a) Positive (b) negative
(c) either positive or negative
(d) zero [Ans. (c) either positive or negative]

5. A convex lens forms a real, diminished point sized image at focus. Then the position of the object is at [FRT-'22]

(a) focus (b) infinity
(c) at 2f (d) between f and 2f [Ans. (b) infinity]

6. Power of a lens is $-4D$, then its focal length is [QY-'23; HY-'24; July-'24 & '25]

(a) 4m (b) $-40m$
(c) $-0.25m$ (d) $-2.5m$ [Ans. (c) $-0.25m$]

7. In a myopic eye, the image of the object is formed $\otimes$ [FRT-'22]

(a) behind the retina
(b) on the retina (c) in front of the retina
(d) on the blind spot [Ans. (c) in front of the retina]

8. The eye defect 'presbyopia' can be corrected by [PTA-2; Sep-2020; FRT-'24; April-'25]

(a) convex lens (b) concave lens
(c) convex mirror (d) Bi focal lenses [Ans. (d) Bi focal lenses]

9. Which of the following lens would you prefer to use while reading small letters found in a dictionary? [QY-'24]

(a) A convex lens of focal length 5 cm
(b) A concave lens of focal length 5 cm
(c) A convex lens of focal length 10 cm
(d) A concave lens of focal length 10 cm [Ans. (a) A convex lens of focal length 5 cm]

10. If V_B , V_G , V_R be the velocity of blue, green and red light respectively in a glass prism, then which of the following statement gives the correct relation? $\otimes$

(a) $V_B = V_G = V_R$ (b) $V_B > V_G > V_R$
(c) $V_B < V_G < V_R$ (d) $V_B < V_G > V_R$ [Ans. (c) $V_B < V_G < V_R$]

II. FILL IN THE BLANKS :

1. The path of the light is called as _____. [Ans. ray of light]

2. The refractive index of a transparent medium is always greater than _____. $\otimes$ [Ans. one]

3. If the energy of incident beam and the scattered beam are same, then the scattering of light is called as _____ scattering. [Ans. elastic]

4. According to Rayleigh's scattering law, the amount of scattering of light is inversely proportional to the fourth power of its _____. [Ans. wavelength]

5. Amount of light entering into the eye is controlled by _____. $\otimes$ [FRT-'22] [Ans. Iris]

III. TRUE OR FALSE. IF FALSE CORRECT IT:

1. Velocity of light is greater in denser medium than in rarer medium $\otimes$

Ans. False.

Correct Statement: Velocity of light is **lesser** in denser medium than in rarer medium.

2. The power of lens depends on the focal length of the lens

Ans. True.

3. Increase in the converging power of eye lens cause 'hypermetropia' ⊗

Ans. False.

Correct Statement: **Decrease** in the converging power of eye lens cause hypermetropia.

4. The convex lens always gives small virtual image.

Ans. False.

Correct Statement: **Concave lens** always gives small virtual image.

IV. MATCH THE FOLLOWING:

Column - I	Column - II
(1) Retina	a Pathway of light
(2) Pupil	b Far point comes closer
(3) Ciliary muscles	c near point moves away
(4) Myopia	d Screen of the eye
(5) Hypermetropia	e Power of accommodation

[Ans. 1-d, 2-a, 3-e, 4-b, 5-c]

V. ASSERTION AND REASONING TYPE:

Mark the correct choice as

- If both assertion and reason are true and reason is the correct explanation of assertion.
- If both assertion and reason are true but reason is not the correct explanation of assertion.
- Assertion is true but reason is false.
- Assertion is false but reason is true.

1. **Assertion:** If the refractive index of the medium is high (denser medium) the velocity of the light in that medium will be small. ⊗

Reason: Refractive index of the medium is inversely proportional to the velocity of the light.

[Ans. (a) If both assertion and reason are true and reason is the correct explanation of assertion]

2. **Assertion:** Myopia is due to the increase in the converging power of eye lens.

Reason: Myopia can be corrected with the help of concave lens.

[Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion]

VI. ANSWER BRIEFLY :

1. What is refractive index? [FRT-'22; July-'24]

Ans. The ratio of **speed of light in vacuum** (c) to the **speed of light in a medium** (v) is defined as refractive index ' μ ' of that medium.

$$\mu = \frac{c}{v}$$

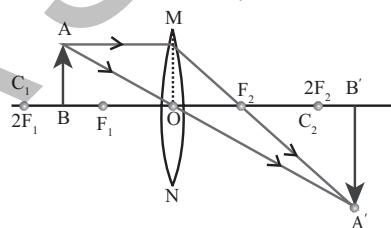
2. State Snell's law. ⊗ [QY-2019; FRT & Aug.-'22]

Ans. Snell's law states that, the ratio of the **sine of the angle of incidence** and **sine of the angle of refraction** is equal to the ratio of **refractive indices** of the two media.

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

3. Draw a ray diagram to show the image formed by a convex lens when the object is placed between F and 2F.

[GMQP-2019; FRT-'22; July-'23; HY-'24; Mar.-'26]



4. Define dispersion of light. ⊗ [April-'24; July-'26]

Ans. When a beam of **white light** or **composite light** is refracted through any **transparent media** such as glass or water, it is split into its **component colours**. This phenomenon is called as **dispersion of light**.

5. State Rayleigh's law of scattering.

[PTA-3; July-'23 & '26]

Ans. The amount of **scattering** of light is **inversely proportional** to the **fourth power** of the **wavelength**. This is called as Rayleigh scattering law.

$$\text{Amount of scattering 'S'} \propto \frac{1}{\lambda^4}$$

6. Differentiate convex lens and concave lens.

Ans. [PTA-3; QY-2019; July-'23 & '24; FRT-'24]

No.	Convex Lens	Concave Lens
1.	Thicker in the middle than at edges.	Thinner in the middle than at edges.
2.	It is converging lens .	It is diverging lens .
3.	Produces mostly real images.	Produces a virtual image.
4.	Used to treat hypermetropia .	Used to treat myopia .

7. What is power of accommodation of eye? ☒ [QY-'24]

Ans. The **ability of the eye** lens to focus **nearby** as well as the distant objects is called **power of accommodation of the eye**. It is achieved by changing the focal length of the eye lens with the help of ciliary muscles.

8. What are the causes of 'Myopia'? [GMQP-2019; FRT-'22]

- Ans.** (i) Myopia, also known as short sightedness, occurs due to the **lengthening** of eye ball.
- (ii) Nearby objects can be **seen clearly** but distant objects **cannot be seen clearly**.
- (iii) The focal length of eye lens is **reduced** or the distance between **eye lens** and **retina** **increases**.
- (iv) Far point will not be infinity and the **far point** has **come closer**.
- (v) Due to this, the image of distant objects are formed **before the retina**.

9. Why does the sky appear in blue colour? [PTA-1; April-'23]

- Ans.** (i) When sunlight passes through the atmosphere, the **blue colour** (shorter wavelength) is **scattered** to a **greater extent** than the red colour (longer wavelength).
- (ii) This scattering causes the sky to appear in **blue colour**.

10. Why are traffic signals red in colour? [PTA-4; HY-'23; April & QY-'24]

- Ans.** (i) Red has the **longest wavelength** so it is scattered the least by atmospheric particles.
- (ii) It travels a longer distance in the atmosphere.
- (iii) As a result whether it is **fog** or **smoke**, red light passes comparatively easily through them.

VII. GIVE THE ANSWER IN DETAIL :

1. List any five properties of light. ☒ [QY-'24] [QY-'19; FRT & May-'22; HY-'23 & '24; July-'23 & '25]

- Ans.** (i) Light is a **form of energy**. [Mar.-'26]
- (ii) Light always travels along a **straight line**.
- (iii) Light **does not need any medium** for its propagation. It can even travel through **vacuum**.
- (iv) The speed of light in vacuum or air is, **$c = 3 \times 10^8 \text{ ms}^{-1}$** .
- (v) Different coloured light has **different wavelength**

and **frequency**.

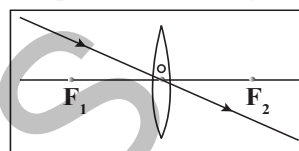
(vi) **Violet** light has the **lowest** wavelength and **red** light has the **highest** wavelength.

(vii) When light is incident on the interface between two media, it is partly reflected and partly refracted.

2. Explain the rules for obtaining images formed by a convex lens with the help of ray diagram. [FRT-'22; HY-'23]

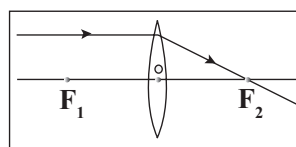
Ans. When an object is placed in front of a lens, the light rays from the object fall on the lens.

Rule-1: When a ray of light strikes the convex lens obliquely at its **optical centre**, it continues to follow its path **without any deviation**.



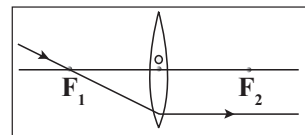
Rays passing through the optical centre

Rule-2: When rays **parallel to the principal axis** strike a convex lens, the **refracted rays** are **converged** to (convex lens) the **principal focus**.



Rays passing parallel to the optic axis

Rule-3: When a ray **passing through** (convex lens) **the principal focus** strikes a convex lens, the refracted ray will be **parallel** to the **principal axis**.



Rays passing through or directed towards the principal focus

3. Differentiate the eye defects: Myopia and Hypermetropia. [PTA-6; Sep-2021; Aug.-'22; April & QY-'23; July-'24; April-'25]

Ans.

	Myopia	Hypermetropia
(i)	It is also known as short sightedness .	It is also known as long sightedness .
(ii)	It occurs due to the lengthening of eye ball.	It occurs due to the shortening of eye ball.

	Myopia	Hypermetropia
(iii)	Nearby objects can be seen clearly but distant objects cannot be seen clearly.	Distant objects can be seen clearly but nearby objects cannot be seen clearly.
(iv)	The focal length of eye lens is reduced or the distance between eye lens and retina increases .	The focal length of eye lens is increased or the distance between eye lens and retina decreases .
(v)	The far point has become closer.	The near point has moved farther.
(vi)	Image of distant objects is formed before the retina.	Image of nearby objects is formed behind the retina
(vii)	It can be corrected using a concave lens.	It can be corrected using a convex lens.

4. Explain the construction and working of a 'Compound Microscope'. ⊗ [QY-2019]

Ans. Construction:

- Compound microscope is used to see the tiny objects.
- A compound microscope consists of **two convex lenses**.
- The lens with the **shorter focal length** is placed **near the object**, and is called as '**objective lens**' or '**objective piece**'.
- The lens with **larger focal length** and larger aperture placed near the observer's eye is called as '**eye lens**' or '**eye piece**'.
- Both the lenses are fixed in a **narrow tube** with adjustable provision.

Working :

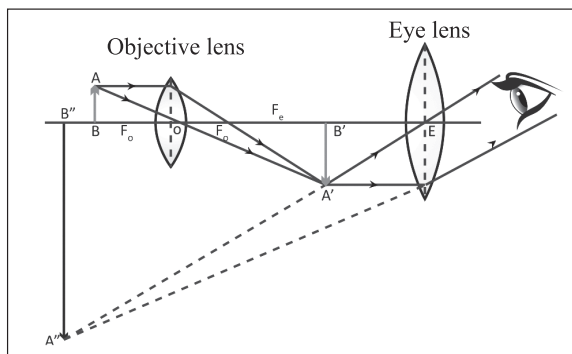


Image formation in compound microscope

- The object (AB) is placed at a distance **slightly greater** than the focal length of objective lens ($u > f_o$).

(vii) A **real, inverted** and **magnified image** (A'B') is formed at the other side of the objective lens. This image behaves as the object for the eye lens.

(viii) The position of the eye lens is adjusted and the image (A'B') falls within the **principal focus** of the **eye piece**. This eye piece forms a **virtual, enlarged** and **erect** image (A''B'') on the same side of object.

VIII. NUMERICAL PROBLEMS :

- An object is placed at a distance 20 cm from a convex lens of focal length 10 cm. Find the image distance and nature of the image.

Given

Object distance, $u = -20$ cm
Focal length of convex lens $f = 10$ cm

To find : Image distance $v = ?$ and
Nature of the image = ?

Solution

If the object is placed on the left side of the lens, then $f = 10$ cm ; $u = -20$ cm

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

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

$$\frac{1}{v} = \frac{1}{10} + \frac{1}{(-20)}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20}$$

Distance of the image $v = 20$ cm.

