SURA'S

Science

10th Standard

Public Exam Edition 2021–22

Strictly as per the Reduced (Prioritised) Syllabus released on 13th August, 2021 (G.O.(Ms).No126)

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SURA PUBLICATIONS
Chennai

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2021-22 *Edition*

ISBN : 978-93-5330-407-2

Code No : RPS_004

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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** based on the reduced syllabus for 2021 - 22, released by the Govt. 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.
- Publisher
Sura Publications

All the Best

Strictly as per the Reduced (Prioritised) Syllabus released on 13th August, 2021 (G.O.(Ms).No126) 10th Std Science.

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* Removed as per the reduced syllabus for 2021 - 22.

PHYSICS

UNIT 1

LAWS OF MOTION

MUST KNOW DEFINITIONS

Linear momentum	:	The product of mass and velocity of a moving body gives the magnitude of its linear momentum. It acts in the direction of the velocity of the body.
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.
Weight	:	Weight is equal to gravitational force. Also weight (W) = mass × 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	$F_{net} = F_1 + F_2$

3.	Parallel unequal forces are acting in the opposite direction	$F_{net} = F_1 - F_2$ (if $F_1 > F_2$) $F_{net} = F_2 - F_1$ (if $F_2 > F_1$)
4.	Force	$F = m \times a$
5.	Weight	$W = mg$
6.	Acceleration	$a = \frac{v - u}{t}$
7.	Law of conservation of linear momentum	$m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$
8.	Newton's Universal law of gravitation	$F = \frac{GMm}{R^2}$ $[G = 6.674 \times 10^{-11}\ Nm^2\ kg^{-2}]$
9.	Acceleration due to gravity	$g = \frac{GM}{R^2}$
10.	Mass of the Earth	$M = \frac{gR^2}{G}$

TEXTBOOK EVALUATION

I. CHOOSE THE CORRECT ANSWER :

1. Inertia of a body depends on
(a) weight of the object
(b) acceleration due to gravity of the planet
(c) mass of the object
(d) Both a & b
Ans. (c) mass of the object

2. 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

3. 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

4. The unit of 'g' is ms^{-2}. It can be also expressed as
(a) $cm\ s^{-1}$ (b) $N\ kg^{-1}$
(c) $N\ m^2\ kg^{-1}$ (d) $cm^2\ s^{-2}$ **Ans. (b) $N\ kg^{-1}$**

5. One kilogram force equals to
(a) 9.8 dyne (b) 9.8×10^4 N
(c) 98×10^4 dyne (d) 980 dyne
Ans. (c) 98×10^4dyne

6. 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

7. 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%
Ans. (d) increase by 300%

8. To project the rockets which of the following principle(s) is /(are) required? *[GMQP-2019]*
(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.
Ans. force
2. Passengers lean forward when sudden brake is applied in a moving vehicle. This can be explained by _____ Ans. inertia of motion
3. 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 particle 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.

4. **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 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. Answer briefly :

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

Ans. The inherent property of the 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) Inertial of direction

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

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.
$F_1 = 5$ N
$F_2 = 15$ N
$R = F_2 - F_1$ (if $F_2 > F_1$)
$= 15 - 5 = 10$
Resultant force = 10 N
Resultant force of 10 N is acting in the direction of F_2. (i.e.) greater force.

4. **Differentiate mass and weight.**

	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. State Newton's second law. *[GMQP-2019]*

Ans. (i) 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.

(ii) F = m × a

Force = mass × acceleration

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

Ans. When the fielder pulls back his hands he experiences a smaller force for a longer interval of time leading to less damage to his hands.

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

Ans. Astronauts are not floating but falling freely around the Earth due to their huge oribital velocity. Since spacestation and astronauts have equal acceleration, they are under free fall condition. (R = 0 refer case 4 in Table 1.2). Hence, both the astronauts and the spacestation are in the state of weightlessness.

VI. 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 = $m_1 = 3$ kg

Mass of bigger body = $m_2 = 4$ kg

Acceleration due to force applied by bigger body = $a_2 = 12\ ms^{-2}$

To find : Acceleration due to the same force on the smaller body = a_1 = ?

Solution

According to Newton's second law of motion.

