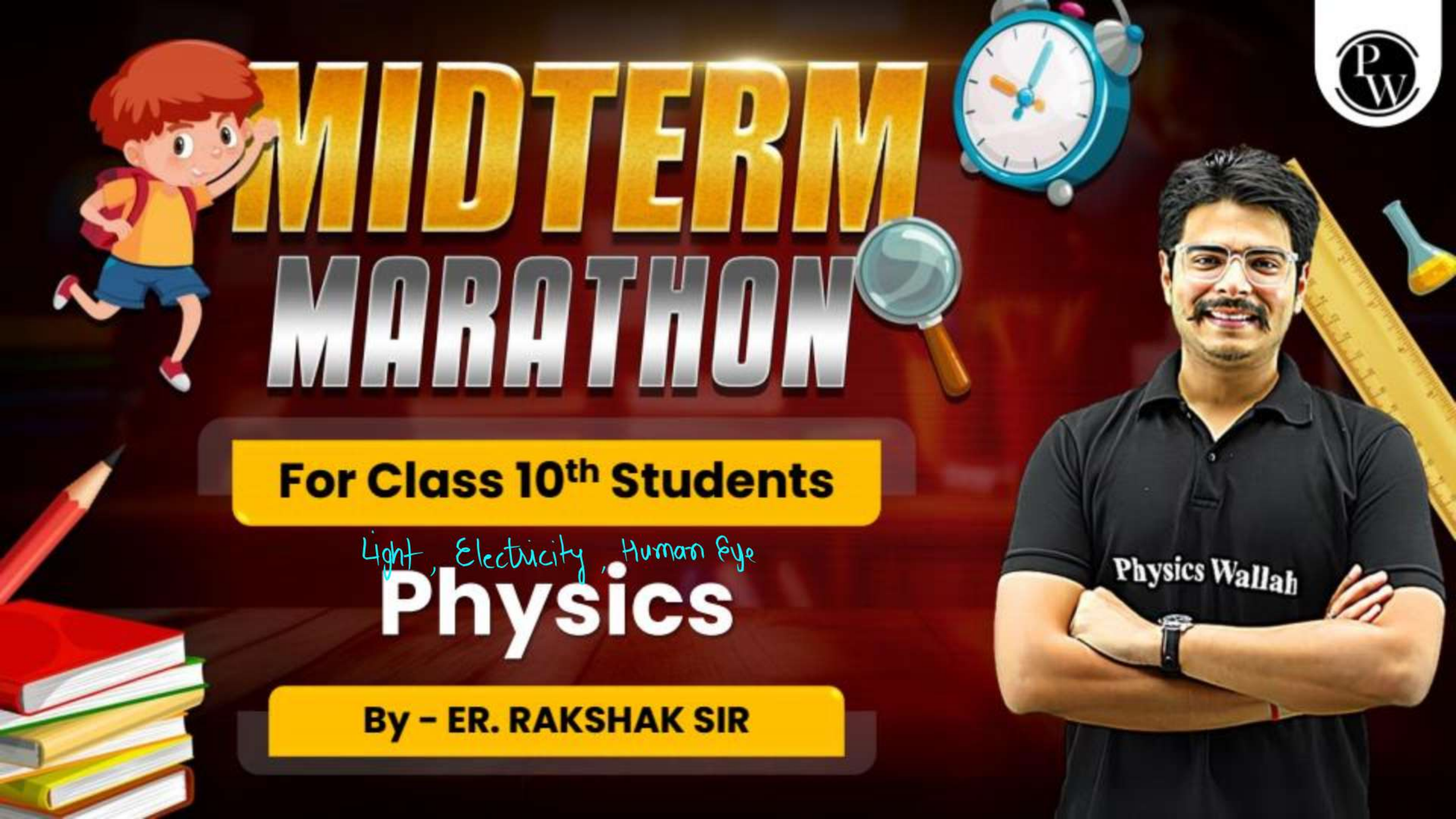


MIDTERM
MARATHON
For Class 10th Students
Light, Electricity, Human Eye
Physics
By - ER. RAKSHAK SIR
Physics Wallah

Topics *to be covered*

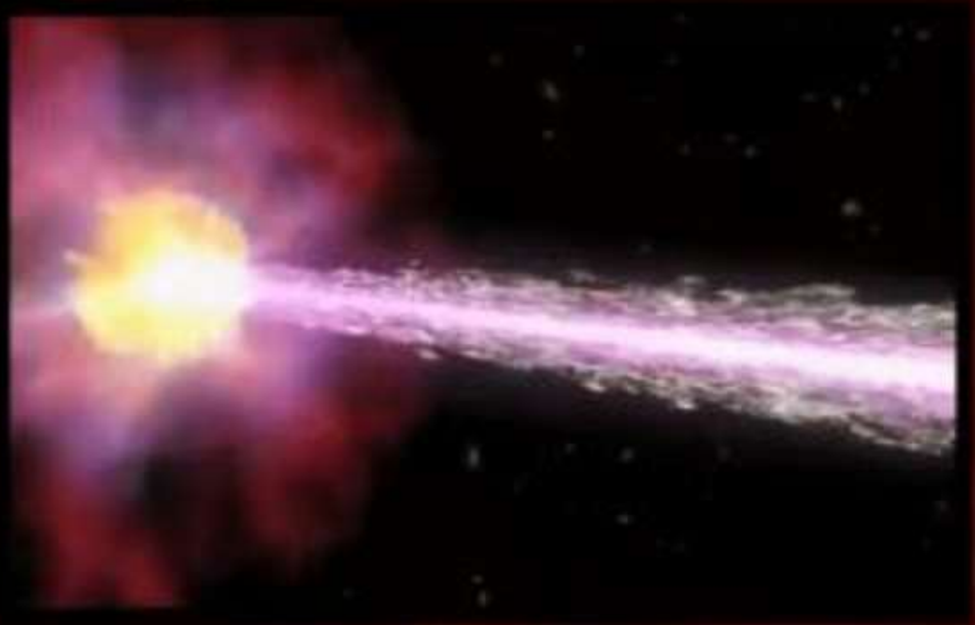
1. # Light
2. # Electricity
3. # Human Eye
4. #

Chapter No. - 01

LIGHT

Ray Nature of Light

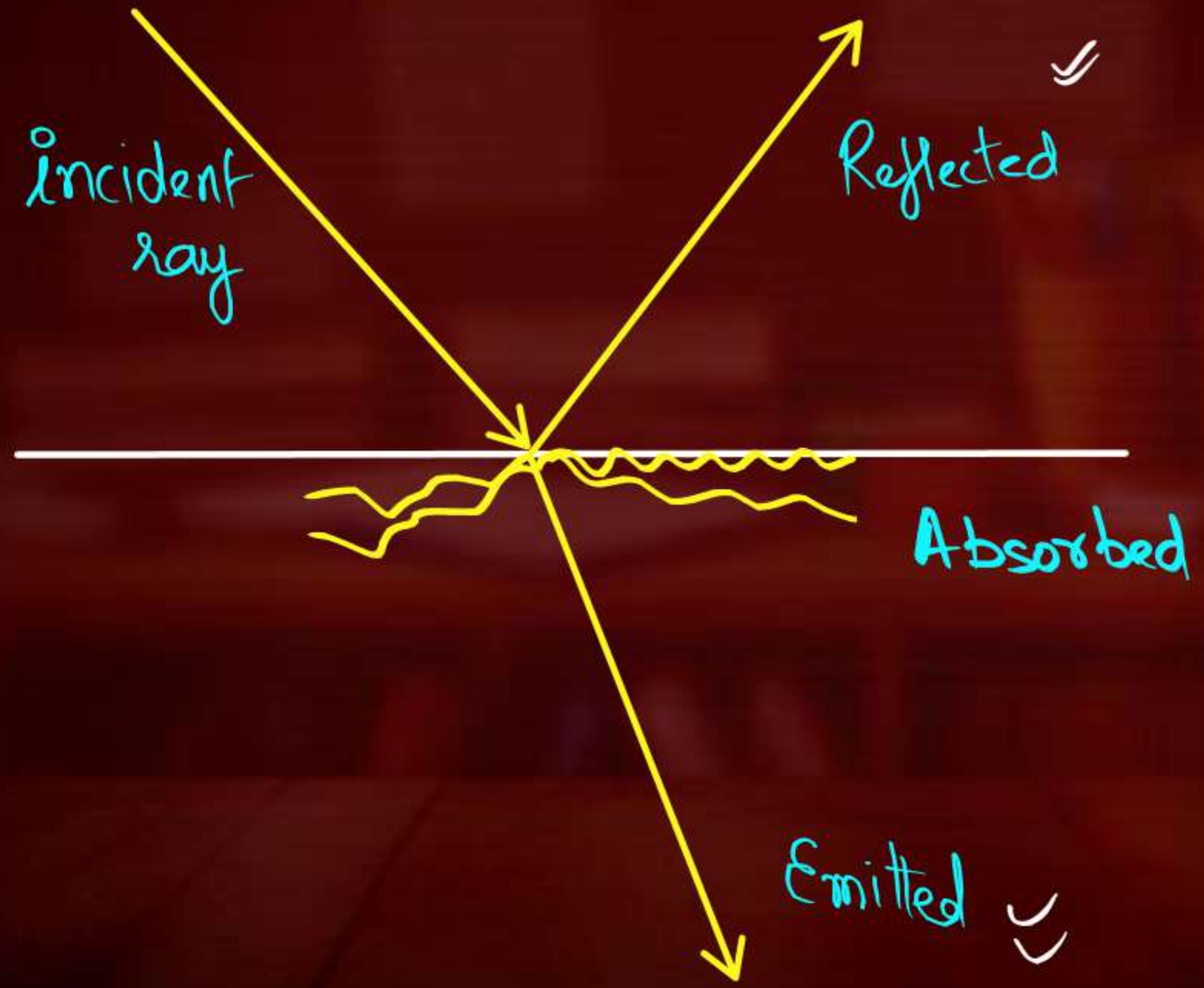
→ treat light is made up of particle - 'PHOTON'



- Light also has the property of a particle. The intensity of the light varies depending on the number of particles. Bright light has many particles while dark light has fewer particles. These particles of light are called "photons"
- Light travels at a speed of about 300,000 kilometers per second ($c = 3 \times 10^8$ m/s). → Vacuum
- When in a vacuum such as outer space where no matter is present, light travels straightforward, this is called Rectilinear Motion of Light
- Several Photons in a single line constitute a Light Ray
- Several Light Rays constitute a Beam of Light

QUESTION

What happened once a light ray is incident on a surface ?



1. Transparent
2. Opaque
3. Translucent

Types of Optical Objects

AAR-PAR

Dhundhla (Bajri Sheesha)

QUESTION

How do we see things?

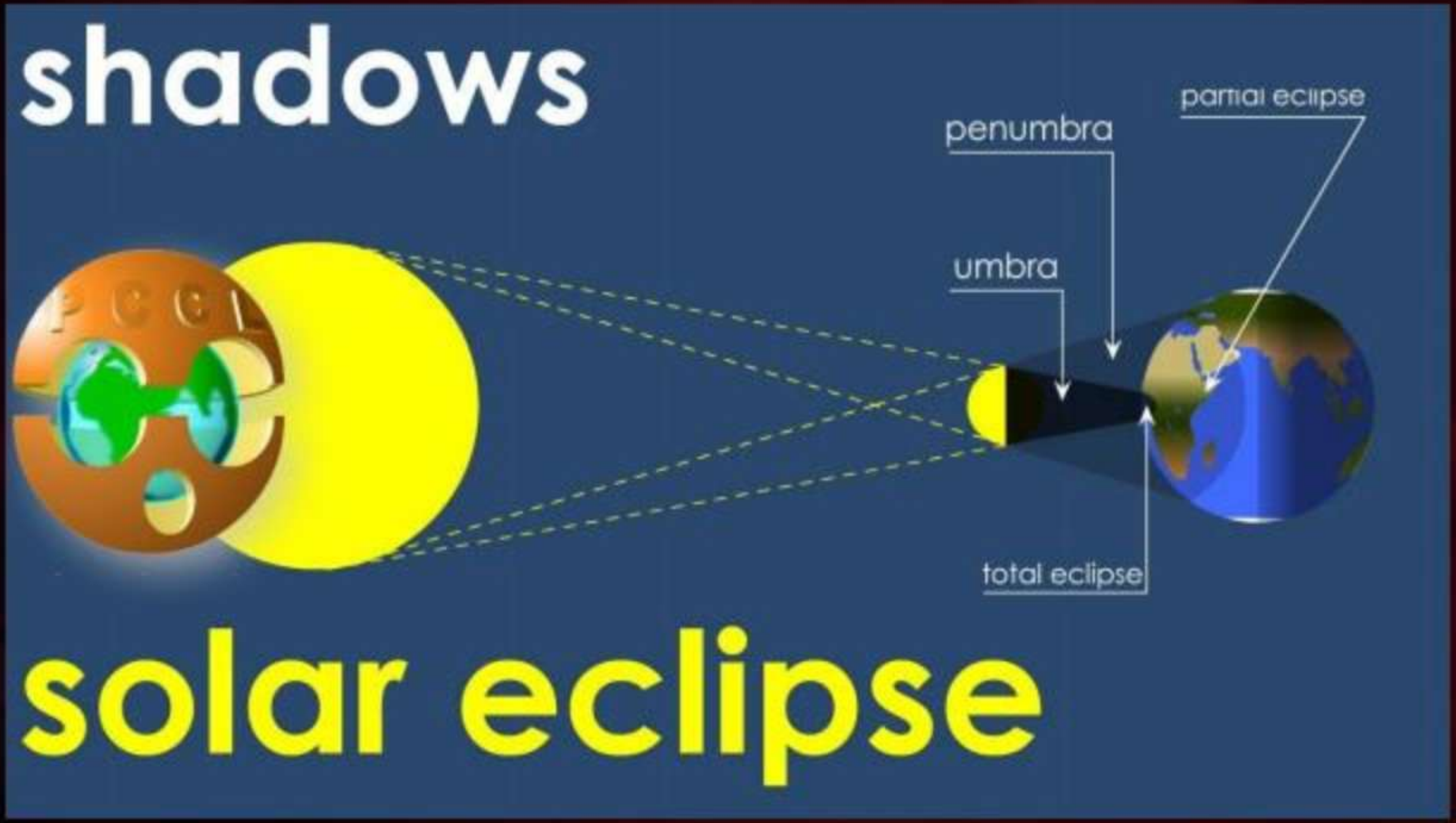
1. Eye
2. Light
3. Object (reflecting)

White Light (Sunlight)

6 Colors absorbed by Patti

White – All colors (VIBGYOR)
Black – Absence of light

The Dark Side of the Light : Shadows

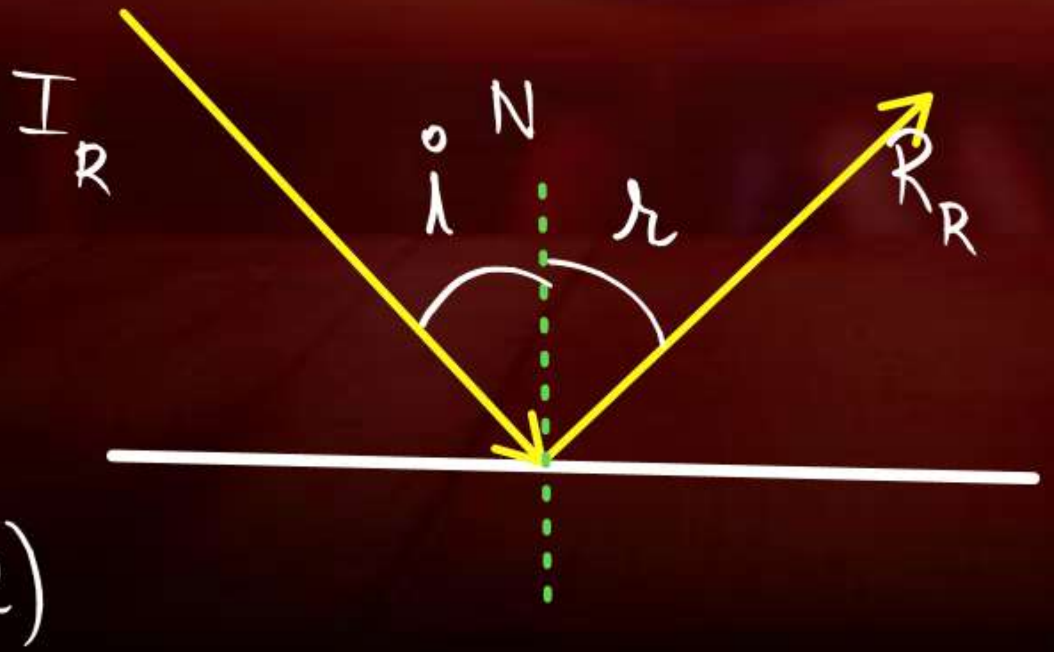


Phenomenon of Light : Reflection

- When a ray of light falls on a smooth polished surface and the light ray bounces back into the same medium, it is called the ***reflection of light***.
- The ***incident light ray*** which lands upon the surface is said to be reflected away the surface. The ray that bounces back is called the ***reflected ray***.
- The perpendicular which is drawn on the surface is called ***Normal***.