Real, inverted, and same-sized image at a distance of 20 cm on the right side of the lens.

$$m = \frac{v}{u} = \frac{20}{-20} = -1$$

(-ve sign indicates the inverted image)

[Nature of the image : Real, inverted and same size.]

2. An object of height 3 cm is placed at 10 cm from a concave lens of focal length 15 cm. Find the size of the image.

GivenObject distance $u = -10$ cm

[Object is placed on the left side]

Focal length $f = -15$ cm [$\because$ concave lens]Height of the object $h_1 = 3$ cm.**To find :** Image distance $v = ?$ Height of the image $h_2 = ?$ **Solution**

$$\begin{aligned}\frac{1}{f} &= \frac{1}{v} - \frac{1}{u} \\ \frac{1}{v} &= \frac{1}{f} + \frac{1}{u} \\ &= \frac{1}{-15} + \frac{1}{-10} \\ \frac{-10-15}{150} &= \frac{-25}{150} \\ v &= \frac{-150}{25} = -6 \text{ cm} \\ \frac{1}{v} = \frac{-1}{6} &\Rightarrow \boxed{v = -6 \text{ cm}}\end{aligned}$$

Magnification $m = \frac{\text{Distance of the image}}{\text{Distance of the object}}$

$$m = \frac{v}{u} = \frac{h_2}{h_1}$$

$$\begin{aligned}m &= \frac{-6}{-10} = \frac{h_2}{3} \\ &= \frac{-18}{-10} = h_2\end{aligned}$$

 $\therefore$ Size of the image $h_2 = 1.8$ cm**IX. HIGHER ORDER THINKING (HOT) QUESTIONS**

1. While doing an experiment for the determination of focal length of a convex lens, Raja suddenly dropped the lens. It got broken into two halves along the axis. If he continues his experiment with the same lens,
- can he get the image?
 - Is there any change in the focal length?

- Ans.** (a) Yes, he can get the image of same size.
 (b) No, there is no change in the focal length of the convex lens even if it is broken into two halves. Only the intensity of the image obtained will be less.

2. The eyes of the nocturnal birds like owl are having a large cornea and a large pupil. How does it help them?

Ans. Increase in their field of vision and an increased retinal surface help them to collect more ambient light during night.

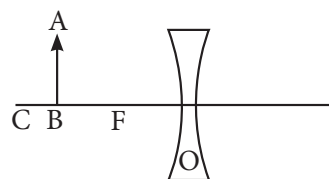
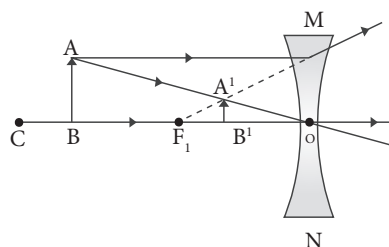
PTA Questions & Answers**1 MARK**

1. The scattered light in Raman scattering contains _____ lines. [PTA-5]

- Rayleigh's
- stokes
- Antistokes
- all the above

[Ans. (d) all the above]**2 MARKS**

1. Complete the ray diagram of a concave lens. [PTA-6]

**Ans.**

2. In common, what is the value of least distance of distinct vision of a human?

[PTA-6]

Ans. 25 cm is the value of least distance of distinct vision of a human.

4 MARKS

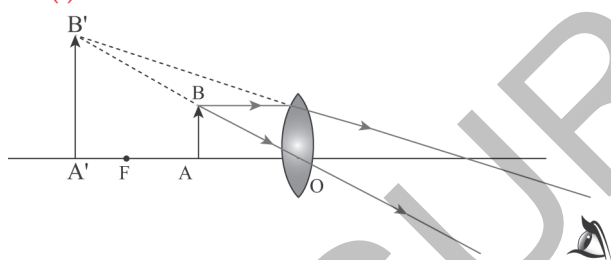
1. A student in a class room can read text book but he/she can't able to see the letters on the black board distinctly. Write the name of his/her eye defect and what is the cause? Suggest a remedy. (* Part of 7 Marks) [PTA-1]

Ans. Name of his / her eye defect: Myopia.

- (i) **Cause:** Myopia also known as short sightedness occurs due to the lengthening of eyeball. With this defect **nearby objects** can be seen **clearly** but **distant objects** cannot be seen **clearly**.
- (ii) **Remedy:** This defect can be corrected using a **concave lens**.

2. i) Draw the ray diagram of image formation in simple microscope. [FRT-'24]
ii) Find the position and write its nature and size of the image formed. [PTA-2]

Ans. (i)



(ii)

- A tiny object (AB) is placed within the principal focus F and the observer's eye is placed just behind the lens.
- As per this position, the convex lens produces an **erect, virtual** and **enlarged image** (A'B').
- The image formed is in the same side of the object and the distance equal to the least distance of distinct vision D.

3. The power of a lens is - 2D Find the focal length of a lens. [PTA-4]

Given Power of lens, $P = -2D$

To find : Focal length of a lens, $f = ?$

Solution

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

$$f = \frac{1}{-2} = -0.5 \text{ m}$$

$$f = -0.5 \text{ m}$$

Note: If power of lens is expressed in 'D', then the focal length is expressed in 'm'.

Negative sign indicates that the lens is concave.

4. An object of height 3 cm is placed at 10 cm from a convex lens which produces an image at 20 cm from its optical centre. Calculate the magnification and height of the image produced. [PTA-5]

Given

$$\begin{aligned} \text{Height of object } h &= 3 \text{ cm} \\ \text{Object distance } u &= -10 \text{ cm} \\ \text{Image distance } v &= 20 \text{ cm} \\ \text{Magnification } m &= ? \\ \text{Height of image } h' &= ? \end{aligned}$$

Solution

$$\text{Magnification, } m = \frac{v}{u} = \frac{20}{-10} = -2$$

$$\text{Magnification, } m = -2$$

$$m = \frac{h'}{h}$$

$$-2 = \frac{h'}{3}$$

$$\text{Height of the image } h' = -6 \text{ cm}$$

7 MARKS

1. Calculate the frequency of visible light having wavelength $3000 \text{ \AA}$ travelling in vacuum. [PTA-5]

Ans. Wavelength $\lambda = 3000 \text{ \AA}$ [$\because 1 \text{ \AA} = 10^{-10} \text{ m}$]
 $= 3000 \times 10^{-10}$

Velocity of light $= 3 \times 10^8 \text{ ms}^{-1}$

$$\text{Frequency, } \eta = \frac{\text{Velocity } (v)}{\text{Wavelength } (\lambda)}$$

$$\eta = \frac{3 \times 10^8}{3000 \times 10^{-10}}$$

$$= \frac{1 \times 10^8}{1000 \times 10^{-10}}$$

$$= \frac{1 \times 10^8 \times 10^{10}}{1000} = \frac{1 \times 10^{18}}{10^3}$$

$$\text{Frequency } (\eta) = 10^{15} \text{ hertz}$$

GOVERNMENT EXAM QUESTIONS & ANSWERS

1 MARKS

1. The speed of light in vacuum or air is (c) = _____. [FRT-'22] [Ans. $3 \times 10^8 \text{ ms}^{-1}$]

2 MARKS

1. A beam of light passing through a diverging lens of focal length 0.3 m appears to be focused at a distance 0.2 m behind the lens. Find the position of the object. [Sep-2020]

Ans. $f = -0.3 \text{ m}$, $v = -0.2 \text{ m}$

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

$$\frac{1}{u} = \frac{1}{-0.2} - \frac{1}{-0.3} = \frac{-10}{6} \Rightarrow u = \frac{-6}{10} = -0.6 \text{ m}.$$

The object is placed at a distance of 0.6 m in front of the diverging lens.

2. A person with myopia can see objects placed at a distance of 4 m. If he wants to see objects at a distance of 20 m, What should be the focal length and power of the concave lens he must wear? [FRT-'22 & May & Aug.-'22]

Ans. Given that $x = 4 \text{ m}$ and $y = 20 \text{ m}$

Focal length of the correction lens is

$$f = \frac{xy}{x - y}$$

$$f = \frac{4 \times 20}{4 - 20} = \frac{80}{-16} = -5 \text{ m}$$

Power of the correction lens

$$= \frac{1}{f} = -\frac{1}{5} = -0.2 \text{ D}$$

3. What is the least count of travelling microscope? [April-'24]

Ans. The least count of travelling microscope is 0.01mm.

4. Write any 2 applications of concave lens. [Sep-2021]

- Ans. (i) Concave lenses are used as eye lens of 'Galilean Telescope'.
(ii) They are used in wide angle spy hole in doors.
(iii) They are used to correct the defect of vision called 'myopia'.

4 MARKS

1. What are the uses of Simple microscope?

[Sep-2020; FRT-'24]

- Ans. (i) Used by watch repairers and jewellers.
(ii) Used to read small letters clearly.
(iii) Used to observe parts of flower, insects etc.
(iv) Used to observe finger prints in the field of forensic science.

2. What are the advantages of telescopes?

[QY-2019]

- Ans. (i) Elaborate view of the Galaxies, Planets, stars and other heavenly bodies is possible.
(ii) Camera can be attached for taking photograph for the celestial objects.
(iii) Telescope can be viewed even with the low intensity of light.

3. Write the Uses (applications) of convex lenses.

(* Part of 7 Marks) [FRT-'22; April-'24]

- Ans. (i) Convex lenses are used as camera lenses.
(ii) Used as magnifying lenses.
(iii) Used in making microscope, telescope and slide projectors.
(iv) Used to correct the defect of vision called hypermetropia.

ADDITIONAL QUESTIONS & ANSWERS

CHOOSE THE CORRECT ANSWER

1 MARK

1. The group of rays is _____.
(a) lines (b) dots
(c) beam (d) none of these
2. Velocity and wavelength of light are related by a relation _____.
(a) $v = c \lambda$ (b) $v = \frac{c}{\lambda}$
(c) $c = v \lambda$ (d) both b & c
3. Violet light has the _____ wavelength.
(a) lowest (b) highest
(c) same (d) standard
4. We can see objects because of _____.
(a) reflection (b) refraction
(c) transmission (d) diffraction

5. _____ determines speed of light in a medium
 (a) thickness (b) wavelength
 (c) refractive index
(d) both b and c
6. When light travels from rarer to denser medium, the refracted ray is _____ the normal.
 (a) bent away (b) along
(c) bent towards
 (d) just grazes the surface of separation
7. For air, the refractive index is _____.
(a) 1 (b) infinity
 (c) 0 (d) 2
8. The splitting up of white light into colours is called _____.
 (a) reflection (b) refraction
 (c) scattering **(d) dispersion**
9. Rainbow formation is due to _____ in water droplets.
 (a) Ionisation
 (b) absorption of sunlight
(c) reflection and refraction of sunlight
 (d) reflection of sunlight
10. Red light is used in traffic signals because _____.
 (a) It has highest wavelength
 (b) scatters least
 (c) red is symbol of danger
(d) both a & b
11. A star appears twinkling in the sky because of _____ by the atmosphere.
 (a) scattering of light
 (b) reflection of light
(c) refraction of light
 (d) both a and b
12. When a beam of light is passed through a colloidal solution, the light will be _____.
(a) scattered (b) reflected
 (c) absorbed (d) unchanged
13. If the energy of the incident and scattered beam of light is the same, then it is called _____ scattering.
 (a) Ray light (b) Inelastic
 (c) Mie **(d) Elastic**
14. The scattering of light by colloidal particles is _____ scattering.
 (a) Ray light (b) Mie
 (c) Raman **(d) Tyndall**
15. The scattering of light with pure liquids or transparent solids is _____ scattering.
 (a) Rayleigh's (b) Mie
(c) Raman (d) Tyndall
16. Convex lens produces a _____ beam of light.
(a) convergent (b) divergent
 (c) scattered (d) dispersed
17. A concave lens is a _____.
 (a) converging lens **(b) diverging lens**
 (c) inverting lens (d) magnifying lens
18. In spherical lenses, all distances are measured from _____.
(a) optic centre (b) principal focus
 (c) principal axis (d) centre of curvature
19. The part of the lens through which the ray of light passes without suffering deviation is called _____.
 (a) focus (b) centre of curvature
 (c) Pole **(d) optic centre**
20. Convex lens always forms a real image, if the object is situated beyond _____.
 (a) optic centre (b) centre of curvature
(c) focus (d) radius of curvature
21. A convex lens forms a virtual image if the object is _____.
 (a) at F (b) At infinity
 (c) below F and 2 F
(d) between the lens and the principal focus
22. The image formation by spherical lenses is due to the phenomenon of _____.
 (a) reflection **(b) refraction**
 (c) interference (d) dispersion
23. When a ray of light enters glass from water, it bends _____.
(a) towards the normal due to decrease in the speed of light
 (b) towards the normal due to increase in the speed of light
 (c) Away from the normal due to increase in the speed of light
 (d) Away from the normal due to decrease in the speed of light