$F = m \times a$

$F_1 = m_1 a_1$ $\quad F_2 = m_2 a_2$

$F_1 = 3a_1$ $\quad F_2 = 4 \times 12 = 48$ N

As the force is the equal

$F_1 = -F_2$

$3a_1 = -48$

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

So acceleration due to the same force on the smaller body a_1 = **16 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

Mass, m = 1 kg

Initial velocity, u = 10 ms^{-1}

Final velocity, v = $-10 ms^{-1}$

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

Solution

Momentum before collision = $mu = (1 \times 10)$ = 10 kg ms^{-1}

Momentum after collision = mv = $-(1 \times 10)$ = -10 kg ms^{-1}

Change in momentum(Δp) = $mv - mu$

$\Delta p = -10 - 10$

= **-20 kg ms^{-1}**

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

Given

Force F_1 = 140 N

Length L_1 = 40 cm = 40×10^{-2} m

Force, F_2 = 40 N

Length, L_2 = ?

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

$$L_2 = \frac{140 \times 40 \times 10^{-2}}{40}$$

$$= 140 \times 10^{-2}\ m$$

Length, L_2 = 1.4 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

The ratio of masses of two bodies is $m_1 : m_2$

i.e 2 : 3

Mass of the smaller body, m_1 = 2 kg

Mass of the bigger body m_2 = 3 kg

Radius of the smaller body, R_1 = 4 km

Radius of the bigger body, R_2 = 7 km

i.e $r_1 : r_2$ = 4 : 7

To find : $g_1 : g_2 = ?$

Solution

We know that

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

$$g_1 = \frac{GM_1}{R_1^2}\ ;\ g_2 = \frac{GM_2}{R_2^2}$$

$$\frac{g_1}{g_2} = \frac{\frac{GM_1}{R_1^2}}{\frac{GM_2}{R_2^2}} = \frac{M_1}{R_1^2} \times \frac{R_2^2}{M_2}$$

$$\frac{g_1}{g_2} = \left(\frac{M_1}{M_2}\right)\left(\frac{R_2}{R_1}\right)^2 = \left(\frac{2}{3}\right)\left(\frac{7}{4}\right)^2$$

$$\frac{g_1}{g_2} = \frac{2}{3} \times \frac{7 \times 7}{4 \times 4} = \frac{49}{24}$$

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

VII. Answer in detail.

1. What are the types of inertia? Give an example for each type. *(PTA-3)*

Ans. (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.

Hint: 3 Physical law describes the relationship between a body and the forces.

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

Ans. (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 → $P_i = mu$

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

(v) Change in momentum → $\Delta p = P_f - P_i$

$= mv - mu$

By Newton's second law of motion,

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

$F \propto$ change in momentum / time

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

$F = k\, m\, (v - u)\, t$

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 × acceleration

4. Describe rocket propulsion. *(PTA-4; Sep-2020)*

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**.

5. State the universal law of gravitation and derive its mathematical expression. *[Qy-2019]*

Ans.

- 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

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

Force $F \propto m_1 \times m_2$

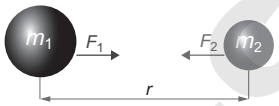
$F \propto 1/r^2$

On combining the above two expressions,

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

$$F = \frac{Gm_1 \times m_2}{r^2} \text{ or } \frac{Gm_1m_2}{r^2}$$

Where G is universal gravitational constant. Its value in SI unit is 6.674×10^{-11} N m^2 kg^{-2}.



Gravitational force between two masses

VIII. 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, $m_1 = 8$ kg

Mass of block 2, $m_2 = 2$ kg

Total mass, $m = m_1 + m_2$

$m = 8 + 2$

$m = 10$ kg

Force, $F_1 = 15$ N

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

Solution

Force, F_1 = mass × acceleration

$F_1 = ma$

$F_1 = 10 \times a$

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

Force exerted on m_2 (2 kg) is,

$F_2 = m_2a = 2 \times 1.5$

$F_2 = 3$ N

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

Given

Kinetic energy of the truck = Kinetic energy of the bike

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

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

Substituting ② in ①

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

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

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

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

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

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

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

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 move 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) Newtons law of inertia takes place. 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) 4 F

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
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

acceleration = 1.8 ms^{-2}
mass = 50 kg
g = 9.8 ms^{-2}

To find : Apparent weight, R = ?

Solution

Formula: $R = m(g - a)$
$R = 50(9.8 - 1.8) = 50 \times 8 = 400$
$R = 400$ N

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 the apples weight more at poles than at equator? *[PTA-3]*

Ans. (i) Acceleration due to gravity (g) is more at poles ($g = 9.8\ ms^{-2}$) than at equator ($g = 9.78\ ms^{-2}$). 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

Force = 5 N

Acceleration = 5 cm s^{-2} = 0.05 ms^{-2}

To find : Mass of the body = ?