(1) $\angle i = \angle r$

(2) I_R, R_R and N lie on the same plane (surface)



LAWS OF REFLECTION

The laws of reflection determine the reflection of incident light rays on reflecting surfaces, like mirrors, smooth metal surfaces, and clear water.

The laws of reflection states that

- The Incident Ray, the Reflected Ray and the Normal all lie in the same plane
  I_R R_R N
- The Angle of Incidence ($\angle i$) = The Angle of Reflection ($\angle r$)

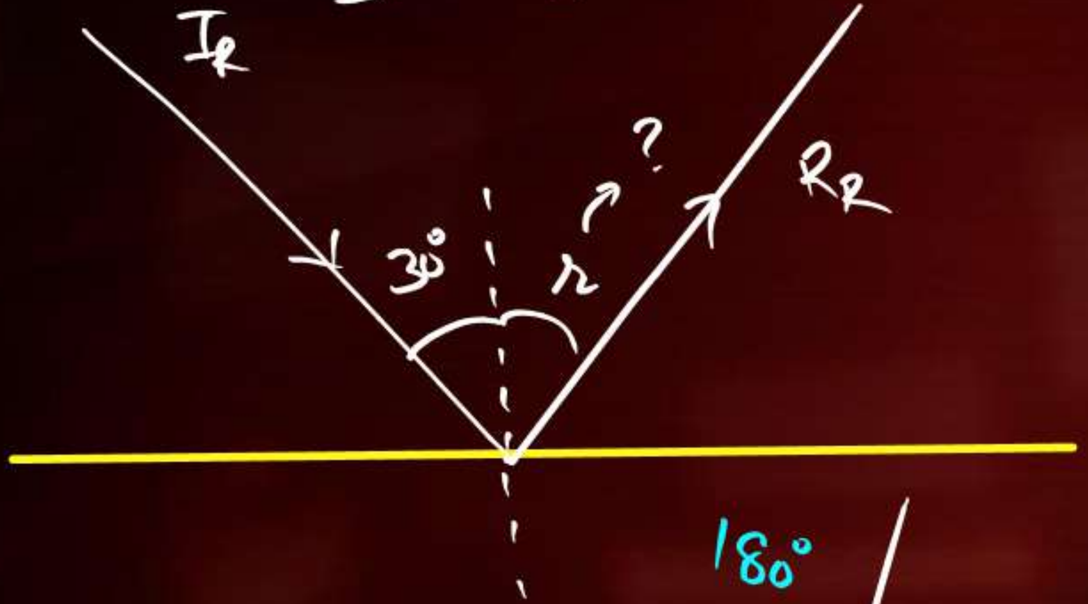
  $(\angle i = \angle r)$

Ex 1

$\angle i = \angle r$

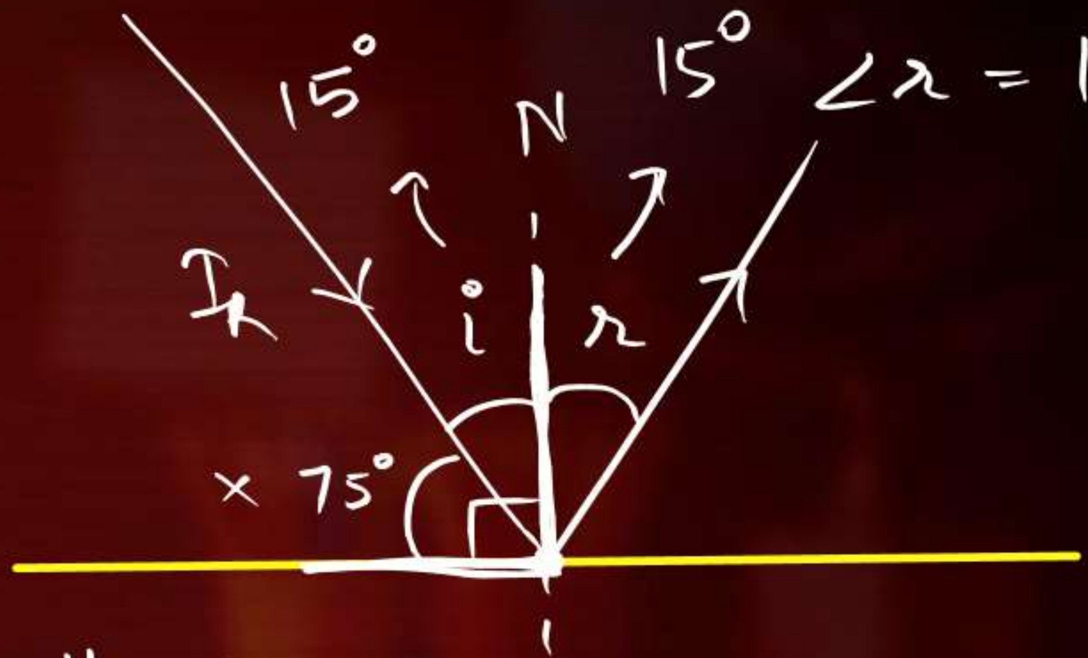
$30^\circ = 30^\circ$

$\angle r = 30^\circ$

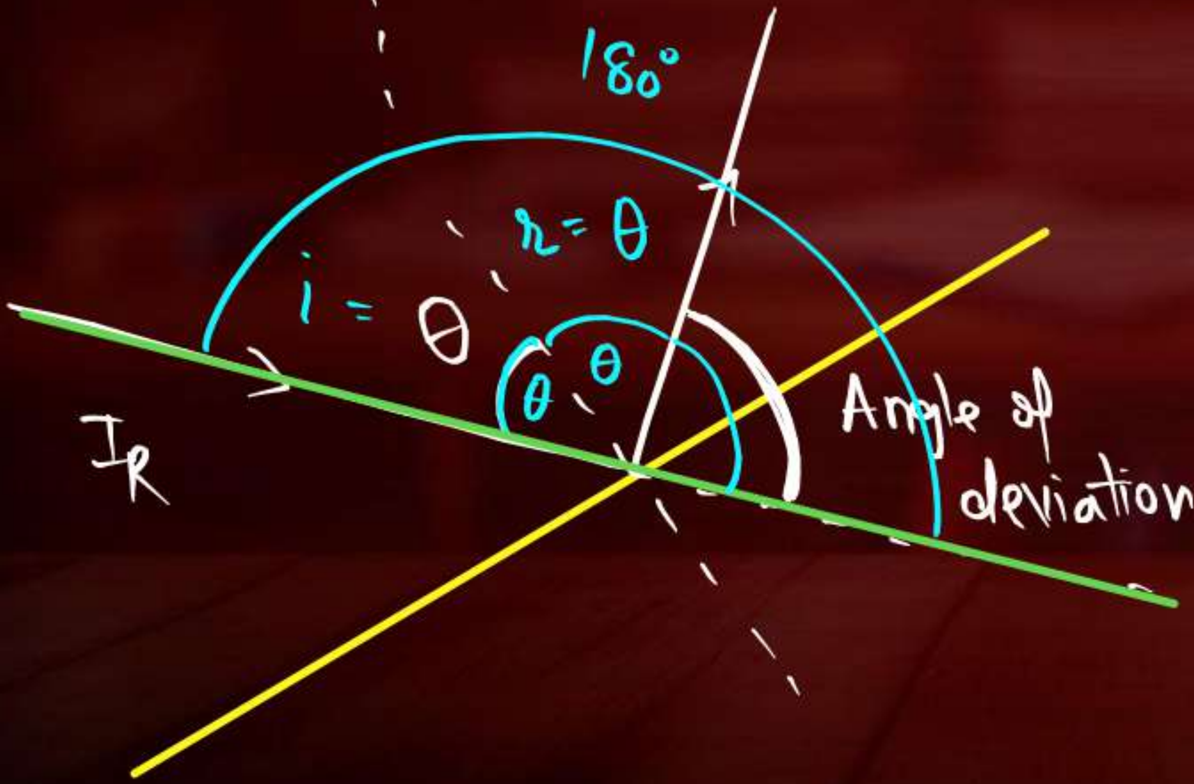


Ex 2

$\angle r = 15^\circ$

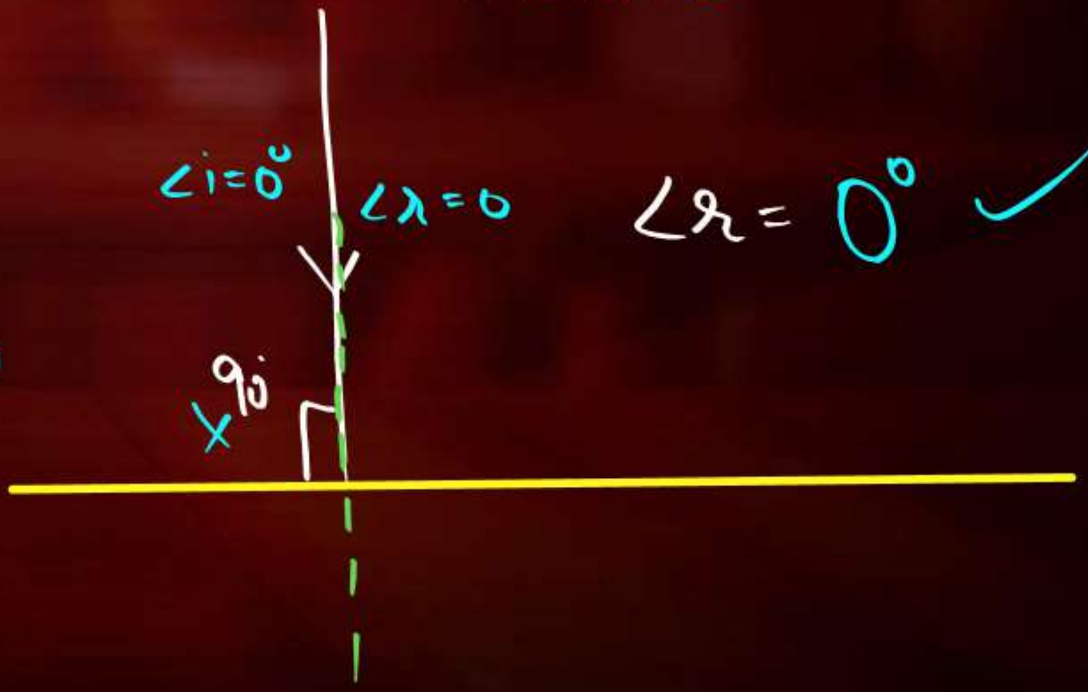


Ex-3



Angle of deviation $\Rightarrow \delta = 180^\circ - 2\theta$

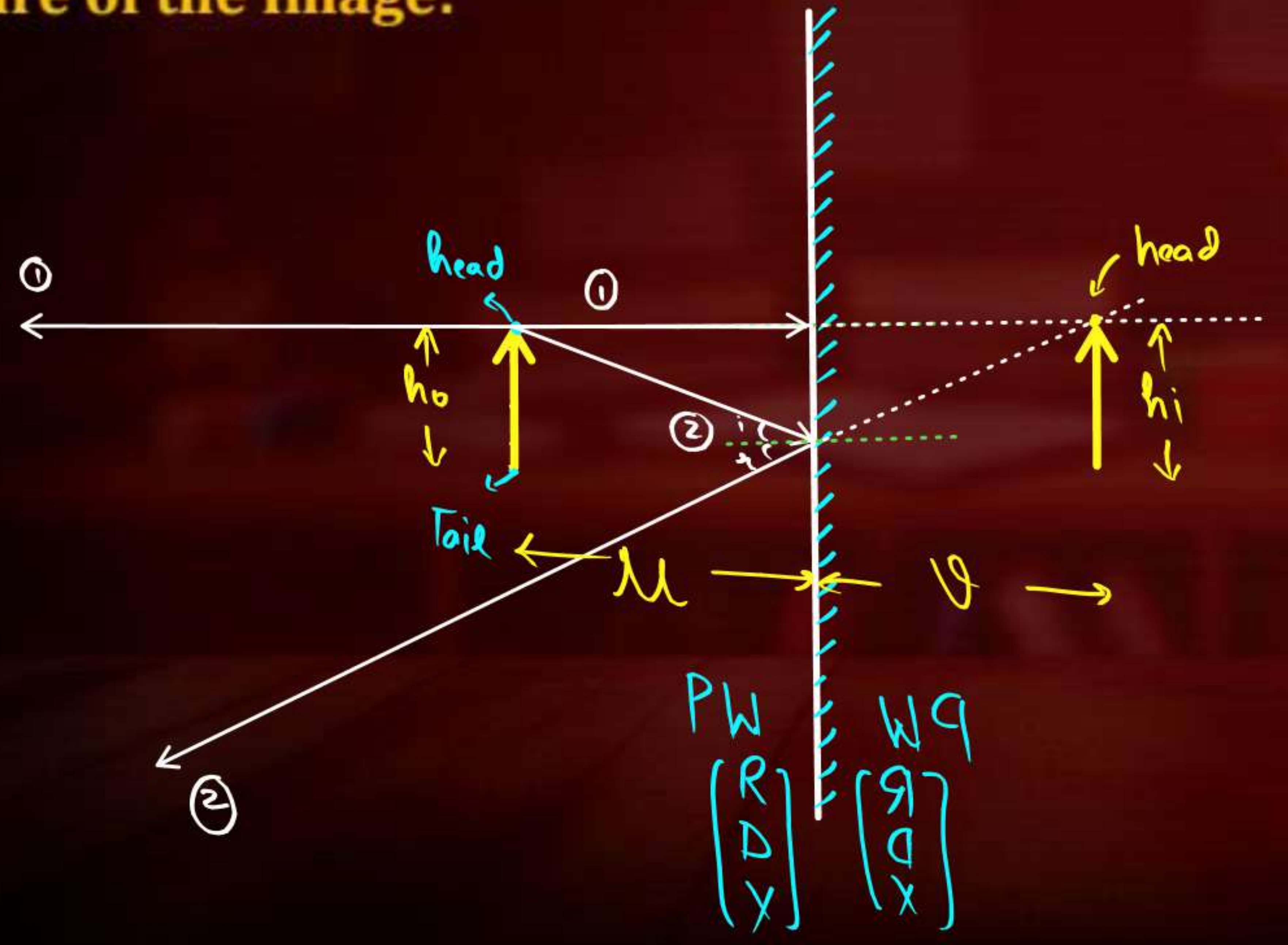
Ex-4 Normal Incidence



$\angle r = 0^\circ$ ✓

Image formation by Plane Mirror

Nature of the Image:



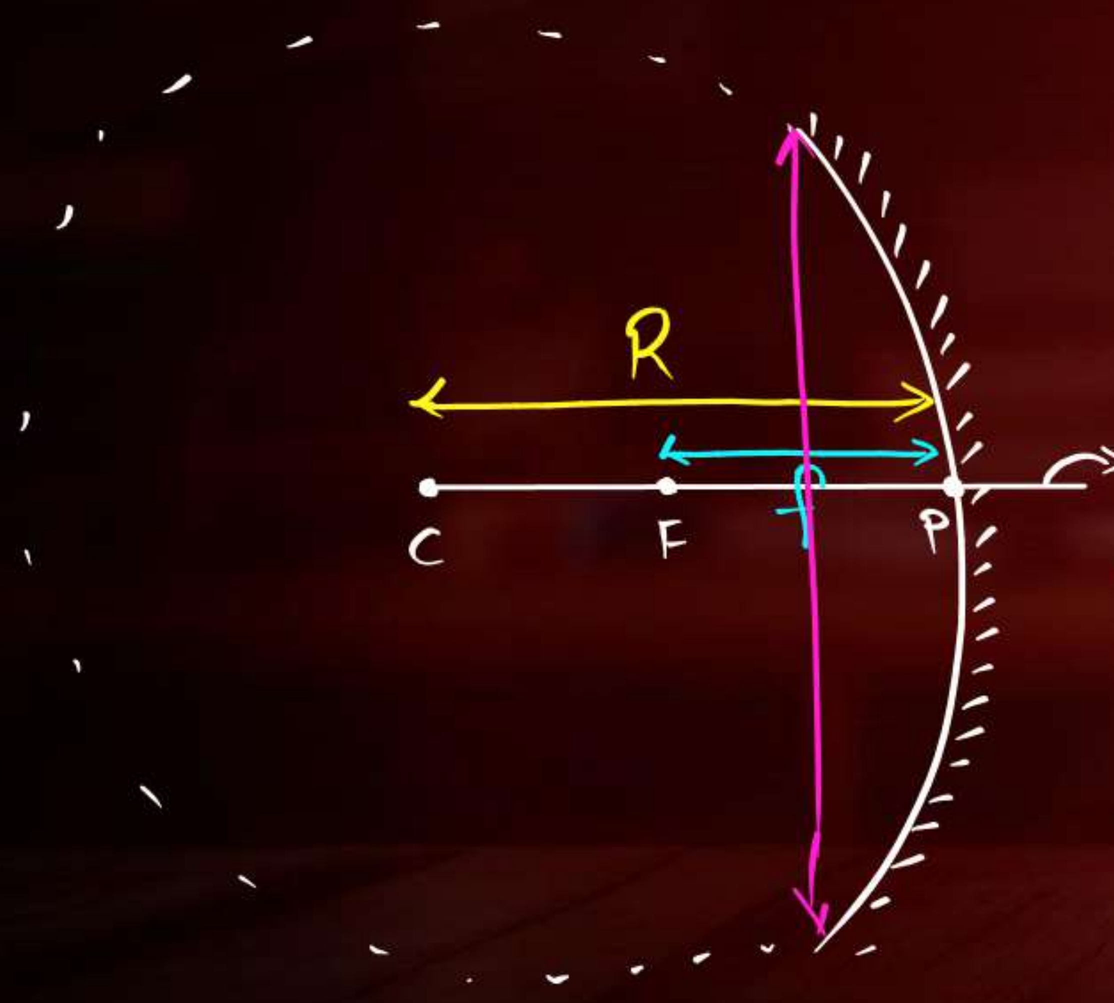
Nature of Image

1. Same distance as that of object
2. Same Size as that of object.
3. Virtual
4. Erect
5. Laterally Inverted

Spherical Mirrors

(1) Concave (Converging)

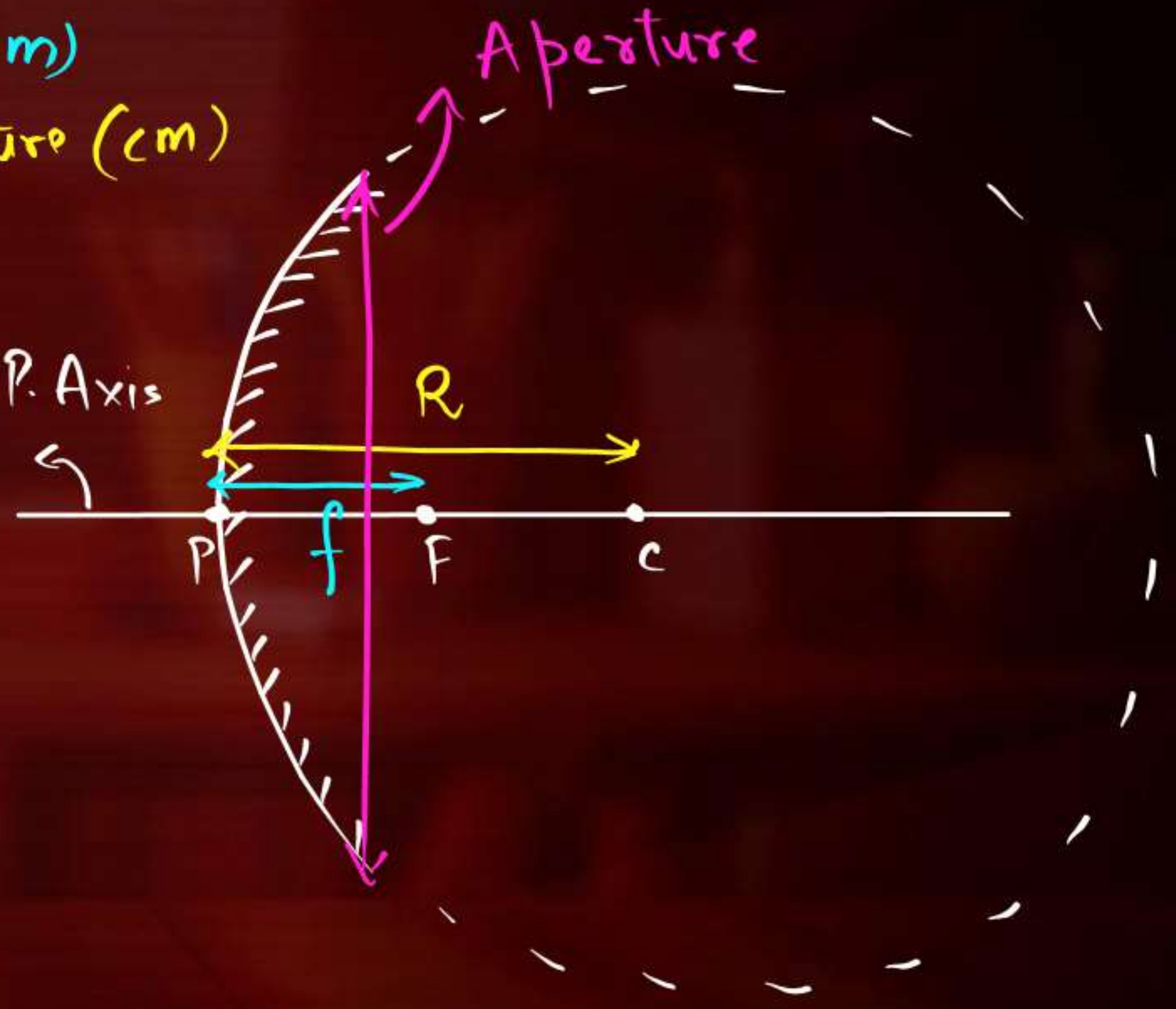
$f \rightarrow$ focal length (cm)
$R \rightarrow$ Radius of Curvature (cm)
$C \rightarrow$ Centre of Curvature
$P \rightarrow$ Pole
$F \rightarrow$ Principal focus



P. Axis (Principal Axis)

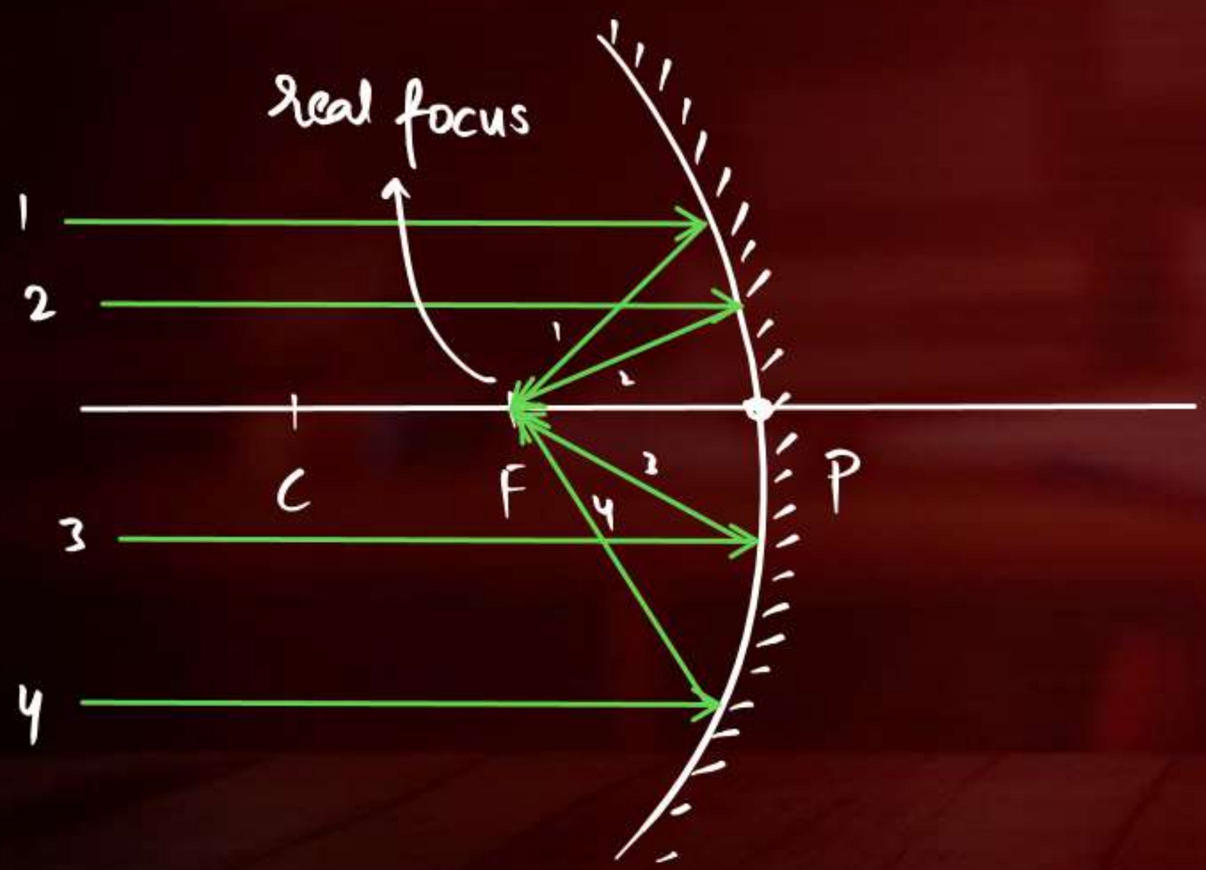
याद* $\boxed{R = 2f}$

(2) Convex (Diverging)

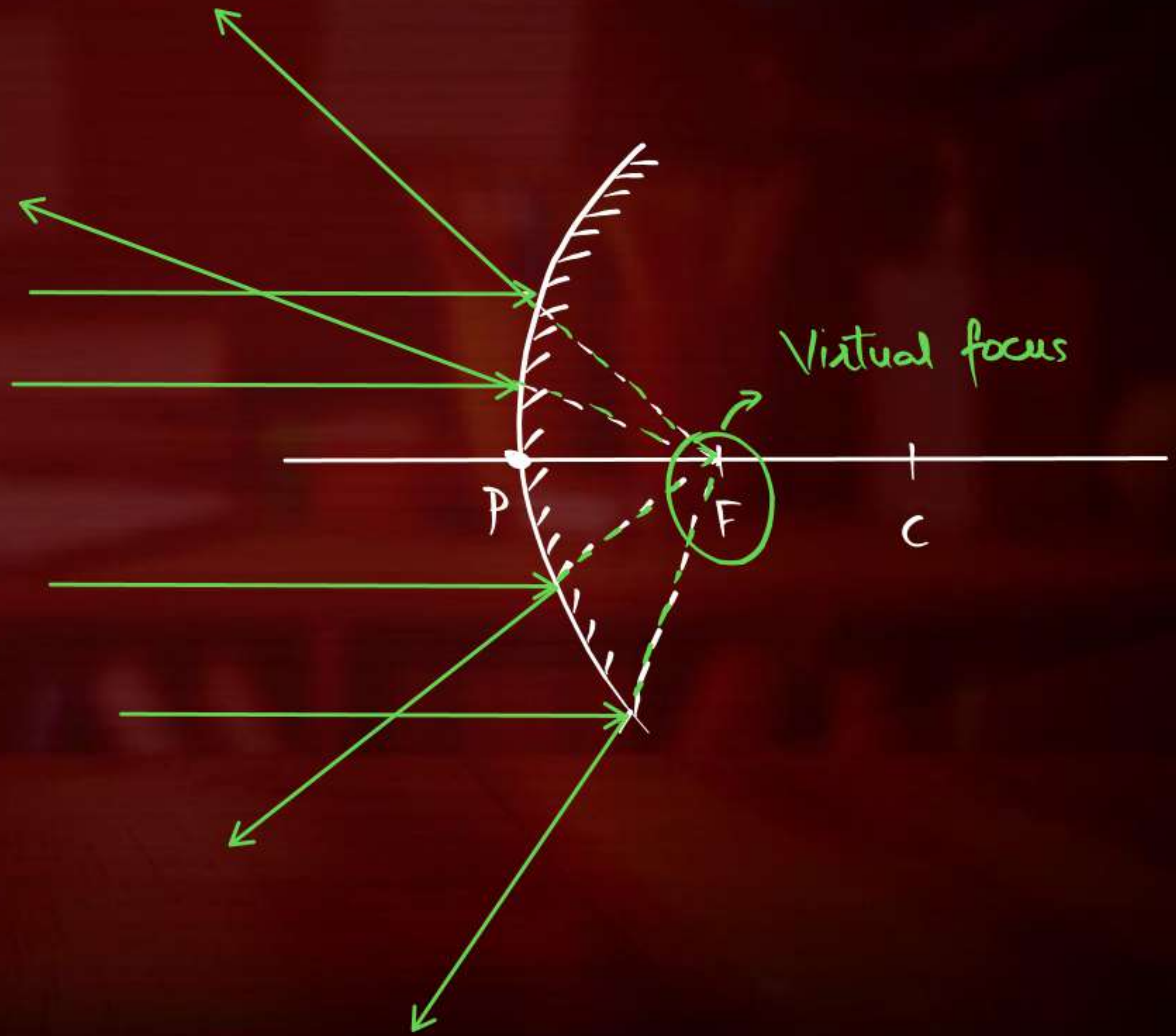


Spherical Mirrors (Nature)

(1) Concave (Converging)



(2) Convex (Diverging)



Important Terms : Spherical Mirrors

Imp.

SOME IMPORTANT DEFINITION :

1. **Centre of curvature** the centre of a hollow sphere of which the spherical mirror forms a part is called centre of curvature it is denoted by c.