24. To get real, inverted and same size of the object, the object is placed in convex lens at _____.
 (a) At F (b) **At 2 F**
 (c) below O and F (d) At infinity
25. The point at which the principal axis meets the surface of the lens is _____.
 (a) centre of curvature
 (b) radius of curvature
 (c) focus (d) **pole**
26. The distance between the lens and its principal focus is called _____.
 (a) pole (b) radius of curvature
 (c) **focal length** (d) principal axis
27. When a person uses a convex lens as a simple magnifying glass, the object must be placed at a distance _____.
 (a) **less than one focal length**
 (b) more than one focal length
 (c) less than twice focal length
 (d) more than twice the focal length
28. Highly enlarged image is obtained by convex lens when object is at _____.
 (a) infinity (b) **F**
 (c) below F & C (d) beyond 2F
29. The image produced by a concave lens is _____.
 (a) always virtual & enlarged
 (b) **always virtual & diminished**
 (c) always real
 (d) Some times real, sometimes virtual
30. Convex lens forms a highly diminished, real and inverted image, when an object is at _____.
 (a) **infinity** (b) F
 (c) below F & c (d) beyond 2 F
31. Convex lenses are used in _____.
 (a) camera (b) magnifying lens
 (c) microscope (d) **all the above**
32. Real images formed by convex lenses are always _____.
 (a) on the same side of the object
 (b) **inverted** (c) erect
 (d) smaller than the object
33. An object is placed at 12 cm from a convex lens whose focal length is 10 cm. The image must _____.
 (a) Virtual and enlarged
 (b) real and reduced in size
 (c) virtual and reduced size
 (d) **real and enlarged size**
34. The diameter of eyeball is _____.
 (a) **2.3 cm** (b) 23 cm
 (c) 2.3 mm (d) 0.23 mm
35. An object is placed 25 cm from a convex lens whose focal length is 10 cm. The image distance is _____ cm.
 (a) 50 (b) **16.66**
 (c) 6.66 (d) 10
- $$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} + \frac{1}{-25} = \frac{1}{10} - \frac{1}{25}$$

$$\frac{1}{v} = \frac{15}{250}; v = \frac{250}{15} = \frac{50}{3} = 16.66 \text{ cm}$$
36. Magnification produced by a lens is
 (a) $\frac{\text{height of the image}}{\text{height of the object}}$
 (b) $\frac{\text{Distance of the image}}{\text{Distance of the object}}$
 (c) **Both a & b** (d) $\frac{1}{v} - \frac{1}{f} = \frac{1}{u}$
37. The reciprocal of the focal length of the lens is _____.
 (a) Magnification (b) **Power**
 (c) Principal focus (d) None
38. The least distance of distinct vision is _____.
 (a) 25 m (b) 20 cm
 (c) 20 m (d) **25 cm**
39. The image formed on retina of human eye is _____.
 (a) Virtual and erect
 (b) **Real & inverted**
 (c) Virtual & inverted
 (d) Real & erect
40. The change in the focal length of human eye is caused by _____.
 (a) Pupil (b) **Ciliary muscles**
 (c) Cornea (d) Iris

41. The phenomena of light responsible for the working of the human eye is _____.
 (a) Reflection (b) **Refraction**
 (c) Power (d) Accommodation
42. The amount of light entering into the human eye is controlled by _____.
 (a) Ciliary muscles (b) Pupil
 (c) Cornea (d) **Iris**
43. The part of the eye refracts light entering the eye from external objects?
 (a) Lens (b) **Cornea**
 (c) Iris (d) Pupil
44. A person cannot see objects clearly beyond 50 cm. The power of lens to correct the vision is _____.
 (a) +5 D (b) -0.5 D
 (c) **-2 D** (d) +2 D
45. The human eye forms the image of an object at its _____.
 (a) Cornea (b) Iris
 (c) Pupil (d) **Retina**
46. In Astigmatism, eye cannot see _____.
 (a) distance object (b) nearby object
 (c) **parallel lines** (d) both a & b
47. Presbyopia is due to _____.
 (a) Lengthening of eye ball
 (b) Shortening of eye ball
 (c) **Ageing**
 (d) Development of Cataract
48. Cylindrical lens is used to correct _____.
 (a) Myopia (b) Hypermetropia
 (c) Presbyopia (d) **Astigmatism**
49. Simple microscope consists of _____.
 (a) **Short focal length of convex lens**
 (b) Large focal length of concave
 (c) Short focal length of concave
 (d) Large focal length of convex
50. Simple microscopes are used _____.
 (a) To observe parts of flower
 (b) Watch repair
 (c) Observe finger prints
 (d) **All the above**
51. Magnification power of microscopes can be increased by using lenses of _____.
 (a) Large focal length eye piece
 (b) Objective lens
 (c) **Shorter focal length of the eye piece**
 (d) Larger focal length of objective
52. A magnifying glass is also called as _____.
 (a) Telescope
 (b) Compound microscope
 (c) **Simple microscope**
 (d) Astronomical telescope
53. To view heavenly objects like stars, _____ is used
 (a) Simple microscope
 (b) Compound microscope
 (c) Terrestrial telescope
 (d) **Astronomical telescope**
54. To increase the magnification of the telescope _____.
 (a) Increase the focal length of the objective
 (b) Increase the focal length of the eye piece
 (c) Decrease the focal length of the eye piece
 (d) **Both a & c**
55. In compound microscope, as compared to eye piece, objective lens has _____ focal length
 (a) -ve focal length (b) Zero
 (c) **Small** (d) Large
56. _____ are used to view the objects on the surface of the earth.
 (a) Simple Microscope
 (b) Compound Microscope
 (c) **Terrestrial Telescopes**
 (d) Astronomical Telescopes
57. The resolving power depends on _____.
 (a) diameter of the lens
 (b) Wavelength (c) Refractive index
 (d) **a & b**
58. A lens which collects light from the distant object in a telescope is _____.
 (a) **Objective lens** (b) Diverging
 (c) Eye lens (d) Polars
59. As compared to single lens, compound microscope gives _____ magnification
 (a) Smaller (b) **Greater**
 (c) No (d) Equal

60. An inverted image of the object is formed in _____.
(a) Simple microscope
(b) Compound microscope
(c) Astronomical telescope
(d) Both b & c
61. Device used to see very small object is _____.
(a) Simple microscope
(b) Compound microscope
(c) Telescope (d) Mirror
62. In a simple microscope to obtain higher magnification, the focal length of convex lens should be _____.
(a) Large (b) Small
(c) 1 cm (d) None
63. In compound microscope, _____ lenses are used.
(a) 2 (b) 3
(c) 4 (d) 1
64. Image formed in simple microscope is _____.
(a) Erect (b) Inverted
(c) Smaller than object
(d) Bright
65. Objective lens of telescope is of _____.
(a) Short focal length & short aperture
(b) Short focal length & large aperture
(c) Large focal length & large aperture
(d) Large focal length & short aperture
66. To increase the magnification of the telescope, the focal length of the _____.
(a) Objective lens is small and eye lens is large
(b) Objective lens is large and eye lens is small
(c) Objective lens and eye lens are small
(d) Objective lens and eye lens are large
67. The second law of refraction is also known as _____.
(a) law of reflection (b) law of dispersion
(c) Mie scattering (d) Snell's law
68. _____ is an optical instrument used to see distant objects.
(a) Microscope (b) Telescope
(c) Kaleidoscope (d) none of the above
69. The speed of light in vacuum is _____ m s^{-1} .
(a) 3×10^8 (b) 388×10^8
(c) 0.38×10^8 (d) 3.6×10^8
70. Light is characterized by _____ and frequency.
(a) waves (b) wavelength
(c) speed (d) distance
71. The ratio of speed of light in vacuum to the speed of light in medium is _____.
(a) velocity (b) refractive index
(c) refraction
(d) scattering property
72. _____ lenses are used as eye lens of 'Galilean Telescope'.
(a) Convex (b) Concave
(c) Bifocal (d) Both (a) and (b)
73. Power of accommodation is achieved by changing the _____ of the eye lens.
(a) curvature (b) retina
(c) focal length (d) vision
74. The refractive index of a medium is dependent on the _____.
(a) wavelength (b) velocity
(c) frequency (d) none of the above
75. _____ scattering is responsible for the white appearance of the clouds.
(a) Rayleigh (b) Mie
(c) Tyndall (d) Raman
76. If one of the faces of a biconcave lens is plane, it is known as _____ lens.
(a) concave (b) convex
(c) plano-concave (d) plano-convex
77. _____ lenses are used as camera lenses.
(a) Concave (b) Bifocal
(c) Convex (d) none of the above
78. When an object is placed at infinity, a _____ image is formed at the focus for a concave lens.
(a) real (b) virtual
(c) enlarged (d) inverted
79. Distances are measured from the _____ of the lens.
(a) focus (b) curvature
(c) beyond curvature
(d) optical centre

FILL IN THE BLANKS

1. Blue and green light have different _____ and _____. [Ans. wavelength, frequency]
2. Refraction is due to difference in _____ of light in different media. [Ans. velocity]
3. Angle of refraction is _____ for red and _____ for violet. [Ans. smallest, largest]
4. The refractive index of a medium is dependent on _____ of the light. [Ans. wavelength]
5. The interacting particle of the medium is called as _____. [Ans. scatterer]
6. The amount of scattering of light depends on _____ and _____. [Ans. wavelength of light, size of the particle]
7. White appearance of the clouds is due to _____. [Ans. Mie scattering]
8. The magnification is greater than 1, then the image obtained is _____. [Ans. enlarged]
9. The magnification is _____ than 1, then the image obtained is diminished. [Ans. less]
10. The object is always placed on _____ side of the lens. [Ans. left]
11. The power of convex lens is _____. [Ans. +ve]
12. The power of concave lens is _____. [Ans. -ve]
13. Unit of power is _____. [Ans. dioptre]
14. 1 D is equal to _____. [Ans. 1 m^{-1}]
15. The diameter of eye ball in our eye is _____. [Ans. 2.3 cm]
16. _____ tough membrane protects the internal parts of the eye. [Ans. Sclera]
17. _____ is the thin and transparent layer on the front surface of eye ball which _____ onto the lens. [Ans. cornea, refract]
18. The coloured part of the eye is _____. [Ans. Iris]
19. Iris _____ amount of light entering into the pupil. [Ans. controls]
20. The pathway for the light to retina is _____. [Ans. pupil]
21. The image of objects are formed on _____. [Ans. retina]
22. Ciliary muscles help to change the _____ of the eye lens according to the position of the object. [Ans. focal length]
23. The refractive index of eye lens is _____. [Ans. 1.437]
24. The eye lens is _____ in nature. [Ans. convex]
25. The focal length of the eye lens is adjusted by _____. [Ans. ciliary muscles]
26. Eye lens is made of a _____ material. [Ans. flexible, jelly-like]
27. When the ciliary muscle relaxes, eye lens becomes _____. [Ans. thinner]
28. To increase the focal length, the ciliary muscle _____. [Ans. relaxes]
29. A normal human eye can see clearly when objects are placed between _____ and _____. [Ans. 25 cm, infinity]
30. The far point of a normal eye is _____. [Ans. infinity]
31. Least distance of distinct vision is _____. [Ans. 25 cm]
32. Presbyopia is corrected by _____ lens. [Ans. bifocal lenses]
33. According to optical property, telescope is classified into _____ and _____. [Ans. Refracting telescope, Reflecting telescope]
34. According to the things which are observed _____ and _____ are major types of telescopes. [Ans. astronomical, terrestrial]
35. _____ is used to view heavenly bodies. [Ans. astronomical telescope]
36. The image in an astronomical telescope is _____. [Ans. inverted]
37. Terrestrial telescope is used to view objects _____. [Ans. on the land]
38. The image of terrestrial telescope is _____. [Ans. erect]
39. The focal length of objective lens is _____ than the eye pieces in compound microscope. [Ans. shorter or lesser]
40. Lenses are classified into _____ types. [Ans. two]
41. Convex lens is also called as _____ lens. [Ans. bi-convex]
42. The band of colours is termed as _____. [Ans. spectrum]
43. Concave lens is also called as _____ lens. [Ans. bi-concave]
44. _____ lens is thicker at the centre than at the edges. [Ans. convex]
45. Magnification is denoted by the letter _____. [Ans. 'm']