Solution

$$F = ma$$

$$5 = m(0.05)$$

$$m = \frac{5}{0.05} = 100 \text{ kg}$$

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

Data

Height from the centre of the Earth,

$$R' = R + h$$

The acceleration due to gravity at that height,

$$g' = g/4$$

Solution

$$g = GMm / R^2$$

$$g' = GMm / R'^2$$

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

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

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

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

(or) $h = R$

$$R' = 2R$$

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? *[PTA-2]*

Ans. (i) Luxury buses are fitted with springs and shock absorbers to reduce jerks while moving on uneven roads.

(ii) A large acting for a short period of time.

(iii) Vehicle receives the sudden movement when it moves on the surfaces and receives impulsive force.

(iv) To minimize this impact, shock absorbers are used in the luxury buses.

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}) *[PTA-2]*

Given

Weight of a mass on earth = 686 N

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

$$\therefore 686 \text{ N} = \frac{686}{9.8} = 70 \text{ kg}$$

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

Solution

Weight = mass (m) × acceleration due to gravity (g)

m = 70 kg

g = 1.625 ms^{-2}

W = mg

W = 70 × 1.625 = 113.75 N

iii) Name the law of motion used in flying of birds. Give another example for the same law. (7 Marks) *[PTA-2]*

Ans. 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 a is 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

$$= mv - mu$$

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

Rate of change of momentum

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

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

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

$\therefore$ The applied force,

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

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

The applied force, $F \ \alpha \ ma$

$$F \ \alpha \ k\,ma \ (k = 1)$$

$$\therefore F = ma$$

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

GOVERNMENT EXAM QUESTIONS & ANSWERS

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

Ans. Linear momentum = mass × velocity

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

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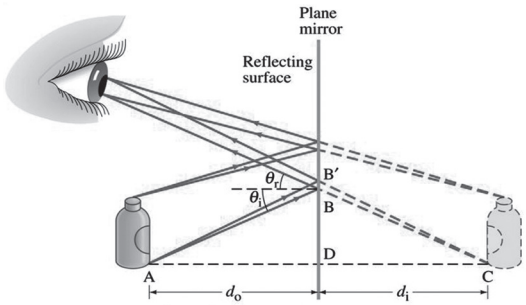
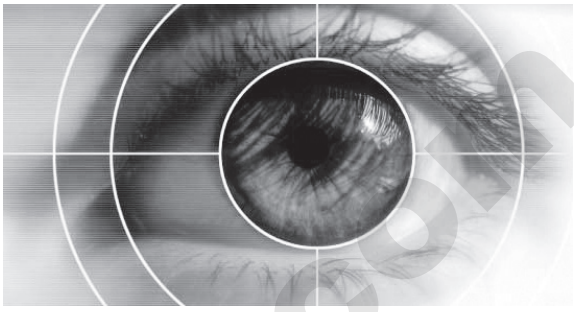
UNIT 2





OPTICS

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.

FORMULAE

Velocity of light	$C = v\lambda$
Snell's law	$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$
lens formula	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

Focal length of required concave lens for myopia	$f = \frac{xy}{x - y}$
Focal length of the required convex lens for hypermeteropia	$f = \frac{dD}{d - D}$

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

(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

(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. A convex lens forms a real, diminished point sized image at focus. Then the position of the object is at

(a) focus (b) infinity
(c) at 2f (d) between f and 2f

Ans. (b) infinity

5. In a myopic eye, the image of the object is formed

(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

6. The eye defect 'presbyopia' can be corrected by *(PTA-2; Sep-2020)*

(a) convex lens (b) concave lens
(c) convex mirror (d) Bi focal lenses

Ans. (d) Bi focal lenses

7. Which of the following lens would you prefer to use while reading small letters found in a dictionary?

(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

8. 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?

(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 _____. Ans. one

3. Amount of light entering into the eye is controlled by _____. Ans. Iris

III. TRUE OR FALSE. IF FALSE CORRECT IT:

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

Ans. False.

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

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

Ans. True.

3. 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 REASON :

Mark the correct choice as

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

(b) If 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:** 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) 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?**

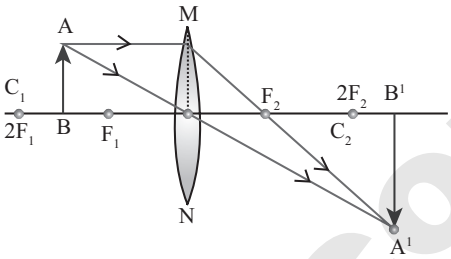
Ans. The ratio of speed of light in vacuum to the speed of light in a medium is defined as refractive index 'μ' of that medium.