2. **Radius of curvature** the radius of a hollow sphere of which the spherical mirror forms a part is called radius of curvature it is denoted by R.

3. **Pole** the midpoint of a spherical mirror is called pole it is denoted by P.

4. **Aperture** the part of a spherical mirror exposed to the incident light is called the aperture of the mirror.

5. **Principal axis** a line joining the centre of curvature and pole is called principal axis.

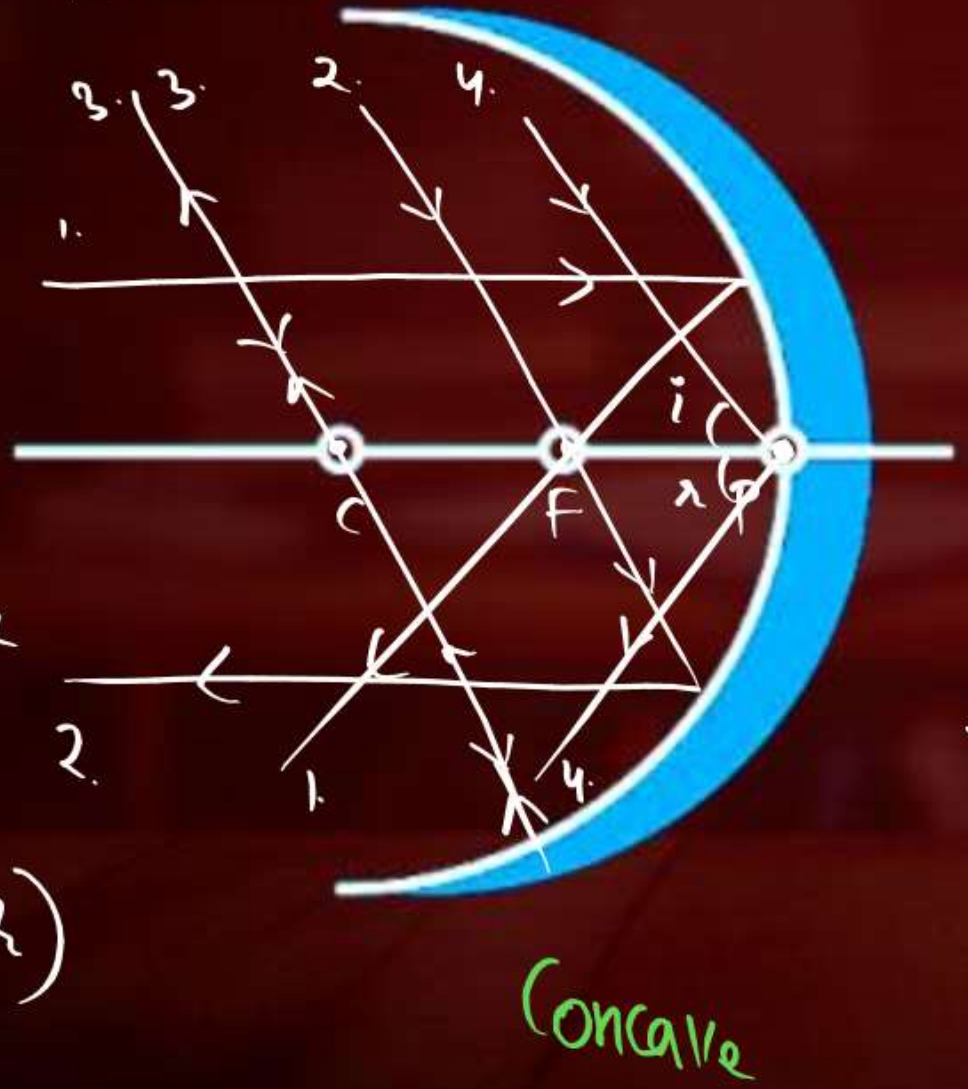
6. **Principal focus** a point on the principal axis of a spherical mirror where the rays of light parallel to the principal axis meet or appear to meet after reflection is called principal focus it is denoted by F.

7. **Focal length** the distance between the pole and principal focus of a spherical mirror is called focal length.

8. **Optical centre** it is a point on the principal axis of the lens such that a ray passing through goes undeviated.

Rules to Obtain Image

- 1. ॥ to P.Axis ⇒ Focus
- 2. F ⇒ ॥ to P.Axis
- 3. C ⇒ Backtrack
- 4. P ⇒ ($\angle i = \angle r$)



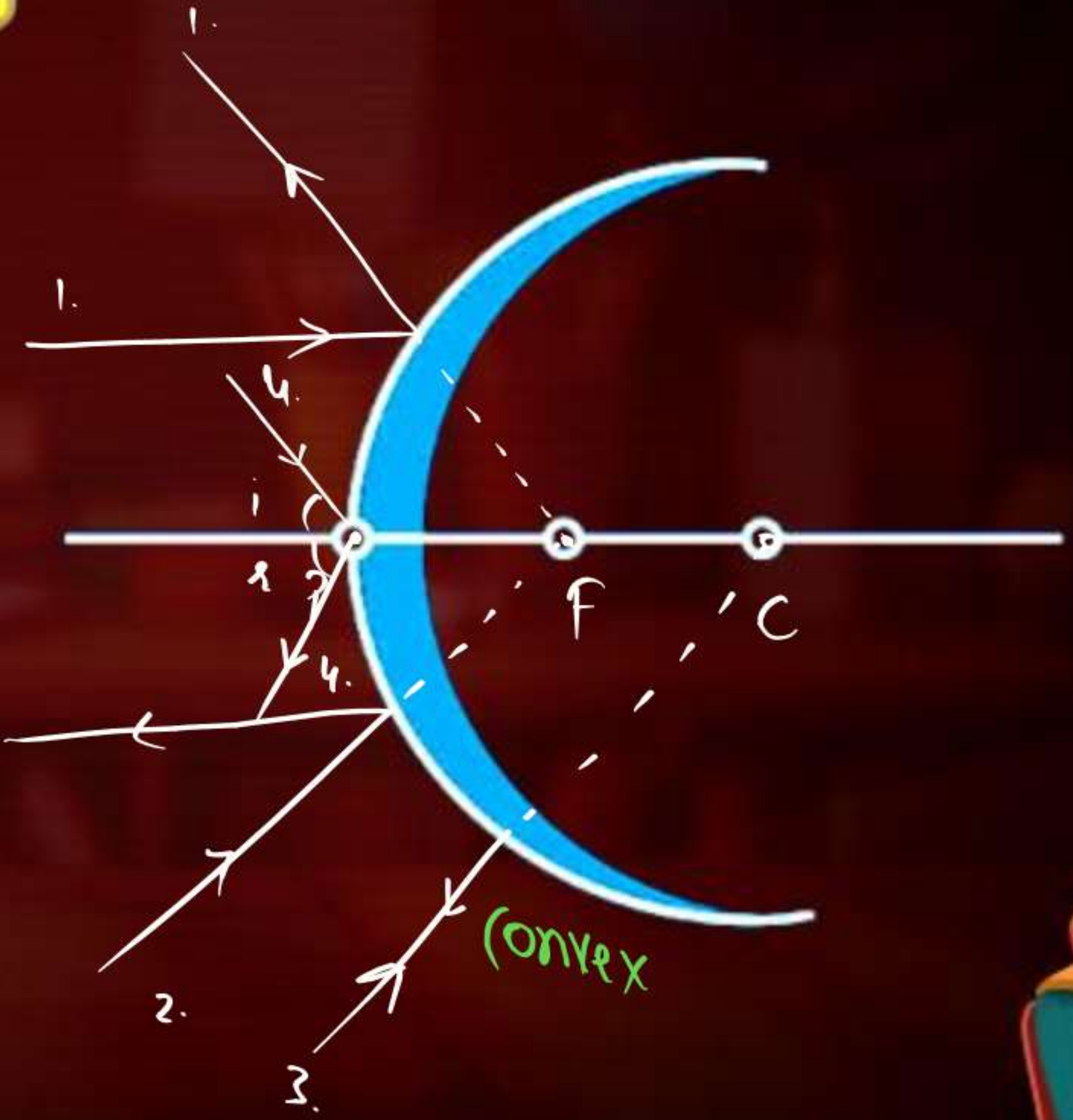
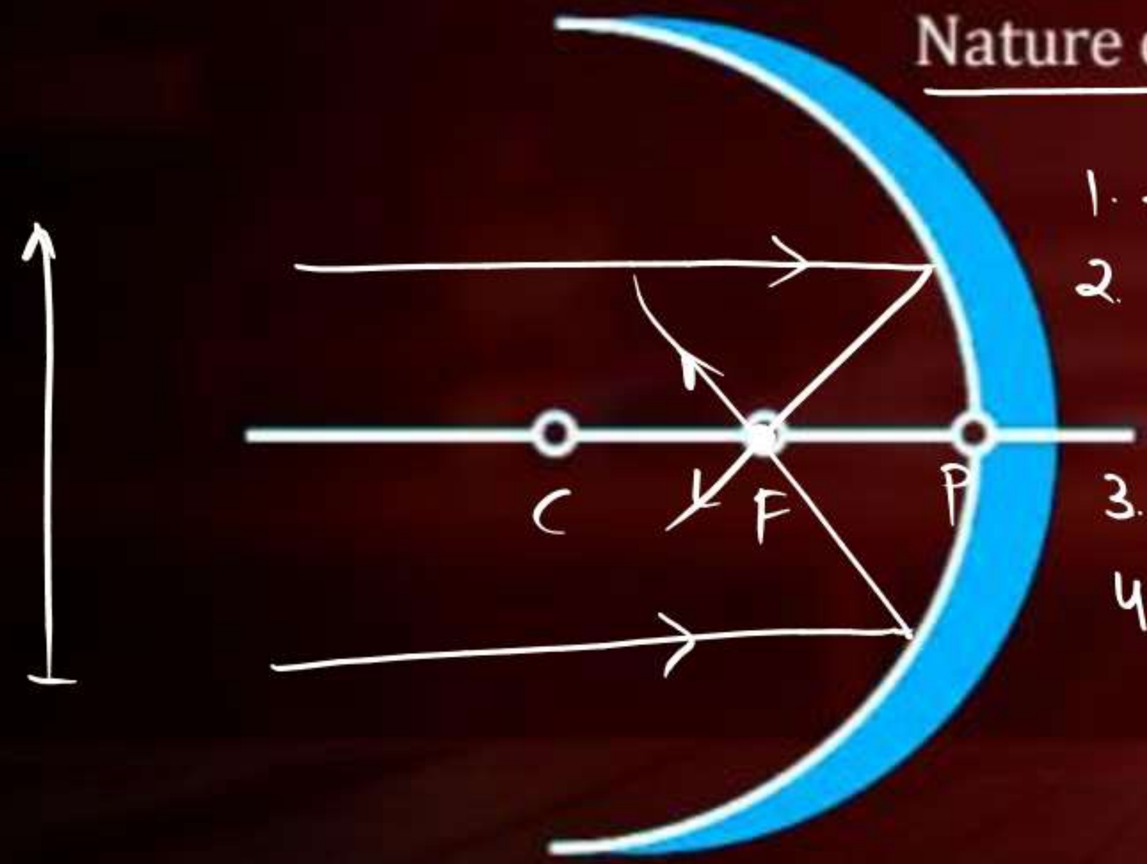


Image Formation : Concave Mirror (1)

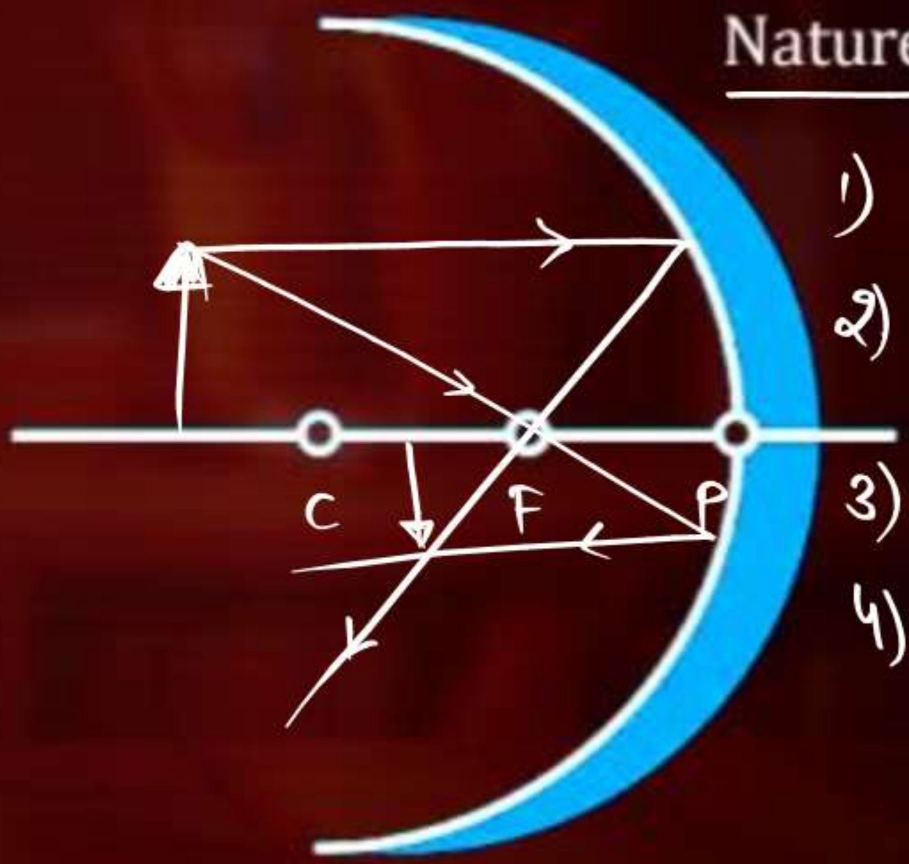
1. Object at Infinity → N.D. → Aukaat se Bahar



Nature of Image

1. At F
2. Highly diminished
3. Real
4. Inverted

2. Object beyond C

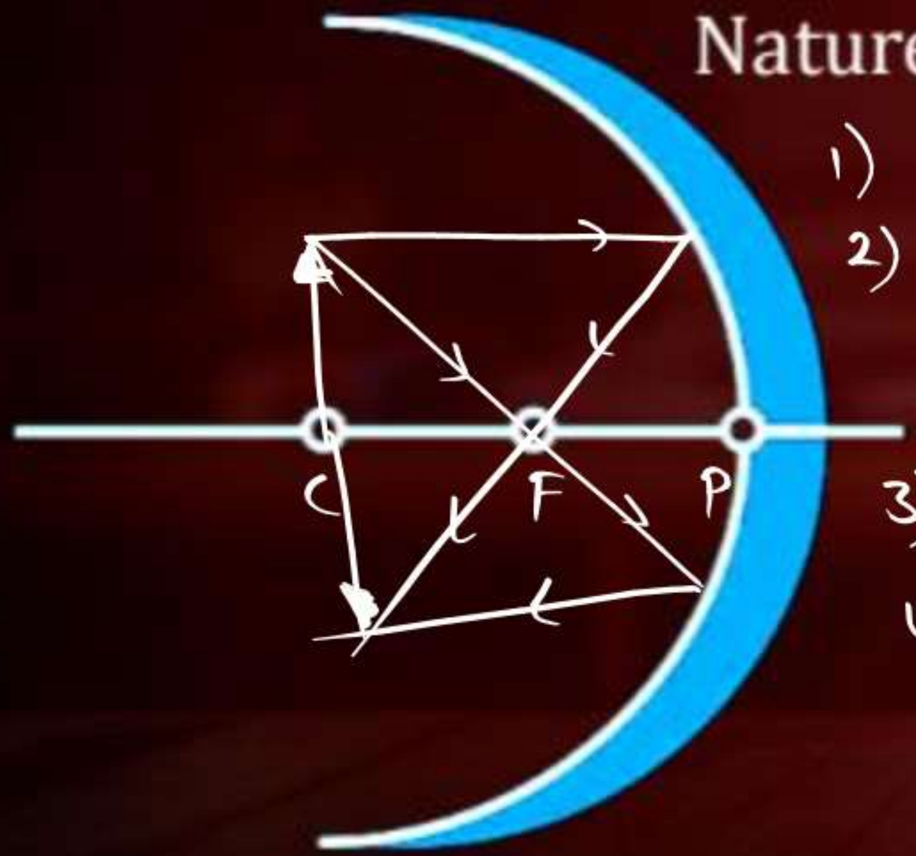


Nature of Image

1) B/w F and C
2) Diminished
3) Real
4) Inverted

Image Formation : Concave Mirror (2)