46. If one of the faces of a bi-convex lens is plane, it is known as a _____. [Ans. plano convex lens]
47. Light travels in the form of _____. [Ans. waves]
48. Scattering can be classified into _____ types. [Ans. two]
49. Objects which emit their own light are called _____ objects. [Ans. luminous]
50. _____ lens is thinner at the centre than at the edges. [Ans. Concave]
51. The Stars and the Sun are _____. [Ans. luminous objects]
52. Light is a form of _____. [Ans. energy]
53. Light travels along a _____ line. [Ans. straight]
54. 1 D is the power of a lens whose focal length is _____. [Ans. 1 metre]
55. Light does not need a _____ for propagation. [Ans. medium]
56. The velocity of light is given by _____. [Ans. $C = v\lambda$]
57. Among visible light, _____ light has the highest wavelength. [Ans. red]
58. When a ray of light travels from one transparent medium into another obliquely, the path of the light undergoes _____. [Ans. deviation]
59. The deviation of a ray of light is called _____. [Ans. refraction]
60. The velocity of light is more in _____ medium. [Ans. rarer]
61. The second law of refraction is also known as _____. [Ans. Snell's Law]
62. The speed of light is low, if the _____ of the medium is high. [Ans. refractive index]
63. The velocity of light is less in _____ medium. [Ans. denser]
64. When light travels from a denser medium to a rarer medium, the refracted ray is bent _____ from the normal. [July-'26] [Ans. away]
65. _____ is the fundamental and natural source of light [Ans. Sun]
66. _____ is an example of a composite source. [Ans. Mercury vapour lamp]
67. The angle of refraction is determined in terms of the _____ of the medium. [Ans. refractive index]
68. If a source of light produces a light of single colour, it is known as a _____ source. [Ans. monochromatic]
69. _____ light is a composite light which consists of light of various colours or wavelengths. [Ans. Sun]
70. If the energy of the incident beam of light and the scattered beam of light are same, then it is called as _____. [Ans. elastic scattering]
71. The _____ and _____ of the scatterer results in different types of scattering. [Ans. nature, size]
72. At sunrise and sunset, the light rays from the sun have to travel a _____ in the atmosphere than at noon. [Ans. larger distance]
73. The scattering of sunlight by the atoms or molecules of the gases in the Earth's atmosphere is known as _____ scattering. [Ans. Rayleigh]
74. The amount of scattering of light is inversely proportional to the _____ power of its wavelength. [Ans. fourth]
75. According to Rayleigh's scattering law, the shorter wavelength colours are scattered _____ than the longer wavelength colours. [Ans. more]
76. When sunlight passes through the atmosphere, the _____ colour is scattered to a greater extent than the red colour. [Ans. blue]
77. Mie scattering is also called as _____ scattering. [Ans. elastic]
78. Milk, ice cream, muddy water are _____. [Ans. colloids]
79. The spectral lines having frequency equal to the incident ray frequency is called _____. [Ans. Rayleigh line]
80. The spectral lines which are having frequencies other than the incident ray frequency are called _____. [Ans. Raman lines]
81. The lines having frequencies lower than the incident frequency is called _____ lines. [Ans. stokes]
82. The lines having frequencies higher than the incident frequency is called _____ lines. [Ans. anti-stokes]
83. _____ is an optically transparent medium bounded by two spherical refracting surfaces or one plane and one spherical surface. [Ans. Lens]
84. When rays parallel to the principal axis strikes a convex lens, the refracted rays are _____. [Ans. converged]
85. When an object is placed beyond C, a real and inverted image is formed between _____ and the principal focus for convex lens. [Ans. centre of curvature]

86. _____ lenses are used in making microscope and telescope. [Ans. convex]
87. When an object is placed between F and C, the size of the image is _____ than that of the object for a convex lens. [Ans. bigger]
88. If one of the faces of a bi-concave lens is plane, it is known as a _____. [Ans. plano-concave lens]
89. Concave lenses are used as eye lens of _____ telescope. [Ans. Galilean]
90. When a ray of light strikes the _____ lens obliquely at its optical centre, it follows without any deviation. [Ans. convex or concave]
91. When an object is placed in between principal focus and optical centre, a _____ is formed. [Ans. virtual image]
92. _____ lenses are used as magnifying lenses. [Ans. Convex]
93. When an object is placed at infinity, a _____ is formed at the focus of a concave lens. [Ans. virtual image]
94. The size of the image formed _____ as the distance between the object and the lens decreases in concave lens. [Ans. increases]
95. _____ lenses are used in wide angle spy hole in doors. [Ans. Concave]
96. The ability of a lens to converge and diverge is called as its _____. [Ans. power]
97. _____ lenses are used as camera lenses. [Ans. Convex]
98. The distances _____ and perpendicular to the principal axis is taken as positive. [Ans. measured upward]
99. _____ is defined as the ratio of the height of the image to the height of an object. [Ans. magnification]
100. Any optically _____ will have a refractive index. [Ans. transparent material]
101. Convex lens mostly produces _____ image. [Ans. real]
102. Power of a lens is numerically defined as the reciprocal of its _____. [Ans. focal length]
103. _____ and the lens maker's formula are applicable to only thin lenses. [Ans. Lens formula]
104. _____ protects the internal parts of the eye. [Ans. Sclera]
105. A thin and transparent layer on the surface of the eyeball is _____. [Ans. Cornea]
106. Central part of eye and pathway for the light to retina is _____. [Ans. Pupil]
107. Eye lens is fixed between the _____ muscles. [Ans. Ciliary]
108. Eye lens is _____ in nature. [Ans. convex]
109. The ability of the eye lens to focus nearby as well as the distant objects is called _____ of the eye. [Ans. power of accommodation]
110. _____ is the centre part of the iris. [Ans. Pupil]
111. The power of accommodation is achieved by changing the _____ of the eye lens. [Ans. focal length]
112. The tiny dust particles present in the air of the room scatter the beam of light is an example of _____. [Ans. Tyndall Scattering]
113. Astigmatism is corrected using _____ lenses. [Ans. cylindrical]
114. Both the defects of vision - myopia as well as hypermetropia can be corrected by _____. [Ans. bifocal lenses]
115. A _____ microscope has a convex lens of short focal length. [Ans. simple]
116. Magnification power of microscopes can be increased by decreasing the _____ of the lens used. [Ans. focal length]
117. Compound microscope has _____ to _____ times more magnification power than simple microscope. [Ans. 50 to 200]
118. A _____ microscope is used to measure very small length with high degree of accuracy. [Ans. travelling]
119. The least count of a travelling microscope is _____. [Ans. 0.01 mm]
120. _____ is an optical instrument to see the distant objects. [Ans. Telescope]
121. The first telescope was invented by _____ in 1608. [Ans. Johann Lippershey]
122. _____ made a telescope to observe distant stars. [Ans. Galileo]
123. _____ invented telescope was similar to the astronomical telescope. [Ans. Kepler]
124. A _____ microscope works based on the principle of vernier. [Ans. travelling]
125. The minimum distance required to see the objects distinctly without strain is called _____. [Ans. Least distance of distinct vision]
126. _____ is known as long sightedness. [Ans. Hypermetropia]

127. ____ mirrors are used in reflecting telescope.
[Ans. parabolic]

128. Aged person cannot see the nearby objects clearly. It is called _____.
[Ans. old age hypermetropia]

129. Galilean telescope, Keplerian telescope are some of the examples of _____ telescope.
[Ans. refracting]

130. The ratio of speed of light in vacuum to the speed of light in medium is defined as _____.
[Ans. Refractive index (μ) of medium]

131. The energy of incident and scattered beam of light are not same, that scattering is called _____.
[Ans. Inelastic Scattering]

132. Mie scattering is caused by _____, _____ and _____.
[Ans. Pollen, Dust, Smoke]

133. The scattering of light contains additional frequencies than incident frequency is called _____.
[Ans. Raman Effect]

134. When light passing through _____, refracted ray will be parallel in convex lens.
[Ans. Principal focus]

STATE WHETHER THE FOLLOWING STATEMENTS ARE TRUE OR FALSE. CORRECT THE STATEMENT IF IT IS FALSE

1. Stars and sun are non-luminous objects.

Ans. False. Correct Statement: Stars and sun are luminous objects.

2. Luminous objects give out their own light.

Ans. True.

3. Light always travels along curved line.

Ans. False. Correct Statement: Light always travels along straight line.

4. Material medium is needed for the propagation of light.

Ans. False. Correct Statement: Material medium is not needed for the propagation of light.

5. Different coloured light has same wavelength and frequency.

Ans. False. Correct Statement: Different coloured light has different wavelength and frequency.

6. Red light has the highest wavelength and violet has lowest wavelength.

Ans. True.

7. Incident ray and refracted ray lie in different plane.

Ans. False. Correct Statement: Incident ray and refracted ray lie in same plane.

8. The speed of light in a medium is low because of low refractive index of the medium.

Ans. False. Correct Statement: The speed of light in a medium is low because of high refractive index of the medium.

9. When light travels from denser to rarer, refracted ray bent away from normal.

Ans. True.

10. When white light pass through transparent medium, it is split into colours is called dispersion.

Ans. True.

11. Mie scattering is responsible for the white appearance of the clouds.

Ans. True.

12. The distance between the principal focus and pole is focal length of the lens.

Ans. True.

13. Amount of scattering of light is directly proportional to fourth power of its wavelength.

Ans. False. Correct Statement: Amount of scattering of light is inversely proportional to fourth power of its wavelength.

14. In inelastic scattering, the energy of incident and scattered light are same.

Ans. False. Correct Statement: In inelastic scattering, the energy of incident and scattered light are not same.

15. The amount of scattering is independent of wavelength in Rayleigh scattering.

Ans. False. Correct Statement: The amount of scattering is independent of wavelength in Mie scattering.

16. In Raman Scattering, the scattered light contains the lines having frequency less than incident frequency is Anti-stokes.

Ans. False. Correct Statement: In Raman scattering, the scattered light contains the lines having frequency less than incident frequency is stokes.

17. If one of the faces of a bi-convex lens is plane. It is known as a plano-convex lens.

Ans. True.

18. The line joining the centre of curvature and the optic centre is pole.

Ans. False. Correct Statement: The line joining the centre of curvature and the optic centre is **principal axis**.

19. The geometrical centre of the lens is called optic centre.

Ans. True.

20. When a ray strikes the pole or optic centre of the concave or convex lens it gets deviated.

Ans. False. Correct Statement: When a ray strikes the pole or optic centre of the concave or convex lens it does not get deviated.

21. Parallel rays are obtained after refraction when light passes through the focus.

Ans. True.

22. Concave lenses are used in camera lenses.

Ans. False. Correct Statement: **Convex** lenses are used in camera lenses.

23. Hypermetropia is corrected by using convex lens.

Ans. True.

24. Concave lens is used to correct hypermetropia.

Ans. False. Correct Statement: Concave lens is used to correct **myopia**.

25. The distance measured against the direction of incident light are taken as positive.

Ans. False. Correct Statement: The distance measured against the direction of incident light are taken as negative.

26. The distance measured upward and perpendicular to the principal axis is taken as positive.

Ans. True.

27. If magnification is greater than one diminished image will be obtained.

Ans. False. Correct Statement: If magnification is greater than one **enlarged** image will be obtained.

28. The power of the lens is the degree of convergence or divergence.

Ans. True.

29. The unit of power of the lens is m.

Ans. False. Correct Statement: The unit of power of the lens is **diopetre or m^{-1}** .

30. Refractive index gives an idea about the velocity of light in a medium.

Ans. True.

31. Rayleigh's scattering is inelastic scattering.

Ans. False. Correct Statement: Rayleigh's scattering is **elastic** scattering.