2. **State Snell's law.** *[Qy-2019]*

Ans. 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]*



Object placed between F and 2F

4. **Define dispersion of light.**

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. **Differentiate convex lens and concave lens.** *[PTA-3; Qy-2019]*

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

6. **What is power of accommodation of eye?**

Ans. The ability of the eye lens to focus nearby as well as the distant objects on the retina of our eye is called **power of accommodation of the eye**.

7. **What are the causes of 'Myopia'?** *[GMQP-2019]*

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.

8. Why are traffic signals red in colour? *[PTA-4]*

Ans. (i) Red has the longest wavelength so it is scattered the least by atmospheric particles.

(ii) 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-2019]*

Ans. (i) Light is a form of energy.

(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, $c = 3 \times 10^8 \, ms^{-1}$.

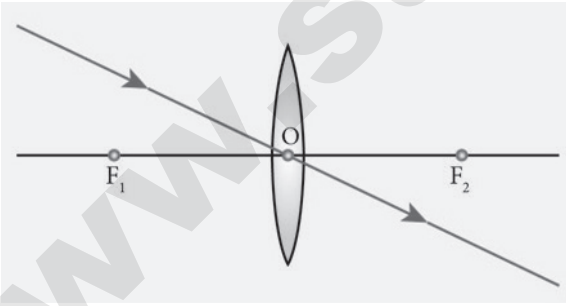
(v) Different coloured light has different wavelength and frequency.

(vi) 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.

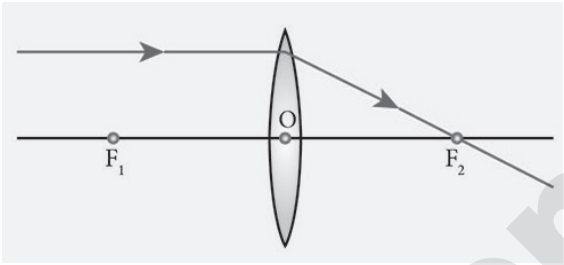
Ans. When an object is placed in front of a lens, the light rays from the object fall on the lens.

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



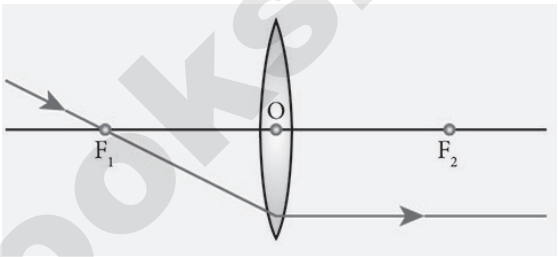
Rays passing through the optical centre

Rule-2: When rays parallel to the principal axis strikes 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]*

	Myopia	Hypermeteropia
(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.
(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)	Image of distant objects are formed before the retina.	Image of nearby objects are formed behind the retina
(vi)	It can be corrected using a concave lens.	It can be corrected using a convex lens.

VIII. Numerical Problems :

1. 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 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.

Enlarged and inverted 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]

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.

Given

Object distance u = – 10 cm

[Object is placed on the left side]

Focal length f = – 15 cm [$\because$ concave lens

To find : Image distance v = ?

Height of the object h = 3 cm.

Solution

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

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

$$= \frac{1}{-15} + \frac{1}{-10}$$

$$\frac{-10-15}{150} = \frac{-25}{150}$$

$$v = \frac{150}{25} = -6 \text{ cm}$$

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

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

$$m = \frac{6}{10} = 0.6$$

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

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

$\therefore h' = m \times h = 0.6 \times 3$

$\therefore$ Size of the image, h' = **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,

(a) can he get the image?

(b) 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.

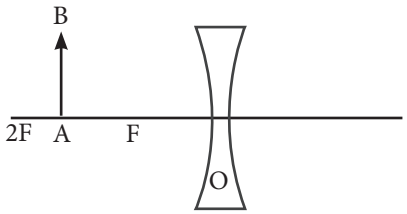
2. The eyes of the nocturnal birds like owl are having a large cornea and a large pupil. How does it help them?

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

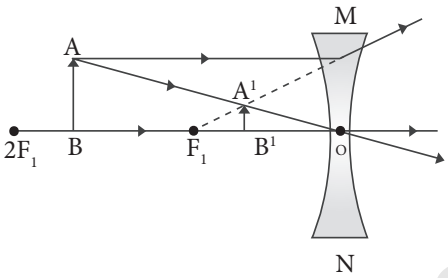
PTA Questions & Answers

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. (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.

GOVERNMENT EXAM QUESTIONS & ANSWERS

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. $f = -0.3$ m, $v = -0.2$ m

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

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

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

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