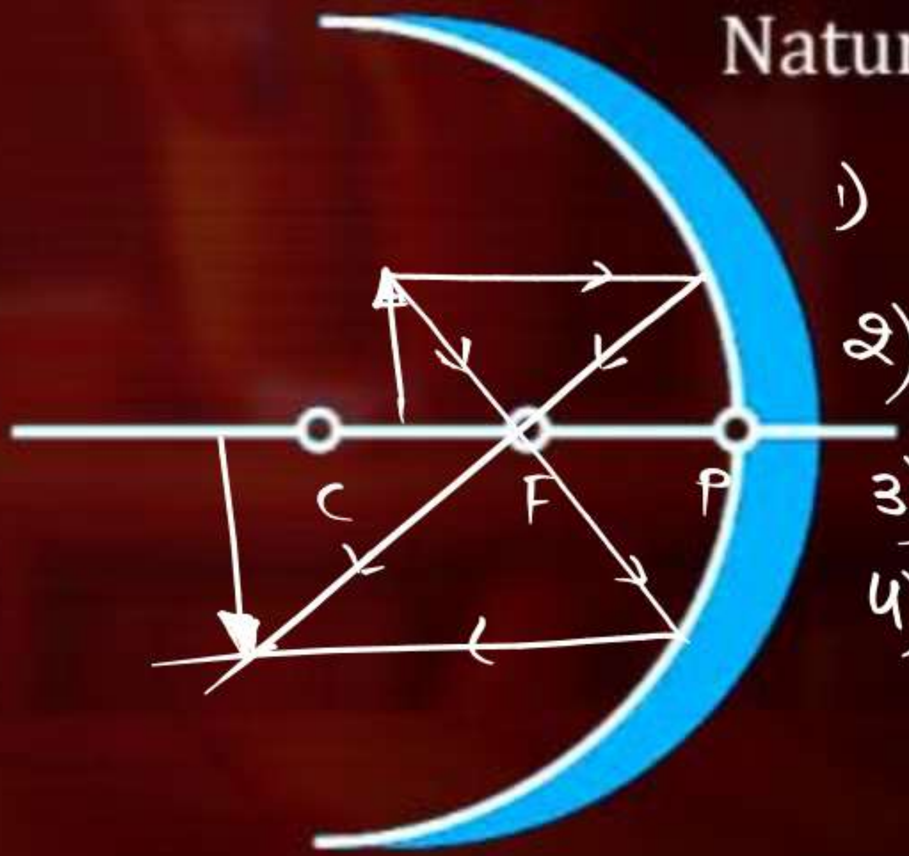
3. Object at C



Nature of Image

1) At C
2) Same Size
3) Real
4) Inverted

4. Object Between C & F

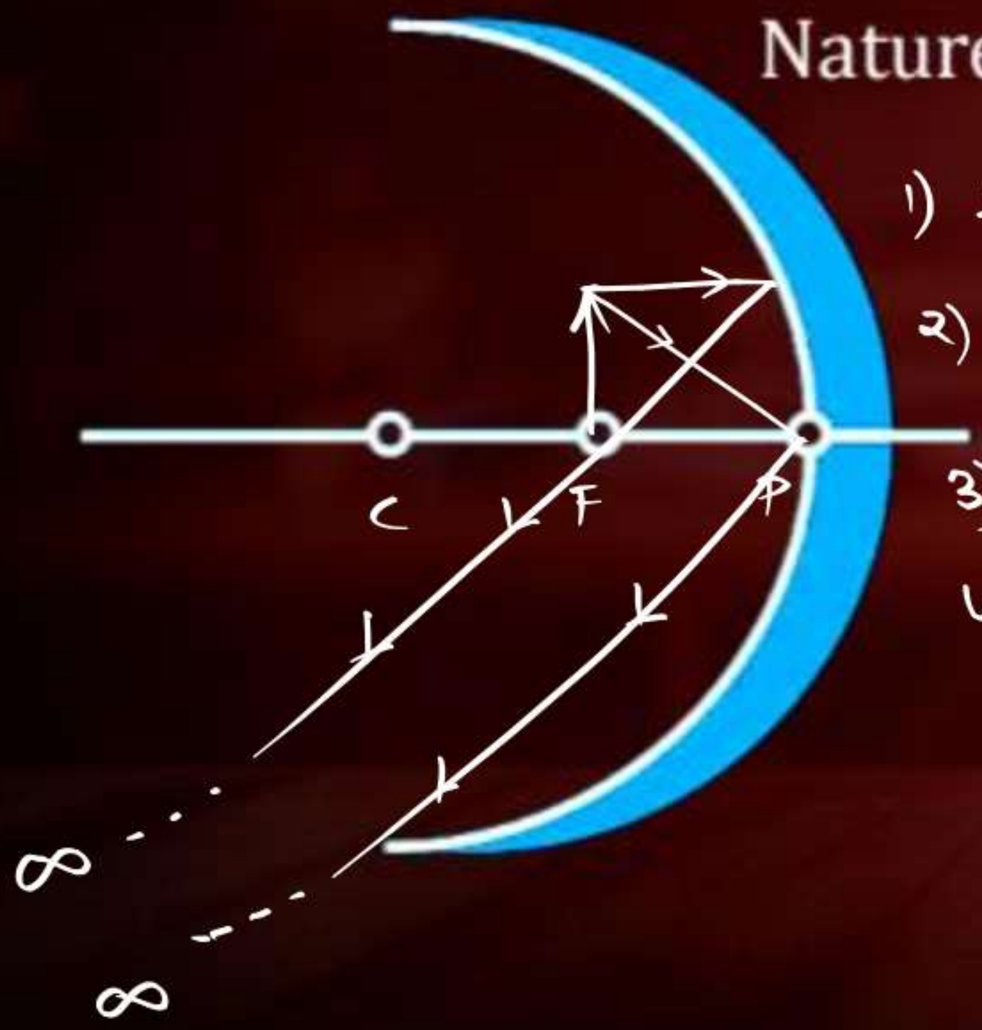


Nature of Image

1) Beyond C
2) Enlarged
3) Real
4) Inverted

Image Formation : Concave Mirror (3)

5. Object at F

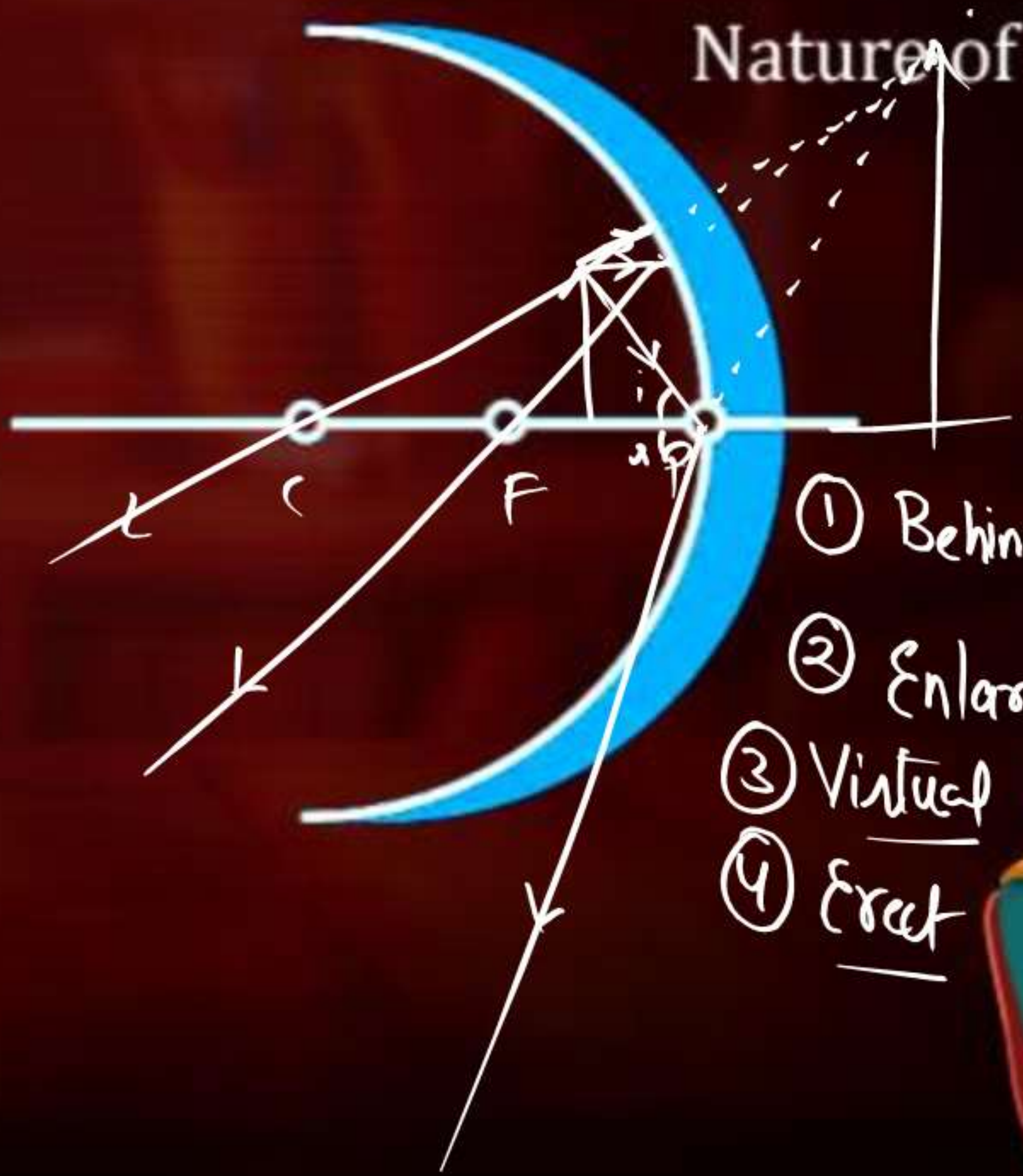


Nature of Image

1) At infinity
2) Highly Enlarged
3) Real
4) Inverted

V.V.I.P. Chathin Case

6. Object Between F & P



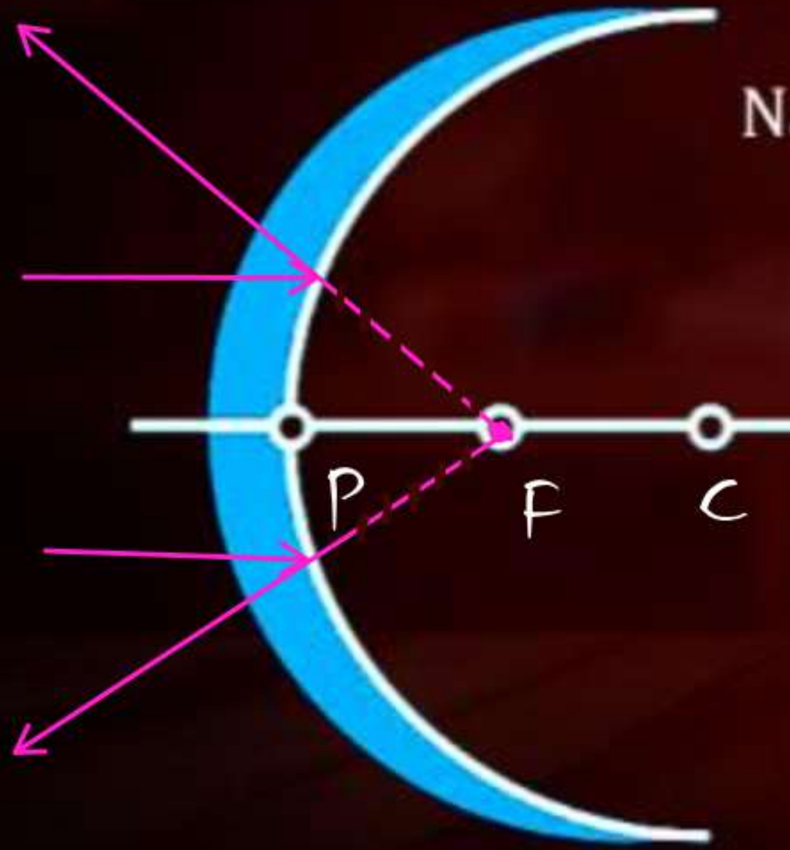
Nature of Image

1. Behind the Mirror
2. Enlarged
3. Virtual
4. Erect

Image Formation : Convex Mirror

V.E.D.

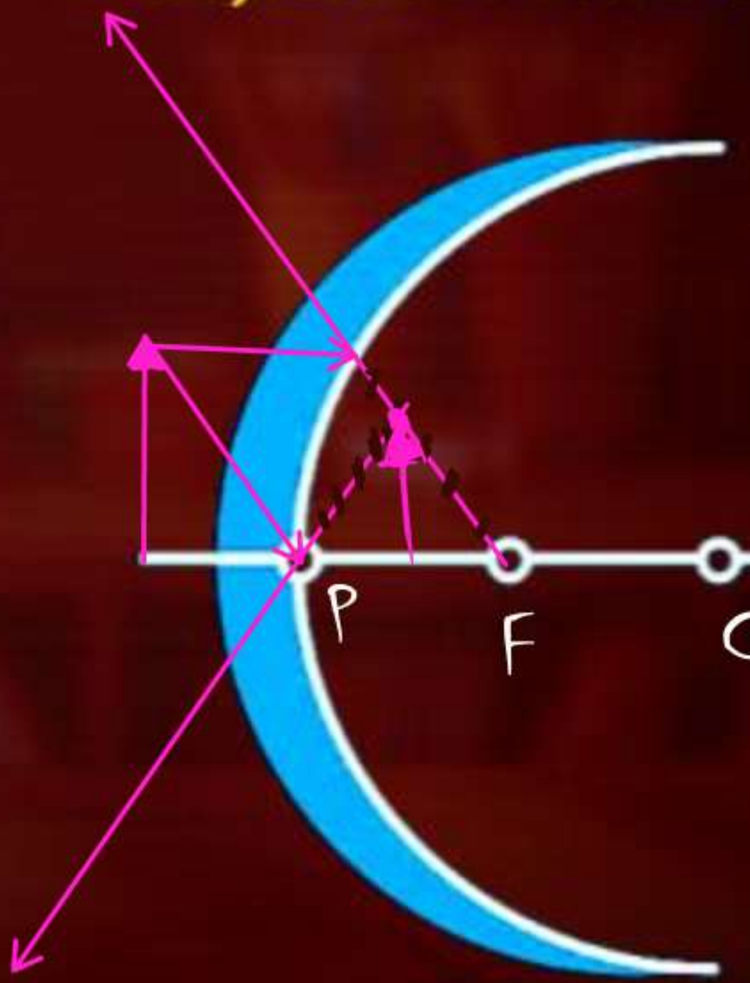
1. Object at Infinity



Nature of Image

1. At F
2. Highly Diminished
3. Virtual
4. Erect

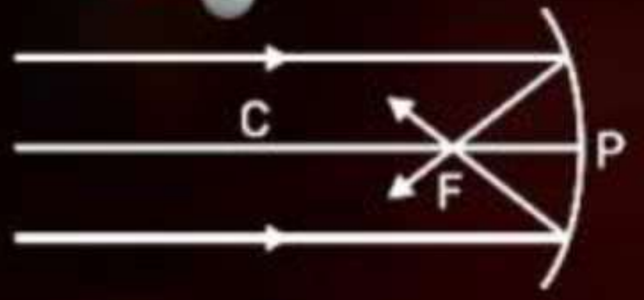
2. Object at Finite Distance ($\infty \rightarrow P$)