32. The distance between optic centre and centre of curvature is called as 'focal length'.

Ans. False. Correct Statement: Focal length of a lens is the distance of its principal focus from its optical centre.

33. Concave lens is used as 'Magnifying lens'.

Ans. False. Correct Statement: **Convex lens** is used as magnifying lens.

34. The final image formed by the astronomical telescope is 'erect image'.

Ans. False. Correct Statement: The final image is an **inverted** image.

MATCH THE FOLLOWING

I.

(1)	Object which gives out light	a	highest frequency
(2)	Object which emit their own light	b	highest wavelength
(3)	violet light	c	source
(4)	red light	d	Luminous

[Ans. 1-c, 2-d, 3-a, 4-b]

II.

(1)	Deviation of ray	a	Dispersion
(2)	Objects can be seen	b	Refraction
(3)	Splitting up of colours	c	Scattering of light
(4)	Blue colour of the sea	d	Reflection

[Ans. 1-b, 2-d, 3-a, 4-c]

III.

(1)	Protection of the internal parts of the eye	a	Iris
(2)	Refracts light	b	Sclera
(3)	Control the amount of light entering	c	pupil
(4)	Pathway of light	d	cornea

[Ans. 1-b, 2-d, 3-a, 4-c]

IV.

(1)	Diameter of the eye ball	a	less than $\frac{1}{16}$ seconds
(2)	Refractive index of eye lens	b	infinity
(3)	Persistence of vision	c	2.3 cm
(4)	Least distance of distinct vision	d	1.437
(5)	Far point of distinct vision	e	25 cm

[Ans. 1-c, 2-d, 3-a, 4-e, 5-b]

V.

Position of the Object		Position of the Image	
(1)	At infinity	a	Between F_2 and $2F_2$
(2)	Beyond $2F_1$	b	at $2F_2$
(3)	At $2F_1$	c	Beyond $2F_2$
(4)	Between F_1 and $2F_1$	d	Infinity
(5)	At F_1	e	F_2

[Ans. 1-e, 2-a, 3-b, 4-c, 5-d]

VI.

(a)	Cornea	-	(1)	bifocal lens
(b)	Retina	-	(2)	cylindrical lens
(c)	Presbyopia	-	(3)	Refracting surface
(d)	Astigmatism	-	(4)	back surface of eye

[Ans. a-3, b-4, c-1, d-2]

VII.

(a)	Velocity of light	-	(1)	$s \propto \frac{1}{\lambda^4}$
(b)	Snell's Law	-	(2)	concave
(c)	Rayleigh's scattering	-	(3)	$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$
(d)	Camera lens	-	(4)	$c = v\lambda$
(e)	Galilean Telescope	-	(5)	convex

[Ans. a-4, b-3, c-1, d-5, e-2]

VIII.

(a)	lens formula	-	(1)	$f = -x$
(b)	Power of lens	-	(2)	$f = \frac{dD}{d-D}$
(c)	Myopia	-	(3)	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
(d)	Hypermetropia	-	(4)	$p = \frac{1}{f}$

[Ans. a-3, b-4, c-1, d-2]

IX.

(a)	Tyndall scattering	-	(1)	Gases
(b)	Rayleigh scattering	-	(2)	Colloids
(c)	Mie scattering	-	(3)	optical centre
(d)	Raman scattering	-	(4)	Pollen
(e)	Distances in a lens	-	(5)	monochromatic light

[Ans. a-2, b-1, c-4, d-5, e-3]

ASSERTION AND REASON

Direction :

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

1. **Assertion:** During sun set, sun appears red.
Reason: Scattering of light is directly proportional to the wavelength.

[Ans. (c) Assertion is true but reason is false]

2. **Assertion:** The air bubble shines in water.
Reason: Air bubble in water shines due to refraction of light.

[Ans. (c) Assertion is true but reason is false]

Hint: Shines due to internal reflection

3. **Assertion:** Blue colour of sky appears due to scattering of blue colour.

Reason: Blue colour has shorter wavelength in visible light.

[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]

4. **Assertion:** The stars twinkle while the planets do not.
Reason: The stars are much bigger in size than the planets. [Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion]
5. **Assertion:** The cloud in sky generally appears white.
Reason: Due to diffraction of clouds [The light is scattered by the water droplets inside the cloud]
 [Ans. (c) Assertion is true but reason is false]
6. **Assertion:** Diamond glitters brilliantly.
Reason: Diamond does not absorb sunlight.
 [Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion]
7. **Assertion:** Property of lens, whether the ray is converging or diverging is independent of the surrounding medium.
Reason: The converging property of a convex lens is the same in all media.
 [Ans. (d) Both assertion and reason are false]
8. **Assertion:** A convex lens made of two different materials. A point object is placed on the principal axis; two images will be formed by the lens.
Reason: The image formed by convex lens is always 'virtual'.
 [Ans. (c) Assertion is true but reason is false]
9. **Assertion:** Bending of light rays from its original path at the interface of the two media is called 'Refraction'.
Reason: Whenever the light travels from denser medium to rarer medium, it bends away from the normal.
 [Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]
10. **Assertion:** Mie scattering is responsible for the white appearance of the cloud.
Reason: Mie scattering is caused by pollen, dust, smoke.
 [Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion]
11. **Assertion:** Astronomical telescope is used to view heavenly bodies.
Reason: Telescope is easily portable.
 [Ans. (c) Assertion is true, but reason is false]

12. **Assertion:** Colour of the sun is red at sunrise and sunset.

Reason: The light rays from the sun have to travel a larger distance in the atmosphere than at noon.

[Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion]

USE THE ANALOGY TO FILL IN THE BLANK

1. Blue : _____ :: Red : longer wavelength
 Ans. Shorter wavelength.
2. Deviation of light : _____ :: Splitting of light : dispersion
 Ans. Refraction.
3. Biology : microscope :: Astronomy : _____
 Ans. Telescope.
4. Scattering of light by gas molecules : Rayleigh scattering :: Scattering of light by dust : _____
 Ans. Mie scattering.
5. Mercury vapour lamp : _____ :: Sodium vapour lamp : monochromatic light
 Ans. White light.
6. Stokes line : low frequency :: Anti-stokes line : _____
 Ans. high frequency
7. Violet : lowest wavelength :: Red : _____
 Ans. highest wavelength
8. Convex lens : converging, real image :: Concave lens : _____
 Ans. diverging, virtual image
9. Myopia : short sightedness :: hypermetropia : _____
 Ans. long sightedness
10. Thicker : convex :: Thinner : _____
 Ans. concave

ARRANGE THE FOLLOWING IN CORRECT SEQUENCE

1. Arrange the colours according to their wavelengths in ascending order.
 Orange, Indigo, Blue, Green
 Ans. Indigo, Blue, Green, Orange

2. Arrange in order accordingly how a bulb gives out light waves.

Transverse waves, Filament heated, Light energy, Electric current.

Ans. Electric current, Filament heated, Light energy, Transverse waves.

3. Arrange the properties of light accordingly, when light travels through any transparent medium.

Diffraction, Dispersion, Reflection, Refraction

Ans. Reflection, Refraction, Dispersion, Diffraction.

4. Arrange in sequence, the steps to find the focal length of a convex lens.

Measure the distance between lens and screen, Find the focal length 'f', Focus the lens on a distant object, Adjust the screen to catch a clear image.

Ans. Focus the lens on to a distant object, Adjust the screen to catch a clear image, Measure the distance between lens and screen, Find the focal length, f.

GIVE THE ANSWER IN ONE OR TWO LINES

1. Which phenomenon is responsible for making the path of light visible?

Ans. Tyndall effect is responsible for making the path of light visible.

2. State one function of iris in human eye.

Ans. Iris controls the size of pupil.

3. State one function of pupil.

Ans. Pupil is the pathway for the light to reach the retina; the amount of light passing through it is controlled by the iris.

4. Define : Principal focus of a convex lens.

Ans. Principal focus is a point on the principal axis, at which a beam of parallel rays are converged after refraction.

5. Fish in shallow water appears closer than its real position. Give reason.

Ans. Fish appears closer due to refraction of light as it travels from denser medium (water) to rarer medium (air).

6. Why do stars twinkle?

Ans. Stars twinkle due to atmospheric refraction of light from the star.

VERY SHORT ANSWERS

2 MARKS

1. What is refraction of light?

Ans. When a ray of light travels from one transparent medium into another obliquely, the path of light undergoes deviation. This deviation of ray of light is called **refraction**.

2. Why do we get the spectrum when white light is refracted by a transparent medium?

Ans. The angle of refraction is different for different colours.

3. What is meant by Scattering of light?

Ans. When sunlight enters the earth's atmosphere, the atoms and molecules of different gases present in the atmosphere refract the light in all possible directions. This is called as '**Scattering of light**'.

4. What is Plano-convex lens?

Ans. If one of the faces of a biconvex lens is plane, it is known as a plano convex lens.

5. Write different types of scattering depend upon the nature and size of the scatterer.

Ans. (i) Rayleigh scattering
(ii) Mie scattering
(iii) Tyndall scattering
(iv) Raman scattering

6. What is meant by Rayleigh scattering?

Ans. The scattering of sunlight by the atoms or molecules of the gases in Earth's atmosphere is known as **Rayleigh scattering**.

7. Why does the cloud appear white instead of blue?

Ans. Mie scattering is responsible for the white appearance of the clouds. When white light falls on the water drop, all the colours are equally scattered which together form the white light.

8. What is Tyndall scattering?

Ans. The scattering of light rays by the colloidal particles in the colloidal solution is called **Tyndall Scattering** or **Tyndall Effect**.

9. What is Colloid? Give example.

Ans. Colloid is a microscopically small substance that is equally dispersed throughout another material. Example: Milk, Ice cream, muddy water, smoke.

10. Define Raman scattering.

Ans. Raman Scattering is defined as "The interaction of light ray with the particles of pure liquids or transparent solids, which leads to a change in wavelength or frequency."

11. What are stokes lines?

Ans. The lines having frequencies lower than the incident frequency is called **stokes lines**.

12. Define Optical centre (O).

Ans. The geometrical centre of the lens.

13. What is Centre of curvature (C_1 and C_2)?

Ans. The centre of the sphere of which the face of the lens forms a part.

14. Define Radius of curvature (R_1 and R_2).

Ans. The radius of the sphere of which the face of the lens forms a part.

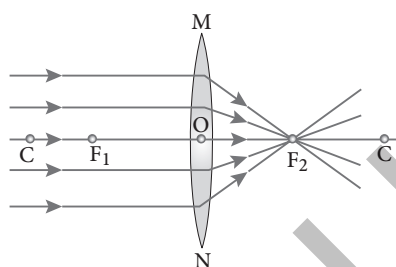
15. Define Principal axis and pole.

Ans. (i) Principal axis : The line joining the centre of curvature and the optical centre.

(ii) Pole (P_1 and P_2) : The point at which the principal axis meets the surface of the lens.

16. Draw formation of images by a convex lens when the object is placed at infinity.

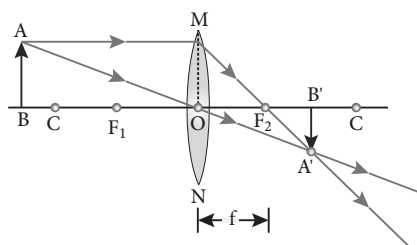
Ans.



Object at infinity

17. Draw a ray diagram of the image formed by a convex lens when the object is placed beyond $2F$ (C).

Ans.



Object placed beyond C ($>2F$)

18. Write the Lens Formula.

Ans. The lens formula gives the relationship among the distance of the object (u), distance of the image (v), and the focal length (f) of the lens.

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

19. Define Magnification of a lens.

Ans. It is defined as the ratio of the height of the image to the height of an object. Magnification is denoted by the letter 'm'.

$$m = \frac{\text{Distance of the image}}{\text{Distance of the object}} = \frac{v}{u}$$

20. Define Power of a lens.

Ans. (i) The degree of convergence or divergence of light rays.

(ii) Power of a lens is numerically defined as the reciprocal of its focal length.

$$P = \frac{1}{f}$$

(iii) The SI unit of power of a lens is dioptre.

21. What is the use of Retina?

Ans. Retina is the most sensitive part of human eye on which real and inverted image of objects is formed.

22. Write the function of Ciliary muscles.

Ans. Ciliary muscles help to change the focal length of the eye lens according to the position of the object.

23. What is persistence of vision?

Ans. If the time interval between two consecutive light pulses is less than $\frac{1}{16}$ second, human eye cannot distinguish them separately. It is called persistence of vision.

24. Why is cornea spherical?

Ans. The spherical nature of cornea helps view objects over wide range. Otherwise, we can only view objects directly in front of cornea.

25. What is the principle used in Microscope?

Ans. Microscope works under the principle of angular magnification of lenses.

26. What is the use of telescope?

Ans. It is an optical instrument to see the distant objects like stars, planets etc., in space.

27. What is Terrestrial Telescope?

Ans. Terrestrial telescope is used for viewing objects on the surface of the Earth as it provides an erect image.

28. What is the major difference between astronomical and terrestrial telescope?

Ans. The major difference between astronomical and terrestrial telescope is erecting the final image with respect to the object.

29. Write the disadvantages of telescope.

- Ans.** (i) Frequent maintenance is required.
(ii) It is not easily portable one.

SHORT ANSWERS

4 MARKS

1. What are the conclusions obtained from laws of refraction?

- Ans.** (i) The speed of light in a medium is low if the refractive index of the medium is high and vice versa.
(ii) When light travels from a denser medium into a rarer medium, the refracted ray is bent away from the normal drawn to the interface.
(iii) When light travels from a rarer medium into a denser medium, the refracted ray is bent towards the normal drawn to the interface.

2. Name and explain the types of scattering.

Ans. Based on initial and final energy of the light beam, scattering can be classified as, (i) Elastic scattering, (ii) Inelastic scattering.

- (i) **Elastic scattering:** If the energy of the incident beam of light and the scattered beam of light are same, then it is called as 'elastic scattering'
(ii) **Inelastic scattering:** If the energy of the incident beam of light and the scattered beam of light are not same, then it is called as 'inelastic scattering.'

3. When does Mie scattering take place? Write the causes.

- Ans.** (i) Mie scattering takes place when the diameter of the scatterer is similar to or larger than the wavelength of the incident light. It is also an elastic scattering.
(ii) The amount of scattering is independent of wave length.

Causes: It is caused by pollen, dust, smoke, water droplets, and other particles in the lower portion of the atmosphere.

4. Explain the types of lens.

Ans. Convex or bi-convex lens:

- (i) It is a lens bounded by two spherical surfaces such that it is thicker at the centre than at the edges.
(ii) A beam of light passing through it is converged to a point. So, a convex lens is also called as **converging lens**.

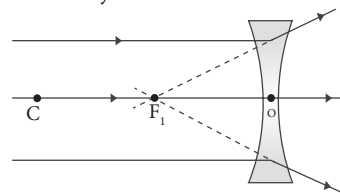
Concave or bi-concave Lens :

- (i) It is a lens bounded by two spherical surfaces such that it is thinner at the centre than at the edges.
(ii) A parallel beam of light passing through it is diverged or spread out. So, a concave lens is also called as **diverging lens**.

5. Draw images formation due to refraction through a concave lens.

Ans. Object at Infinity:

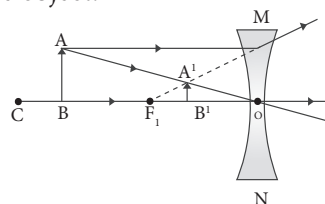
- (i) When an object is placed at infinity, a virtual image is formed at the focus.
(ii) The size of the image is much smaller than that of the object.



Concave lens-Object at infinity

Object anywhere on the principal axis at a finite distance :

- (i) When an object is placed at a finite distance from the lens, a virtual image is formed between optical centre and focus of the concave lens.
(ii) The size of the image is smaller than that of the object.



Concave lens- Object at a finite distance

6. How do we see distant and closer objects?

- Ans.** (i) To see distant objects, the ciliary muscle relaxes and makes the eye lens thinner. This increases the focal length of eye lens.

- (ii) Hence, the distant object can be clearly seen. When we look at a closer object, the focal length of the eye lens is decreased by the contraction of ciliary muscle.

- (iii) Thus, the image of the closer object is clearly formed on the retina.

7. What is near point and far point of a human eye?

Ans. (i) Near point : The minimum distance required to see the objects distinctly without strain is called least **distance of distinct vision**. It is 25 cm for normal human eye.

- (ii) **Far point :** The maximum distance up to which the eye can see objects clearly is called as **far point of the eye**. It is infinity for normal eye.

8. What is 'Presbyopia'?

Ans. (i) Due to ageing, ciliary muscles becoming weak and the eye-lens becoming rigid (inflexible), the eye loses its power of accommodation.

- (ii) Because of this, an aged person cannot see the nearby objects clearly. So, it is also called as 'old age hypermetropia'.

9. The colour of the sun is reddish during the sun rise and sunset. Explain why?

Ans. (i) At sunrise and sunset, the light rays from the sun have to travel a larger distance in the atmosphere than at noon.

- (ii) Hence, most of the blue lights are scattered away and only the red light which gets least scattered reaches us.

- (iii) Therefore, the colour of the sun is red at sunrise and sunset.

10. Why is a normal eye not able to see clearly the objects placed closer than 25 cm?

Ans. (i) The ciliary muscles cannot contract beyond a certain limit, so the focal length of the eye lens cannot be reduced below a certain minimum value.

- (ii) Hence, rays from objects nearer than 25 cm cannot be brought to focus on the retina.

11. What is Lens? What are types of lenses?

Ans. (i) A lens is an optically transparent medium bounded by two spherical refracting surfaces or one plane and one spherical surface.

- (ii) Lens is basically classified into two types. They are: (i) Convex Lens (ii) Concave Lens.

12. What is the function of Cornea?

Ans. (i) This is the thin and transparent layer on the front surface of the eyeball.

- (ii) It is the main refracting surface.

- (iii) When light enters through the cornea, it refracts or bends the light on to the lens.

13. Explain the function of Iris.

Ans. (i) It is the coloured part of the eye. It may be blue, brown or green in colour.

- (ii) Every person has a unique colour, pattern and texture.

- (iii) Iris controls amount of light entering into the pupil like camera aperture.

14. What is Astigmatism? How it is corrected?

Ans. (i) In this defect, eye cannot see parallel and horizontal lines clearly.

- (ii) It is due to the imperfect structure of eye lens because of the development of cataract on the lens, ulceration of cornea, injury to the refracting surfaces, etc.

- (iii) Astigmatism can be corrected by using cylindrical lenses.

LONG ANSWERS

7 MARKS

1. State the laws of refraction.

Ans. (i) First law of refraction : The incident ray, the refracted ray of light and the normal to the refracting surface all lie in the same plane.

- (ii) **Second law of refraction :** The ratio of the sine of the angle of incidence and sine of the angle of refraction is equal to the ratio of refractive indices of the two media. This law is also known as Snell's law.

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

2. Explain Raman Scattering.

Ans. (i) When a parallel beam of monochromatic (single coloured) light passes through a gas or liquid or transparent solid, a part of light rays are scattered.

- (ii) Raman Scattering is defined as "The interaction of light ray with the particles of pure liquids or transparent solids, which leads to a change in wavelength or frequency."

- (iii) The scattered light contains some additional frequencies (or wavelengths) other than that of incident frequency (or wavelength). This is known as **Raman scattering** or **Raman Effect**.

- (iv) The spectral lines having frequency equal to the incident ray frequency is called 'Rayleigh line' and the spectral lines which are having frequencies other than the incident ray frequency are called 'Raman lines'.
- (v) The lines having frequencies lower than the incident frequency is called Stokes lines and the lines having frequencies higher than the incident frequency are called Antistokes lines.

3. Explain the Sign Conventions of lenses.

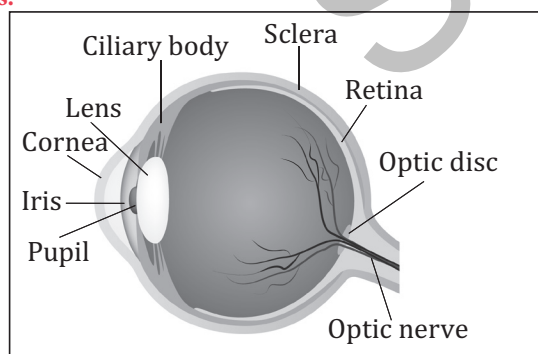
Ans. Cartesian sign conventions are used for measuring the various distances in the ray diagrams of spherical lenses.

According to Cartesian sign convention,

- (i) The object is always placed on the left side of the lens.
- (ii) All the distances are measured from the optical centre of the lens.
- (iii) The distances measured in the same direction as that of incident light are taken as positive.
- (iv) The distances measured against the direction of incident light are taken as negative.
- (v) The distances measured upward and perpendicular to the principal axis is taken as positive.
- (vi) The distances measured downward and perpendicular to the principal axis is taken as negative.

4. Explain the working of the eye.

Ans.



Human eye

- (i) The transparent layer cornea bends the light rays through pupil located at the centre part of the Iris.
- (ii) The adjusted light passes through the eye lens. Eye lens is convex in nature. So, the light rays from the objects are converged and a real and inverted image is formed on retina.

- (iii) Then, retina passes the received real and inverted image to the brain through optical nerves. Finally, the brain senses it as erect image.

5. Explain the construction of Simple Microscope.

Ans. (i) Simple Microscope : Simple microscope has a convex lens of short focal length. It is held near the eye to get enlarged image of small objects.

- (ii) Let an object (AB) is placed at a point within the principal focus ($u < f$) of the convex lens and the observer's eye placed just behind the lens.

- (iii) As per this position the convex lens produces an erect, virtual and enlarged image (A'B'). The image formed is in the same side of the object and the distance equal to the least distance of distinct vision (D) ($D = 25$ cm for normal human eye)

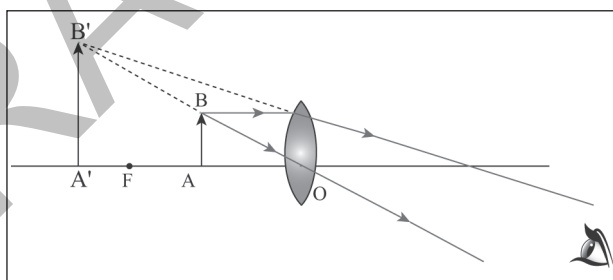


Image formation in simple microscope

6. Explain the types of Telescope.

Ans. According to optical property, it is classified into two types.

- (i) Refracting telescope
- (ii) Reflecting telescope
- (i) **Refracting telescope :** Lenses are used in this kind of telescopes. Galilean telescope, Keplerian telescope, Achromatic refractors, are some refracting telescopes.
- (ii) **Reflecting telescope :** In reflecting telescope parabolic mirrors are used. Gregorian, Newtonian, Cassegrain telescope are some reflecting telescopes. According to the things which are observed, **Astronomical Telescope and Terrestrial Telescopes** are the two major types of telescope.

7. Explain the refraction of light through a glass prism.

- Ans. (i)** When a beam of white light or composite light is refracted through any transparent media such as glass or water, it is split into its component colours. This phenomenon is called as '**dispersion of light**'.
- (ii)** The band of colours is termed as spectrum. This spectrum consists of following colours: Violet, Indigo, Blue, Green, Yellow, Orange, and Red. These colours are represented by the acronym "VIBGYOR".
- (iii)** When white light is refracted by a transparent medium, different coloured lights are bent through different angles. That is the angle of refraction is different for different colours.
- (iv)** Angle of refraction is the smallest for red and the highest for violet.
- (v)** From Snell's law, we know that the angle of refraction is determined in terms of the refractive index of the medium.
- (vi)** Hence, the refractive index of the medium is different for different coloured lights.

NUMERICAL PROBLEMS

1. The refractive index of kerosene is 1.44. Find the velocity of light through kerosene.

Given

Velocity of light through air, $c_a = 3 \times 10^8 \text{ ms}^{-1}$

Velocity of light through air, $C_a = 3 \times 10^8 \text{ ms}^{-1}$

To find : Speed of light through kerosene,
 $c_k = ?$

Refractive index of kerosene, $\mu_k = 1.44$

Solution

$$\mu_k = \frac{c_a}{c_k} \Rightarrow 1.44$$

$$C_a = \frac{3 \times 10^8}{1.44} = 2.083 \times 10^8 \text{ ms}^{-1}$$

Speed of light through kerosene,

$$c_k = 2.083 \times 10^8 \text{ ms}^{-1}$$

2. The refractive index of kerosene is 1.44 and that of diamond is 2.42. Calculate the refractive index of diamond with respect to kerosene.