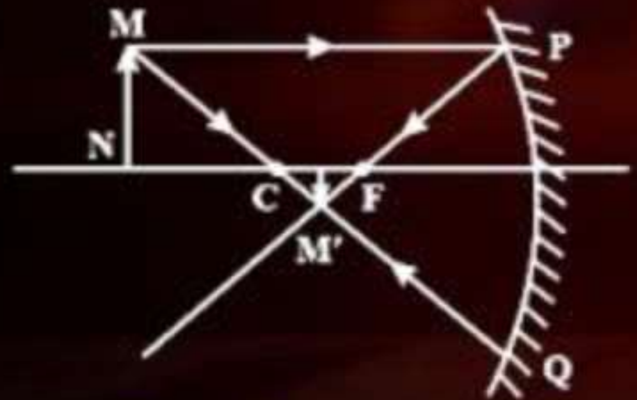
Nature of Image

1) B/w F and P
2) Diminished
3) Virtual
4) Erect

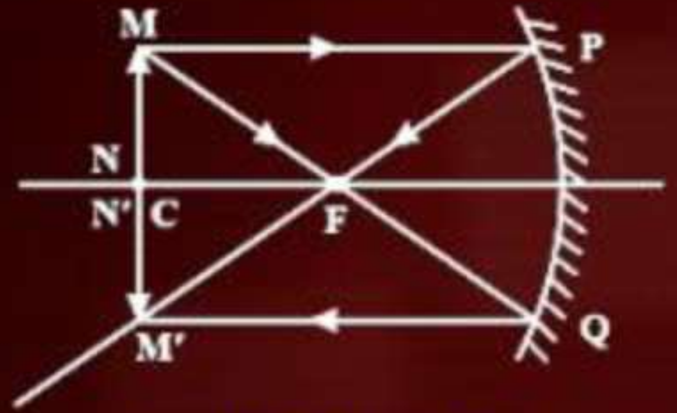
All Ray Diagrams : Spherical Mirrors



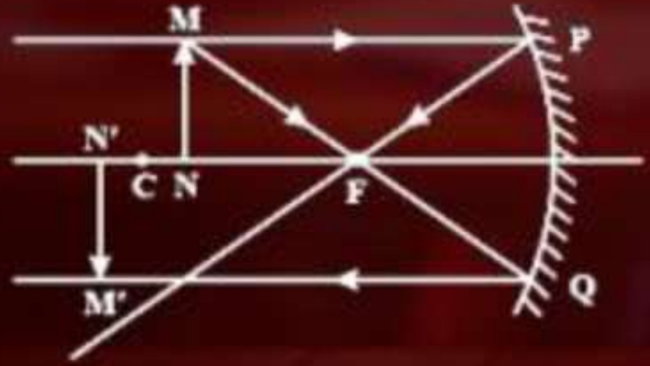
1. Object at Infinity



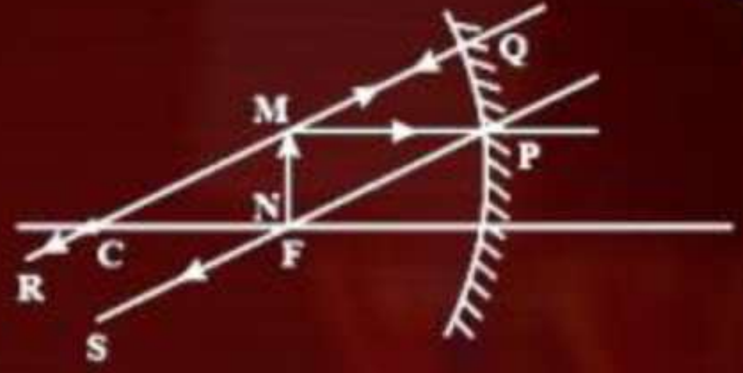
2. Object beyond C



3. Object at C



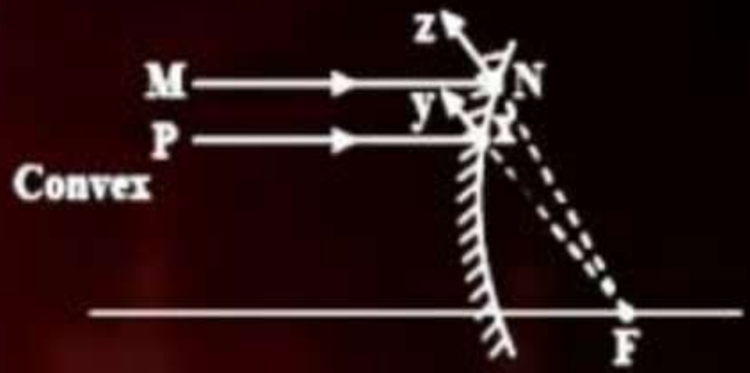
4. Object Between F and C



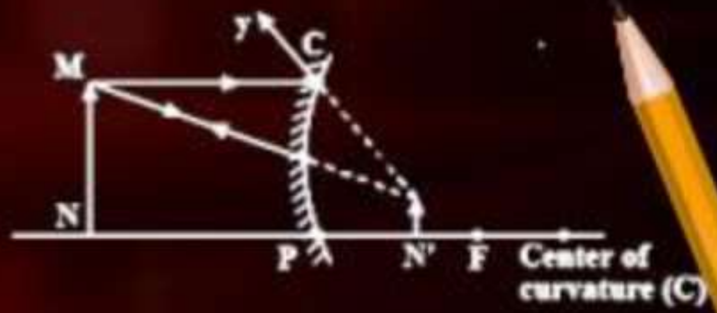
5. Object at F

6. Object Between F and P

Concave Mirror



1. Object at Infinity

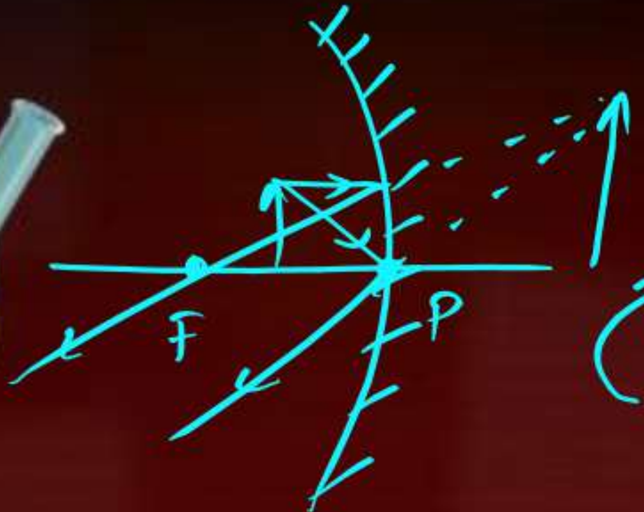


2. Object at Finite Distance

Convex Mirror

Concave Mirror Convex Mirror

Uses of Mirrors



V.V.I.P. Chatha case

6th

Convex Mirror

Side-view

(rear-view)

Parking lots

(large field of view)

Concave Mirror

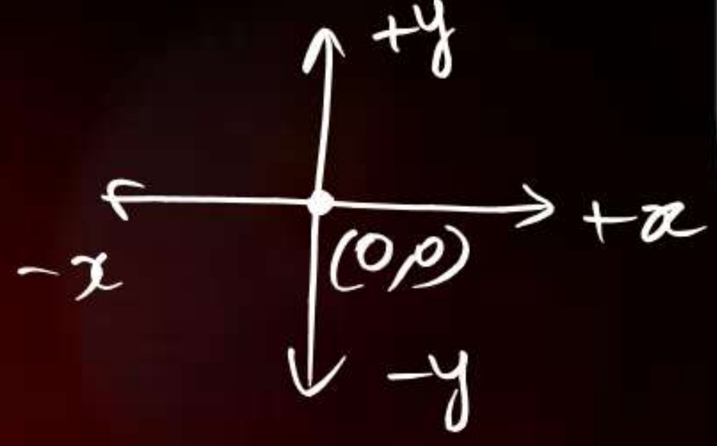
Let us Practice some Half Ray Diagrams

Agar Numerical Karne Ho To !!!

- Ray Diagrams
- Sign Convention
- Formulae

(New Cartesian)

Sign Convention in Mirrors



* याद

Always

u - h_o +

Left F, C ⊖

Right F, C ⊕

R → Radius

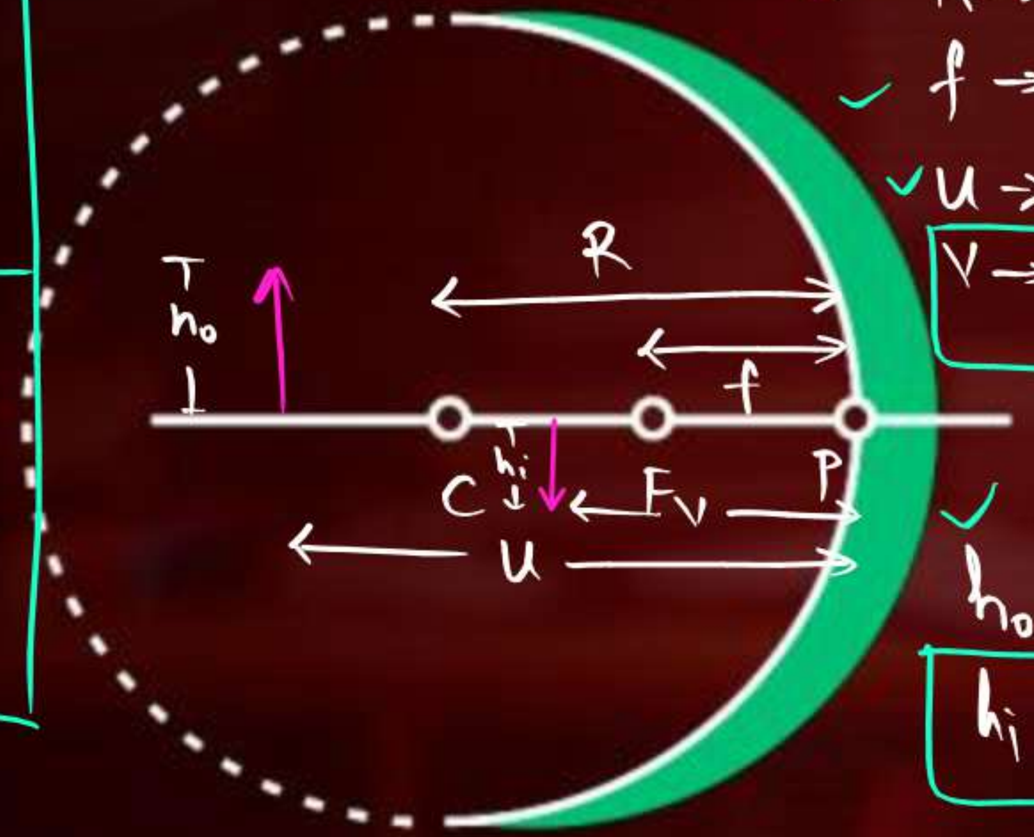
f → focal length

u → obj dist.

V → img. dist

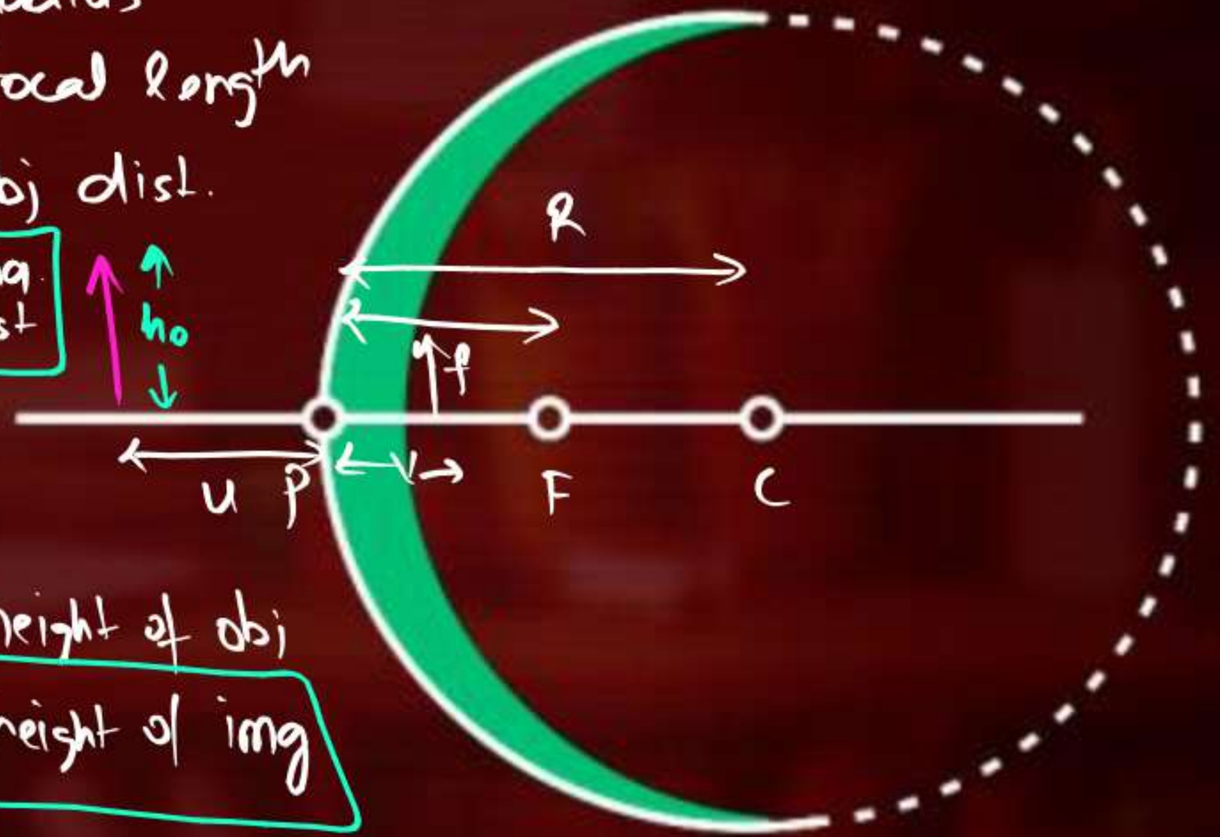
h_o - height of obj

h_i - height of img



Concave

f ⊖ R ⊖ u ⊖ h_o ⊕



Convex

f ⊕ R ⊕ u ⊖ h_o ⊕

One Step Ahead : Formulae

Weapons to "Kill Nature"

- Mirror Formula :

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

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

- Magnification Formula :

Define m = ?

Ans - The ratio of image height w.r.t. object height

\# Unitless.

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

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

$$m = \frac{h_{\text{image}}}{h_{\text{object}}}$$

$$\boxed{m = \frac{h_i}{h_o}}$$

$\to$ ~~cm~~

$\to$ ~~cm~~

$0 < m < 1$: Diminished

$m = 1$: Same size

$m > 1$: Enlarged / Magnified

m → + : ERECT + Virtual

m → − : INVERTED + Real

QUESTION

Concave Mirror

An object is placed at a distance of 10 cm from a converging mirror of focal length 5 cm. find the nature and position of the image.