Solution

Refractive index of diamond with respect to kerosene

$$= \frac{\text{Refractive index of diamond}}{\text{Refractive index of kerosene}}$$

$$= \frac{2.42}{1.44} = 1.68$$

3. Speed of light in glass is $2 \times 10^8 \text{ ms}^{-1}$. Find the refractive index of glass.

Given

Velocity of light in air, $c = 3 \times 10^8 \text{ ms}^{-1}$

Velocity of light in glass, $v = 2 \times 10^8 \text{ ms}^{-1}$

To find : Refractive index of glass,

$$\mu = \frac{c}{v} = ?$$

$$\mu = \frac{3 \times 10^8}{2 \times 10^8} = 1.5; \mu = 1.5 \text{ (No unit)}$$

4. A light travels from air into water, the angle of refraction is 25° to the normal. Find the angle of incidence. Refractive index of water is 1.33. $\mu_a = 1$.

Given

$$\mu_1 \sin i = \mu_2 \sin r$$

$$\mu_a \sin i = \mu_w \sin r$$

$$\mu_a = 1$$

$$\mu_w = 1.33$$

$$r = 25^\circ$$

To find : Angle of incidence, $i = ?$

Solution

$$\frac{\sin i}{\sin r} = \frac{\mu_w}{\mu_a}; \sin i = \frac{1.33 \times \sin 25^\circ}{1}$$

$$i = \sin^{-1} \left(\frac{1.33 \times \sin 25^\circ}{1} \right)$$

Angle of incidence,

$$i = 34.2^\circ$$

5. Light in air enters a diamond at 45° . What is the angle of refraction? G.T $\mu_{\text{dia}} = 2.42$.

Solution

$$\mu_a \sin i = \mu_{\text{dia}} \sin r \quad \dots\dots ①$$

(Refractive index of air, $\mu_a = 1$)

(Angle of incidence, $i = 45^\circ$) in ①,

$$(1) \Rightarrow (\sin 45^\circ) = 2.42 (\sin r)$$

$$\sin r = \left(\frac{\sin 45^\circ}{2.42} \right)$$

$$r = \sin^{-1} \frac{1}{2.42}$$

$$r = \sin^{-1} \left[\frac{1}{\sqrt{2} \times 2.42} \right]$$

Angle of refraction,

$$r = 16.977 = 17^\circ$$

6. A 5 cm tall object is placed fraction to the principal axis of a convex lens of focal length 20 cm. The distance of the object from the lens is 30 cm. Find the (i) Position (ii) Nature (iii) Size of the image formed.

Given

Object size, $h_o = 5 \text{ cm}$

Object distance, $u = -30 \text{ cm}$

Focal length of convex lens, $f = 20 \text{ cm}$

To find : Position of image = ?

Nature of image = ?

Size of image $h_i = ?$

Solution

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

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

$$= \frac{1}{20} + \frac{1}{-30} = \frac{3-2}{60}$$

$$(\text{or}) \frac{1}{v} = \frac{1}{60} \Rightarrow v = 60 \text{ cm}$$

$$\text{Magnification} = \frac{\text{height of the image size}}{\text{height of the object}}$$

$$m = \frac{h_i}{h_o} \Rightarrow \frac{v}{u} = \frac{60}{-30} = -2$$

$$\therefore h_i = h_o \times (-2) = 5 \times (-2) = -10 \text{ cm.}$$

Hint: Thus, the size of the image is 10 cm, and the minus sign implies that the image is inverted (below the principal axis).

- (i) Position of the image: $v = 60 \text{ cm}$ on the opposite side of the lens.
- (ii) The image is **real, inverted** and **magnified**.
- (iii) Size of the image, $h_i = 10 \text{ cm}$.

7. An object is placed in front of a convex lens of a focal length 10 cm. What is the nature of the image formed if the object distance is 15 cm?

Given

Object distance, $u = -15 \text{ cm}$

Focal length, $f = 10 \text{ cm}$

To find : Nature of the image = ?

Solution

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

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} + \frac{1}{-15}$$

$$\frac{1}{v} = \frac{3-2}{30} = \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{30}$$

$$\therefore v = 30 \text{ cm} \quad [\text{Image distance}]$$

$$\text{Magnification, } m = \frac{v}{u} = \frac{30}{-15} = -2$$

$\therefore$ Image is real, inverted, 30 cm from lens on the opposite side of the object and magnified 2 times.

8. A concave lens has focal length of 20 cm. At what distance from the lens a 5 cm tall object be placed so that it forms an image at 15 cm from the lens? Calculate the size of the image formed.

Given

Focal length, $f = -20 \text{ cm}$ (concave lens)

Height of the object, $h_o = 5 \text{ cm}$

Image distance $v = -15 \text{ cm}$

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

$$\frac{1}{u} = \frac{1}{-15} + \frac{1}{(20)}$$

$$= \frac{-20+15}{300} = \frac{-5}{300}$$

$$u = -60 \text{ cm}$$

$$\text{Magnification, } m = \frac{h_i}{h_o} = \frac{v}{u}$$

$$h_i = \frac{v}{u} \times h_o$$

$$\text{Size of the image, } h_i = \frac{-15}{-60} \times 5$$

$$= \frac{5}{4} = 1.25 \text{ cm}$$

Image is **diminished & virtual**.

9. A person needs a lens of power -4 D for correcting his distant vision. For correcting his near vision he needs a lens of power $+1.5 \text{ D}$. What is focal length of the lens required for correcting? (i) Distant vision and (ii) Near vision?

Given

Power, $P = -4 \text{ D}$ (for distant vision)

$P = +1.5 \text{ D}$ (for near vision)

To find : Focal length of the lens, $f = ?$

For correct near vision, $f = ?$

Solution

$$P = \frac{1}{f}$$

$$\therefore f = \frac{1}{P} \Rightarrow \frac{1}{-4}$$

(i) $f = -0.25 \text{ m}$

$$P = +1.5 \text{ D} \quad P = \frac{1}{f}$$

$$\therefore f = \frac{1}{P} \Rightarrow f = \frac{1}{1.5}$$

(ii) Focal length of correcting, $f = 0.67 \text{ m}$.

10. When an object is placed at 25 cm from a concave lens, a virtual image is produced at a distance of 10 cm . Calculate the magnification produced by the lens.

Given

Object distance, $u = -25 \text{ cm}$

virtual image distance, $v = -10 \text{ cm}$

To find : Magnification, $m = ?$

Solution

$$m = \frac{\text{Distance of the image}}{\text{Distance of the object}} = \frac{v}{u}$$

$$= \frac{-10}{-25} = 0.4$$

Magnification, $m = 0.4$.

11. An object placed at 50 cm from a lens produces a virtual image at a distance of 10 cm in front of the lens. What is the focal length of the lens? Is it converging or diverging?

Given

Object distance, $u = -50 \text{ cm}$

Since the image distance is lesser than object distance and a virtual image is formed. It is a concave lens, Image distance, $v = -10 \text{ cm}$

To find : Focal length of the lens, $f = ?$

Solution

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

$$\frac{1}{f} = \frac{-1}{10} - \left(\frac{1}{-50} \right)$$

$$\frac{1}{f} = \frac{-1}{10} + \frac{1}{50}$$

$$\frac{1}{f} = \frac{-50+10}{500}$$

$$\frac{1}{f} = \frac{-40}{500}$$

$$f = \frac{-500}{40}$$

$$\therefore f = -12.5 \text{ cm}$$

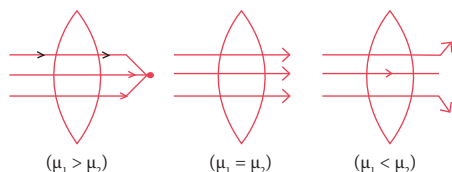
It is a diverging lens. $\therefore$ It is a concave lens.

HIGHER ORDER THINKING SKILLS (HOTS)

1. A convex lens of refractive index μ_1 is kept in a medium of refractive index (μ_2). A parallel beam of light is incident on the lens. Draw the path of the rays of light emerging from a lens. If

(a) $\mu_1 > \mu_2$ (b) $\mu_1 = \mu_2$ (c) $\mu_1 < \mu_2$

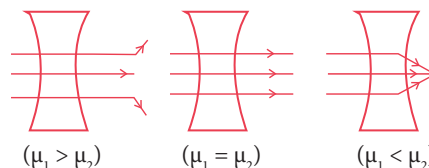
Ans.



2. A concave lens of refractive index μ_1 is kept in a medium of refractive index (μ_2). A parallel beam of light is incident on the lens. Draw the path of the rays of light emerging from a lens. If

(a) $\mu_1 > \mu_2$ (b) $\mu_1 = \mu_2$ (c) $\mu_1 < \mu_2$

Ans.



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- Instructions :**
1. Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.
 2. Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.
- Note :** This question paper contains **four** parts.

PART - I

Note: (i) Answer **all** the questions. (12 × 1 = 12)
(ii) Choose the most appropriate answer from the given **four** alternatives and write the option code and the corresponding answer.

1. 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%
2. Magnification of a convex lens is
(a) Positive (b) Negative
(c) Either positive or negative
(d) Zero
3. In a simple circuit, why does the bulb glow when you close the switch?
(a) The switch produces electricity
(b) Closing the switch completes the circuit
(c) Closing the switch breaks the circuit
(d) The bulb is getting charged
4. In the nuclear reaction ${}_6X^{12} \xrightarrow{\alpha \text{ decay}} {}_Z Y^A$, the value of A and Z is :
(a) 8, 6 (b) 8, 4
(c) 4, 8
(d) Cannot be determined with given data
5. The basis of modern periodic law is _____.
(a) Atomic number (b) Atomic mass
(c) Isotopic mass
(d) Number of neutrons
6. Solubility of NaCl in 100 ml water is 36 g. If 25 g of salt is dissolved in 100 ml of water, how much more salt is required for Saturation?
(a) 12 g (b) 11 g
(c) 16 g (d) 20 g
7. Powdered CaCO_3 reacts more rapidly than flaky CaCO_3 because of _____.
(a) large surface area (b) high pressure
(c) high concentration
(d) high temperature
8. Which of the following pairs can be the successive members of a homologous series?
(a) C_3H_8 and C_4H_{10}
(b) C_2H_2 and C_2H_4
(c) CH_4 and C_3H_6
(d) $\text{C}_2\text{H}_5\text{OH}$ and $\text{C}_4\text{H}_8\text{OH}$
9. The endarch condition is the characteristic feature of :
(a) root (b) stem
(c) leaves (d) flowers
10. The loss of one or more chromosome in a ploidy is called _____.
(a) Tetraploidy (b) Aneuploidy
(c) Euploidy (d) Polyploidy
11. Excessive consumption of alcohol leads to :
(a) Loss of memory (b) Cirrhosis of liver
(c) State of hallucination
(d) Suppression of brain function
12. Which is used to edit programs?
(a) Inkscape (b) Script editor
(c) stage (d) sprite

PART - II

Note: Answer **any seven** questions. Question No. **22** is **compulsory**. ($7 \times 2 = 14$)

13. State Boyle's law.
14. Define: Relative atomic mass.
15. What is rust? Give the equation for formation of rust.
16. Name the simplest ketone and give its structural formula.
17. Why is the circulation in man referred to as double circulation?
18. Write the differences between endocrine and exocrine gland.
19. How can menstrual hygiene be maintained during menstrual days?
20. Why is Archaeopteryx considered to be a connecting link?
21. Match the following :

1. Bio gas	- energy saving
2. Natural gas	- CO_2
3. Green House gas	- Renewable energy
4. CFL Bulbs	- Non-renewable energy
22. A source producing a sound of frequency 500Hz, is moving towards a listener with a velocity of 30 ms^{-1} . The speed of the sound is 330 ms^{-1} in air. What will be the frequency heard by listener?

PART - III

Note: Answer **any seven** questions. Question No. **32** is **compulsory**. ($7 \times 4 = 28$)

23. (a) List any two properties of light.
(b) Draw a ray diagram to show the image formed by a convex lens when the object is placed between F and 2F.
24. (a) Distinguish between linear and areal expansion.
(b) What is co-efficient of Real expansion?
25. What are the factors that affect the velocity of sound in gases?
26. (i) In Japan, after the Second World War some of the new born children are having congenital diseases. Why?

(ii) Give any two uses of radio isotopes in the field of agriculture.

27. (a) Identify the bond between H and F in HF molecule.
(b) What property forms the basis of identification?
(c) How does the property vary in Periods and in Groups?
28. How is ethanoic acid prepared from ethanol? Give the chemical equation.
29. (i) Why are the rings of cartilages found in trachea of Rabbit?
(ii) List out any two parasitic adaptations in leech.
30. Classify neurons based on its structure.
31. Enumerate the importance of forest.
32. A container whose capacity is 70 ml is filled with a liquid up to 50 ml. Then, the liquid in the container heated. Initially, the level of the liquid falls from 50 ml to 48.5 ml. Then we heat more, the level of the liquid rises to 51.2 ml. Calculate the apparent and real expansion.

PART - IV

Note : Answer **all** the questions. Draw diagrams wherever **necessary**. ($3 \times 7 = 21$)

33. (a) (i) What are the types of inertia? Give an example for each type.
(ii) While catching a cricket ball, the fielder lowers his hands backwards. Why?

(OR)

- (b) (i) Three resistors of 1Ω , 2Ω and 4Ω are connected in parallel in a circuit. If a 1Ω resistor draws a current of 1A, find the current through the other two resistors.
(ii) State Ohm's Law.
34. (a) (i) What is mean by binary solution?
(ii) Give an example each for.
1) Gas in liquid 2) Solid in liquid
3) Solid in solid 4) Gas in gas
(iii) What is aqueous and non-aqueous solution? Give an example.

(OR)

- (b) (i) Explain the types of double displacement reactions with examples.
- (ii) Calculate the pH of 1.0×10^{-4} molar solution of HNO_3 .
35. (a) (i) Name the three basic tissue system in flowering plants.
- (ii) What is photosynthesis and where in a cell does it occur?
- (iii) What is Respiratory Quotient?
- (OR)**
- (b) (i) Why did Mendel select pea plant for his experiments?
- (ii) What are Okazaki fragments?
- (iii) DNA consists of two _____ chains.

Answers

PART - I

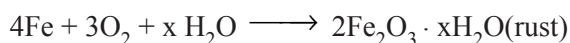
1. (d) increase by 300%
2. (c) Either positive or negative
3. (b) Closing the switch completes the circuit
4. (b) 8, 4
5. (a) Atomic number
6. (b) 11 g
7. (a) large surface area
8. (a) C_3H_8 and C_4H_{10}
9. (b) stem
10. (b) Aneuploidy
11. (b) Cirrhosis of liver
12. (b) Script editor

PART - II

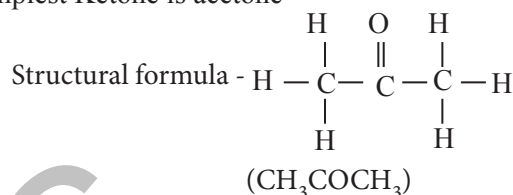
13. (i) When the temperature of a gas is kept constant, the volume of a fixed mass of gas is inversely proportional to its pressure.
- (ii) $P \propto 1/V$
- (iii) $PV = \text{constant}$.
14. (i) Relative atomic mass of an element is the ratio between the average mass of its isotopes to $\frac{1}{12^{\text{th}}}$ part of the mass of a **carbon-12 atom**.

- (ii) It is denoted as A_r .
- (iii) It is otherwise called "**Standard Atomic Weight**".

15. When iron is exposed to moist air, it forms a **layer of brown hydrated ferric oxide** on its surface. This compound is known as rust and the phenomenon of formation of rust is known as rusting.



16. Simplest Ketone is acetone



17. (i) In our body, blood circulates twice through the heart in one complete cycle and it is called double circulation.
- (ii) In double circulation, the oxygenated blood does not mix with the deoxygenated blood.

18.

Endocrine Gland	Exocrine Gland
They are called ductless glands. Their secretions are carried by the blood stream.	They have specific ducts to carry their secretions.
They produce hormones. Eg : Thyroid gland, Pituitary gland.	They produce enzymes. Eg : Salivary gland, Sweat glands.

19. (i) Sanitary pads should be changed regularly, to avoid infections due to microbes from vagina and sweat from genitals.
- (ii) Use of warm water to clean genitals helps to get rid of menstrual cramps.
- (iii) Wearing loose clothing rather than tight-fitting clothes will ensure the airflow around the genitals and prevent sweating.
20. (i) Archaeopteryx is the oldest known fossil bird.
- (ii) It is considered to be a connecting link between reptiles and birds. It had wings with feathers, like a bird. It had long tail, clawed digits and conical teeth, like a reptile.

21. 1. Bio gas - Renewable energy
 2. Natural gas - Non-renewable energy
 3. Green House gas - CO₂
 4. CFL Bulbs - energy saving

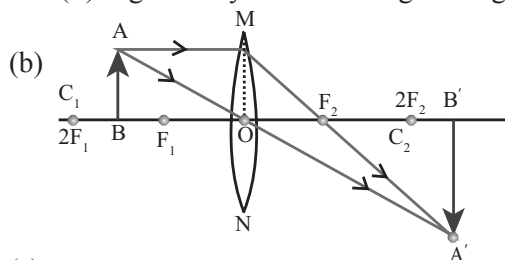
22. **Solution:** When the source is moving towards the stationary listener, the expression for apparent frequency is

$$n' = \left(\frac{v}{v - v_s} \right) n$$

$$n' = \left(\frac{330}{330 - 30} \right) \times 500 = 550 \text{ Hz}$$

PART - III

23. (a) (i) Light is a form of energy.
 (ii) Light always travels along a straight line.



24. (a)

	Linear Expansion	Areal Expansion
(i)	Length of the body changes due to change in its temperature.	Increase in the area of a solid object due to heating, then the expansion is called superficial or areal expansion.
(ii)	The ratio of increase in length of the body per degree rise in temperature to its unit length is called as the coefficient of linear expansion.	The ratio of increase in area of the body per degree rise in temperature to its unit area called coefficient of superficial expansion.
(iii)	$\frac{\Delta L}{L_o} = \alpha_L \Delta T$	$\frac{\Delta A}{A_o} = \alpha_A \Delta T$

- (b) Co-efficient of real expansion is defined as the ratio of the true rise in the volume of the liquid per degree rise in temperature to its unit volume. The SI unit of coefficient of real expansion is K⁻¹.

25. The following factors that affect the speed of sound in gases are,

Effect of density:

- (i) The velocity of sound in gas is **inversely proportional** to the square root of the **density** of the gas.
 (ii) Hence, the **velocity decreases** as the **density** of the gas **increases**. $v \propto \sqrt{\frac{1}{d}}$

Effect of temperature:

- (i) The velocity of sound in a gas is **directly proportional** to the square root of its **temperature**.
 (ii) The velocity of sound in a gas **increases** with **increase** in **temperature**. $V \propto \sqrt{T}$.
 (iii) Velocity at temperature T is given by the following equation.

$$v_T = (v_0 + 0.61 T) \text{ ms}^{-1}$$

Here, v_0 is the velocity of sound in the gas at 0° C. For air, $v_0 = 331 \text{ ms}^{-1}$.

- (iv) Hence, the velocity of **sound changes** by 0.61 ms^{-1} , when **temperature changes** by each degree Celsius.

Effect of relative humidity:

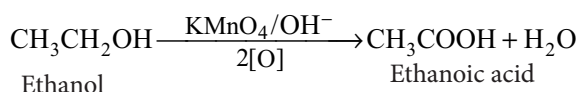
- (i) When humidity increases, the speed of **sound increases**.
- (ii) We can hear sound from **long distances clearly** during rainy seasons.
26. (i) During the atom bomb explosion, the emission of hazardous radiation like gamma rays, which adversely affect the living creatures. This radiation can be affected genetically.

(ii) **Radio isotopes :**

- ▶ The radio isotope of phosphorous (P-32) helps to increase the productivity of crops.
- ▶ Prevent the wastage of agricultural products.
- ▶ Certain perishable cereals exposed to radiations remain fresh beyond their normal life, enhancing the storage time.
- ▶ Very small doses of radiation prevent sprouting and spoilage of onions, potatoes and gram.

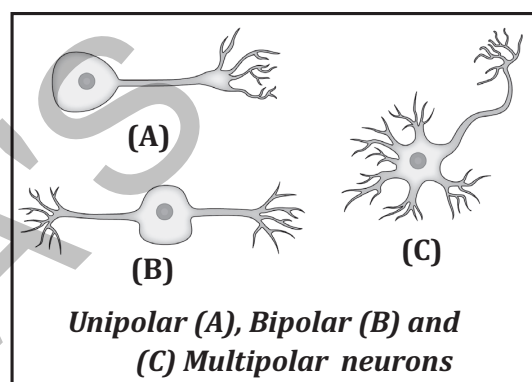
27. (a) Covalent bond (or) Ionic bond
(b) Electronegativity difference.
(c) Along the period, from left to right in the periodic table, the electronegativity increases. On moving down a group, the electronegativity of the elements decreases.

28. Ethanoic acid is prepared by the oxidation of **ethanol** in the presence of **alkaline potassium permanganate** or **acidified potassium dichromate**.



29. (i) Trachea is the windpipe. Tracheal walls are supported by rings of cartilage which help in the free passage of air.
- (ii) Leeches lead a parasitic mode of life by sucking the blood of vertebrates, and show several important modifications in their structure.
- (i) Blood is sucked by pharynx.
- (ii) Anterior and posterior ends of the body are provided with suckers by which the animal attaches itself to the body of the host.

30. The neurons may be of different types based on their structure and functions.



Structurally the neurons may be of the following types :

- (i) **Unipolar neurons** : Only one nerve process arises from the cyton which acts as both axon and dendron.
- (ii) **Bipolar neurons** : The cyton gives rise to two nerve processes of which one acts as an axon while another as a dendron.
- (iii) **Multipolar neurons** : The cyton gives rise to many dendrons and an axon.
31. (i) Forests are an important component of our environment and are dominated by microorganisms, flowering plants, shrubs, climbers, dense trees and provide a vast habitat for wild animals.
- (ii) Forests also contribute to the economic development of our country.
- (iii) Forests are vital for human life, it is a source for a wide range of renewable natural resource.
- (iv) They provide wood, food, fodder, fibre and medicine.

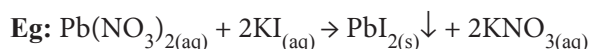
(OR)

(b)

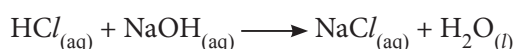
(i) There are two major classes of double displacement reactions. They are

Precipitation Reactions:

- (1) When aqueous solutions of two compounds are **mixed**, if they react to form an insoluble compound and a soluble compound, then it is called precipitation reaction.
- (2) **Eg:** When the clear aqueous solutions of potassium iodide and lead (II) nitrate are mixed, a double displacement reaction takes place between them.

**Neutralization Reactions:**

- (1) Acid reacts with the base to form a salt and water.
- (2) It is called **neutralization reaction** as both acid and base neutralise each other.



(ii)

$$\begin{aligned} [\text{H}^+] &= 1.0 \times 10^{-4} \\ \text{pH} &= -\log_{10} [\text{H}^+] \\ &= -\log_{10} [1 \times 10^{-4}] \\ \text{pH} &= -(\log_{10} 1 - 4 \log_{10} 10) \\ &= 0 + 4 \times \log_{10} 10 \\ &= 0 + 4 \times 1 = 4 \\ \text{pH} &= 4 \end{aligned}$$

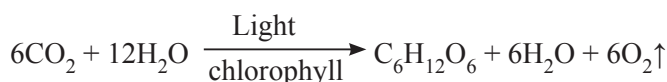
35. (a)

(i) (1) Epidermal tissue system

(2) Ground tissue system

(3) Vascular tissue system

(ii) Photosynthesis is a process by which autotrophic organisms like green plants, algae and chlorophyll containing bacteria utilize the energy from sunlight to synthesize their own food. In this process, carbon dioxide combines with water in the presence of sunlight and chlorophyll to form carbohydrates and oxygen is released as a byproduct.



It occurs in the chloroplast of plant cells.