Given :-

$u = -10cm$

$f = -5cm$

$v = ?$

$m = ?$

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

$$\frac{1}{-5} = \frac{1}{v} - \frac{1}{10}$$

$$\frac{1}{10} - \frac{1}{5} = \frac{1}{v}$$

$$\frac{1-2}{10} = \frac{1}{v}$$

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

$$\boxed{v = -10cm}$$

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

$$= -\frac{(\cancel{-10})}{(\cancel{-10})}$$

$$\boxed{m = -1}$$

m → $-ve$: Real + Inverted

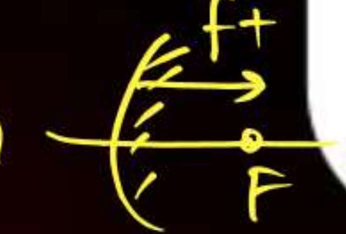
m → $m = 1$: Same Size

QUESTION

An object is placed at a distance of 15 cm from a diverging mirror of focal length 6 cm. find the nature and position of the image.

QUESTION

Convex Mirror



An object 2 cm tall is placed at 10 cm from a diverging mirror of focal length 6 cm. find the size, nature and position of the image.

Given :-

Always $\begin{cases} h_0 = +2\,cm \\ u = -10\,cm \end{cases}$

$f = +6\,cm$

$h_i = ?$

$m = ?$

✓ $V = ?$

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

$$\frac{1}{6} = \frac{1}{V} - \frac{1}{10}$$

$$\frac{1}{6} + \frac{1}{10} = \frac{1}{V}$$

$$\frac{5+3}{30} = \frac{1}{V}$$

$$\frac{8}{30} = \frac{1}{V}$$

$$\boxed{V = \frac{30}{8}\,cm}$$

$$m = \frac{-V}{u}$$

$$= +\frac{3\cancel{0}}{8(+1\cancel{0})}$$

$$\boxed{m = +\frac{3}{8}}$$

$m \rightarrow +$: Virtual + Erect

$m \rightarrow 0 < m < 1$: Diminished

$$m = \frac{h_i}{h_0}$$

$$+\frac{3}{\cancel{8}_4} = \frac{h_i}{\cancel{2}}$$

$$h_i = \frac{3}{4}\,cm \text{ or } 0.75\,cm$$

NCERT DISCUSSION

REFLECTION

Phenomenon of Light : Refraction

- Refraction of light is the change in the direction of a light ray passing from one medium to another.

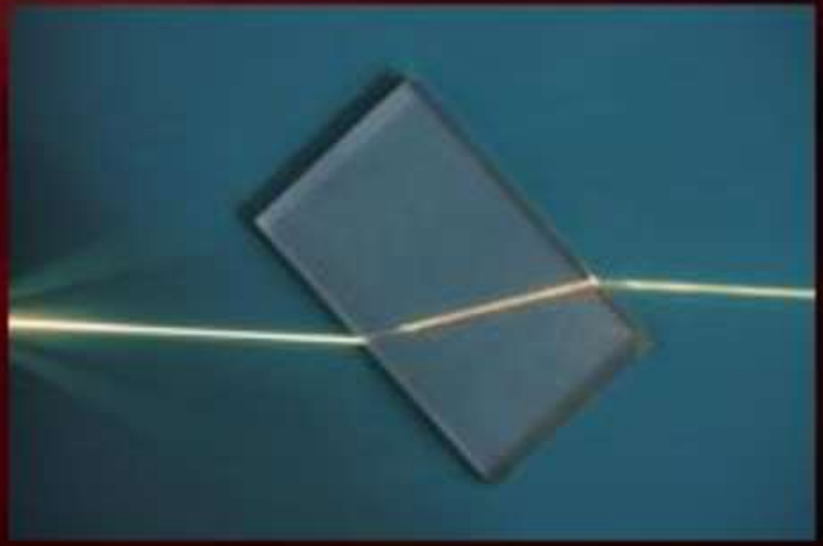
Transparent eg- Vacuum (1), air (1.003), Water, glass, Diamond (2.42)

Oil, Kerosene, Alcohol, Acid, Base etc.

'refractive Index'

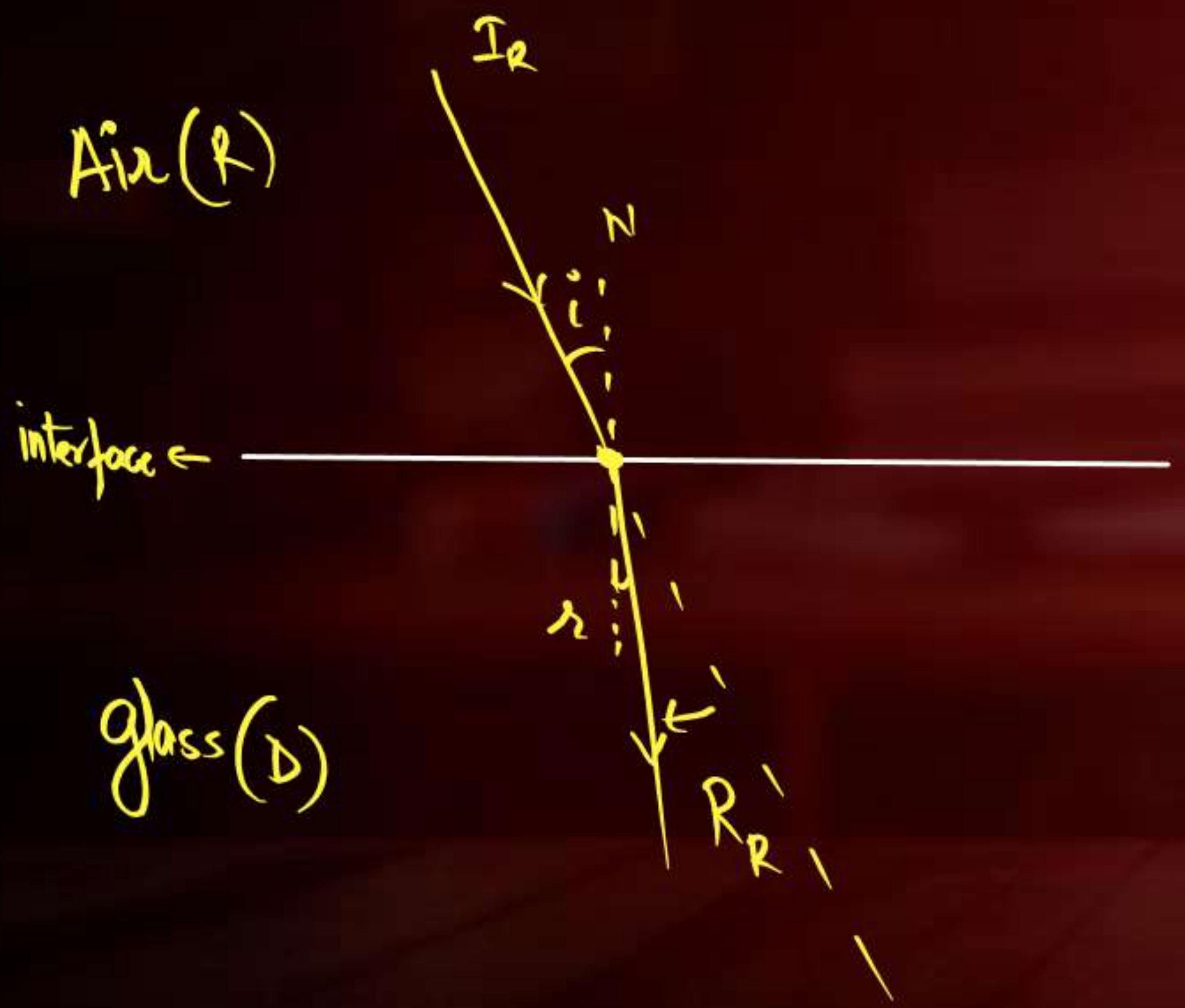
- The bending of Light Ray is caused due to the differences in optical density between the two transparent media. ✓

R.I. ↑ optically density ↑
R.I. ↓ optically Rarer ↑

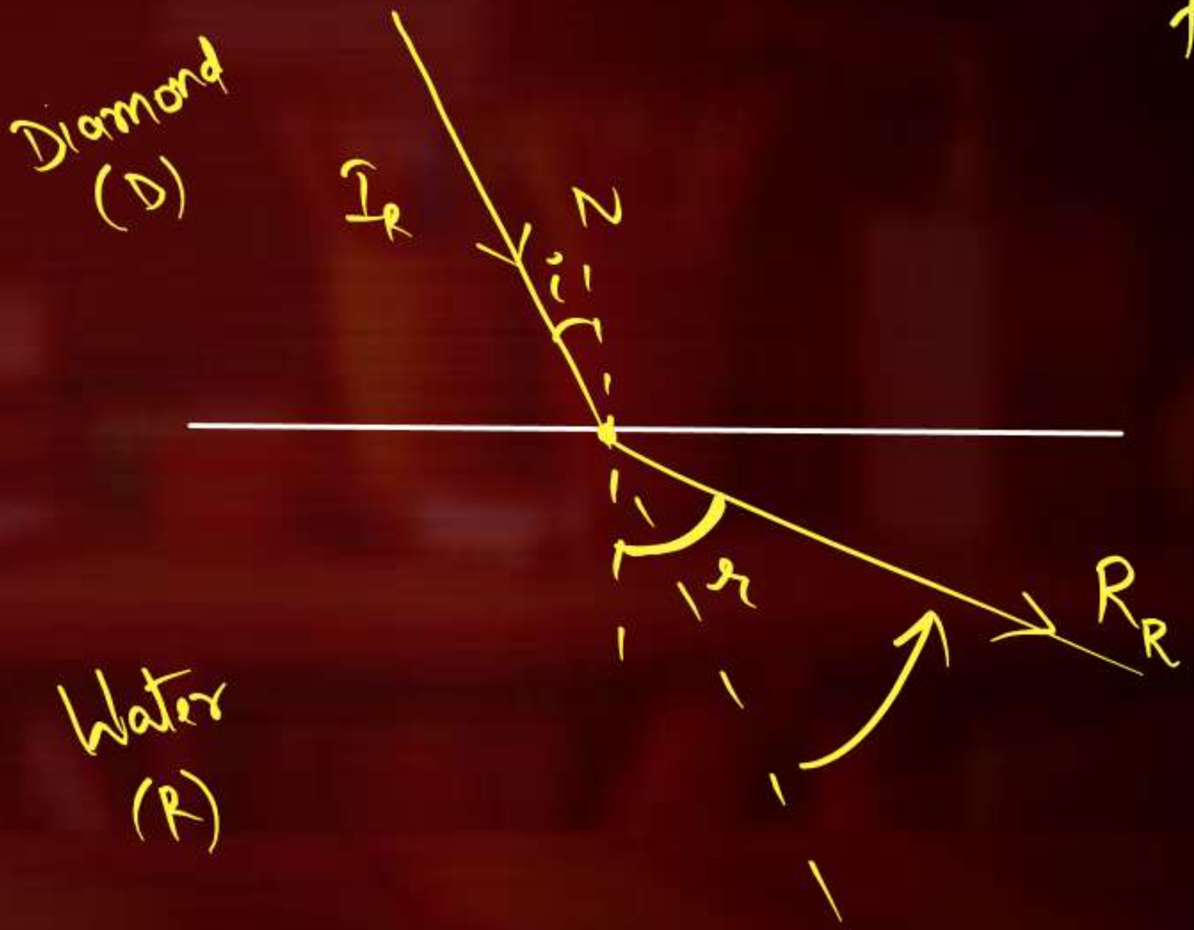


Rules of Refraction (Transiting Media)

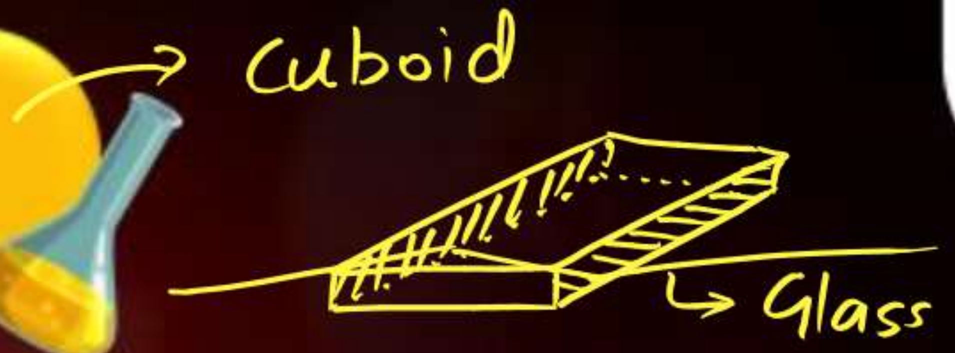
(1) Rarer → Denser : Bend towards N



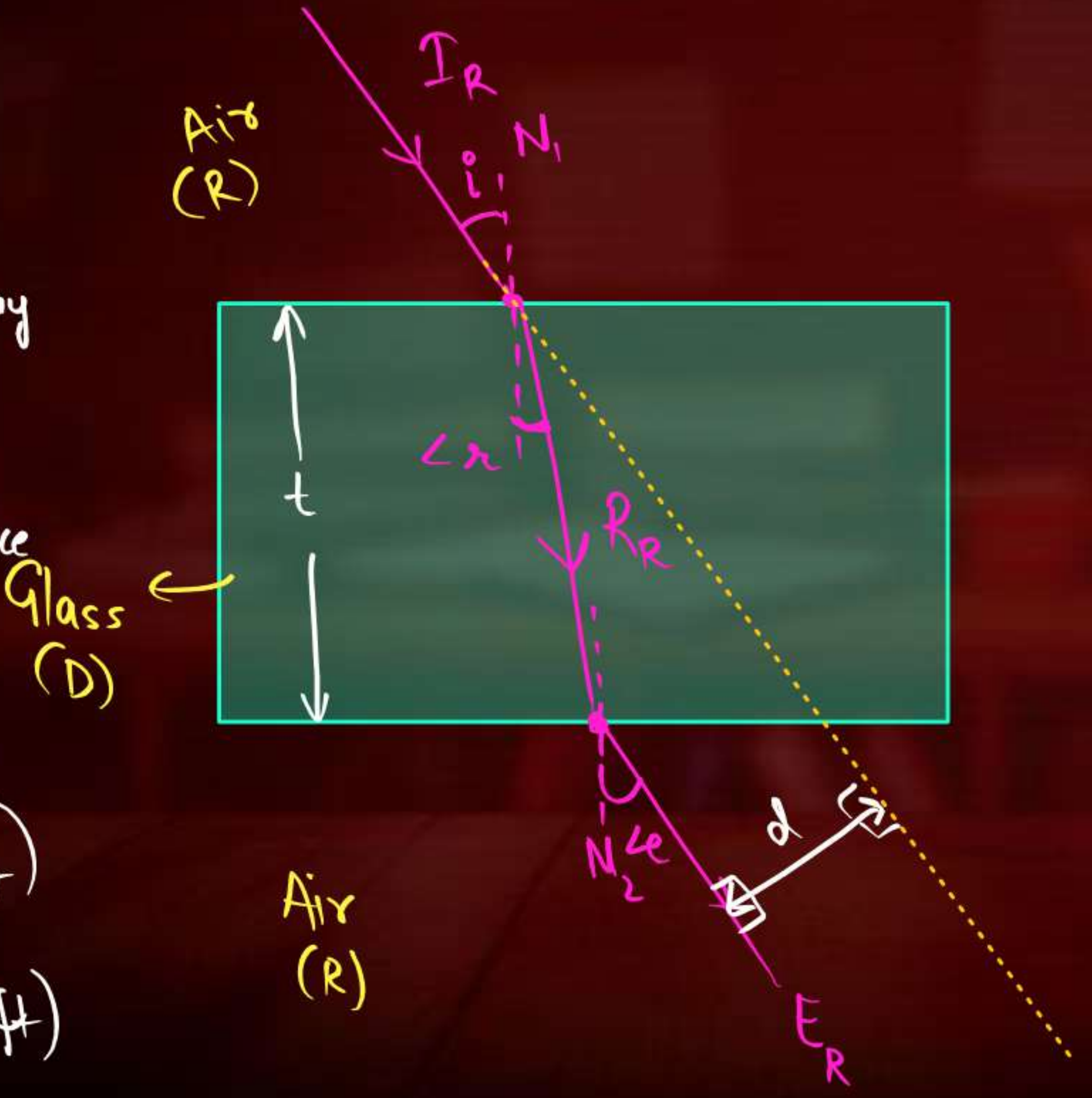
(2) Denser → Rarer : Bend away from Normal



Refraction through Glass Slab



1. I_R
2. R_R
3. E_R – Emergent Ray
4. $\angle i$
5. $\angle r$
6. $\angle e$ – Angle of Emergence
7. N_1
8. N_2
9. 'd' → (Lateral displacement) or (Optical shift)

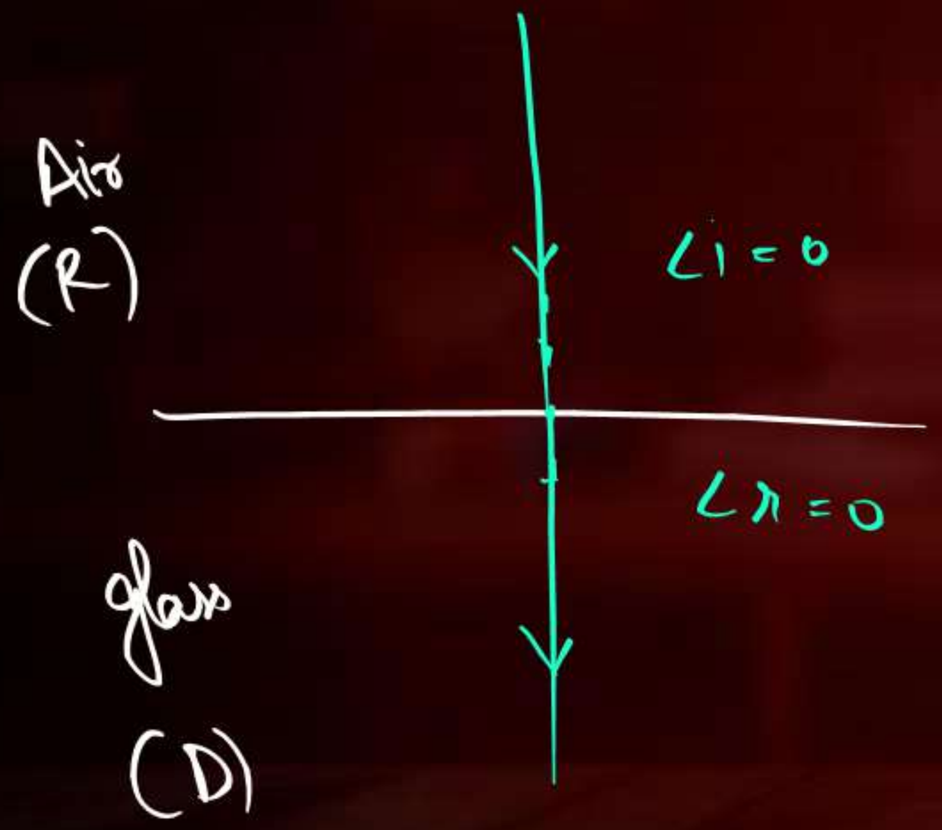


Lateral displacement –

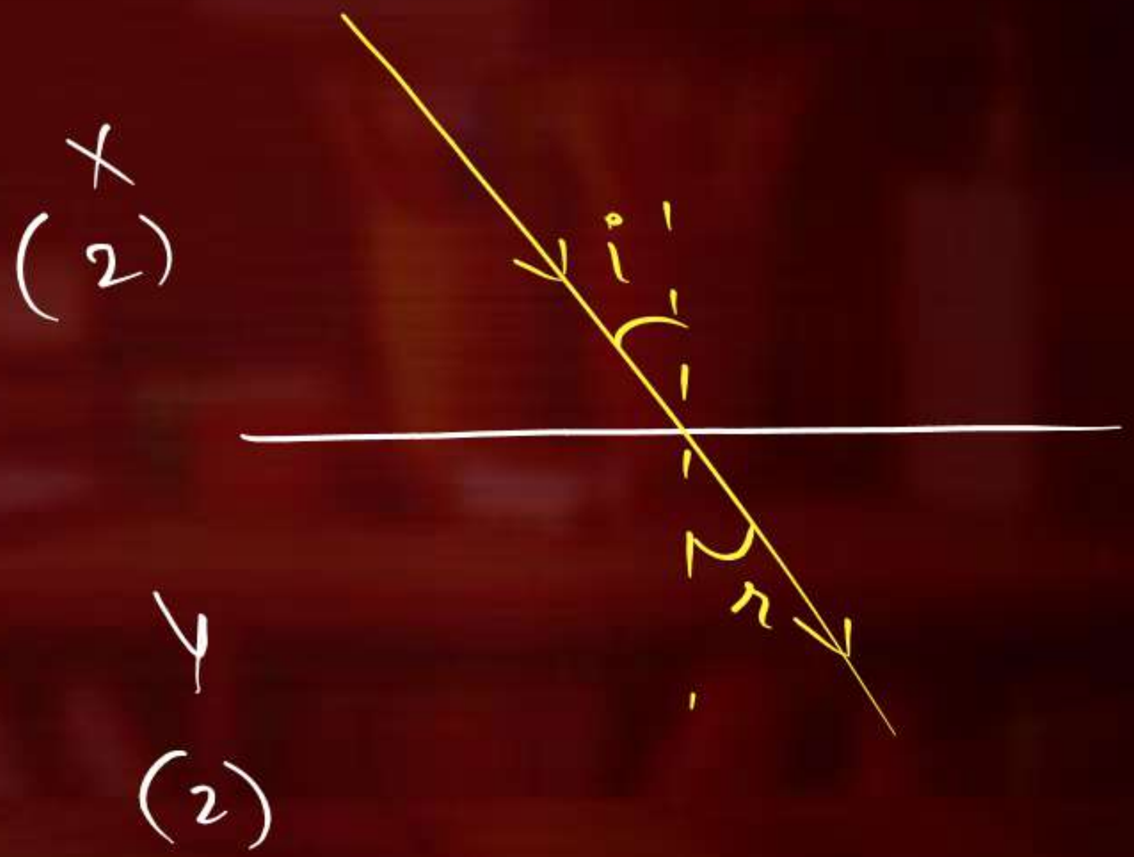
- Perpendicular distance between I_R and E_R.
- depends –
  1. Optical density of Glass
  2. Wavelength of light
  3. thickness of slab.

When Refraction does not occur !!!

1. Normal Incidence



2. Refractive Index is same.



LAWS OF REFRACTION

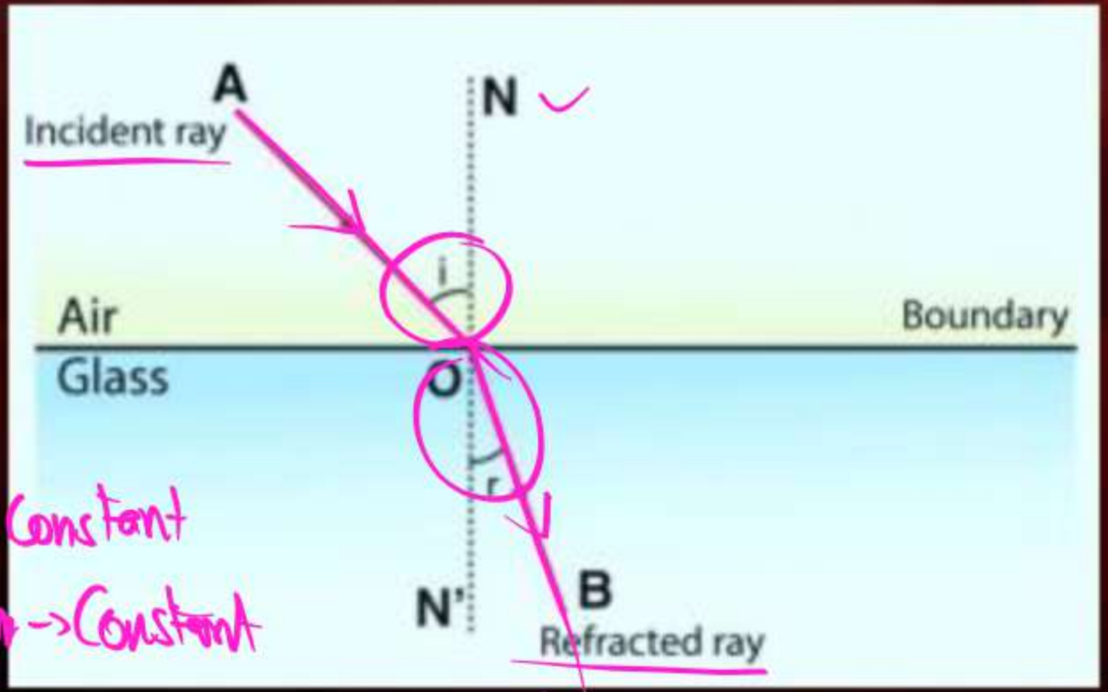
The laws of refraction states that

IR RR N

- The incident ray, refracted ray, and the normal to the interface of two media at the point of incidence all lie on the same plane.
- The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant. This is also known as Snell's law of refraction.

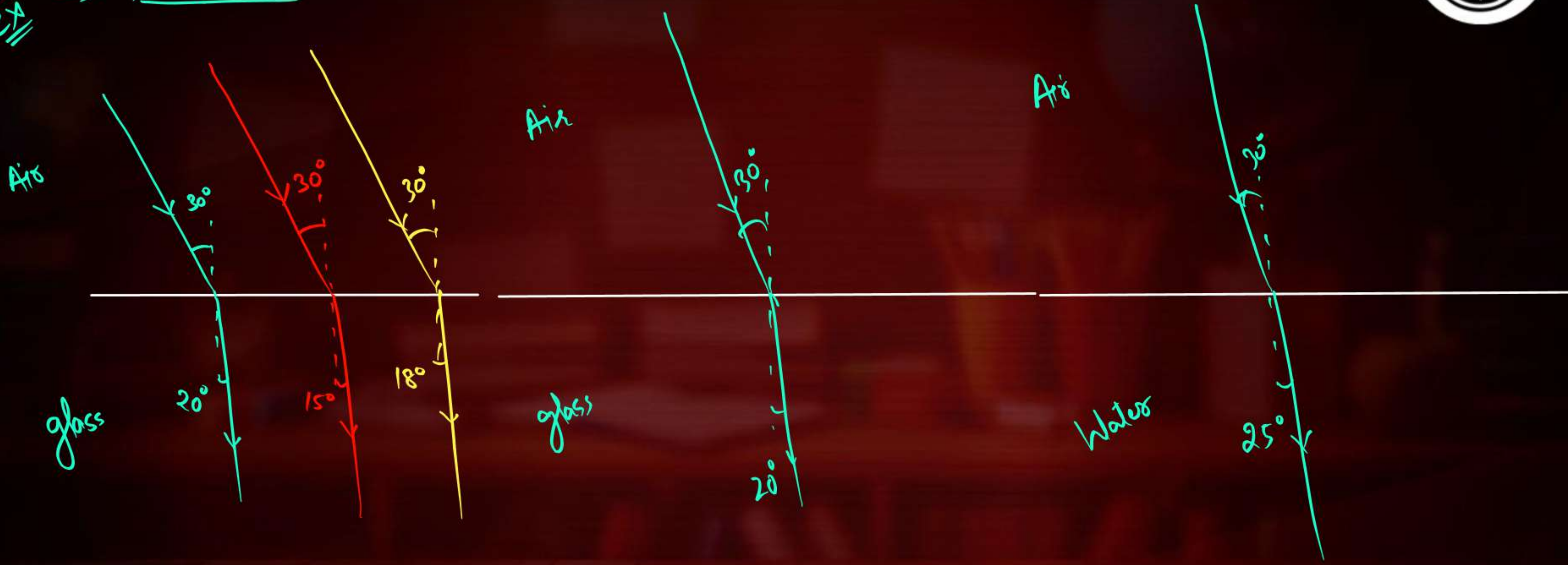
$$\frac{\sin i}{\sin r} = \text{Constant}$$

1. Wavelength → Constant
2. pair of Medium → Constant



$$\frac{\sin i}{\sin r} = \text{constant}$$

Ex → Snell's Law



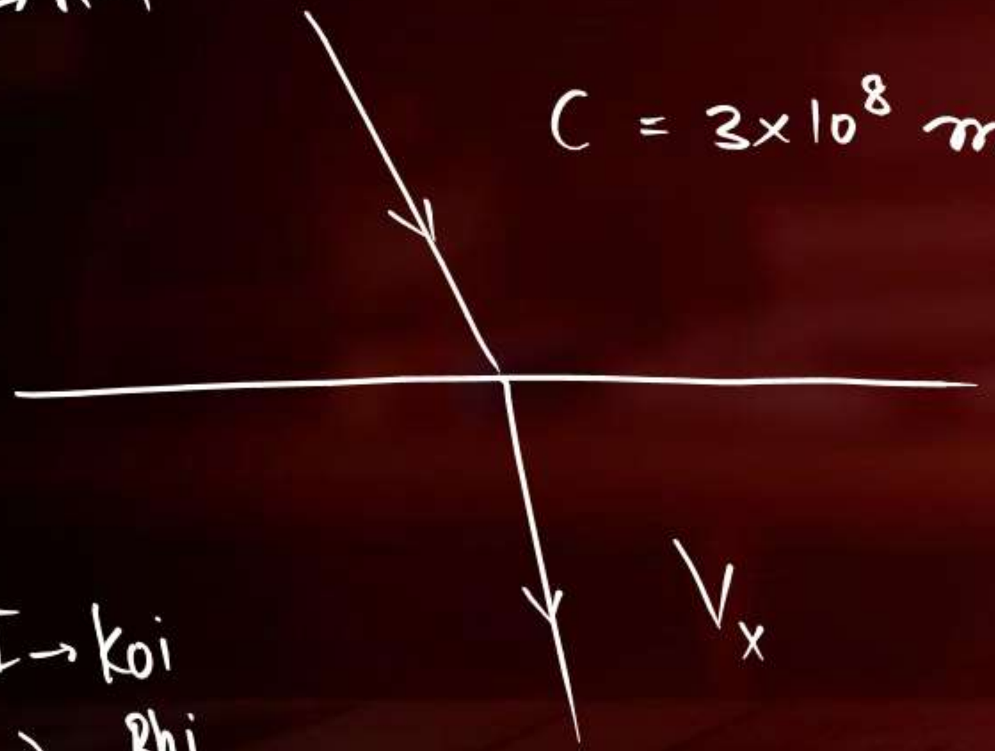
* Refractive Index $\left(n = \dfrac{\text{Speed of light in M-I}}{\text{Speed of light in M-II}}\right)$

① Absolute R.I.

$$\boxed{n_x = \frac{c}{V_x}}$$

I → Air/Vacuum

$C = 3\times10^{8}$ m/s

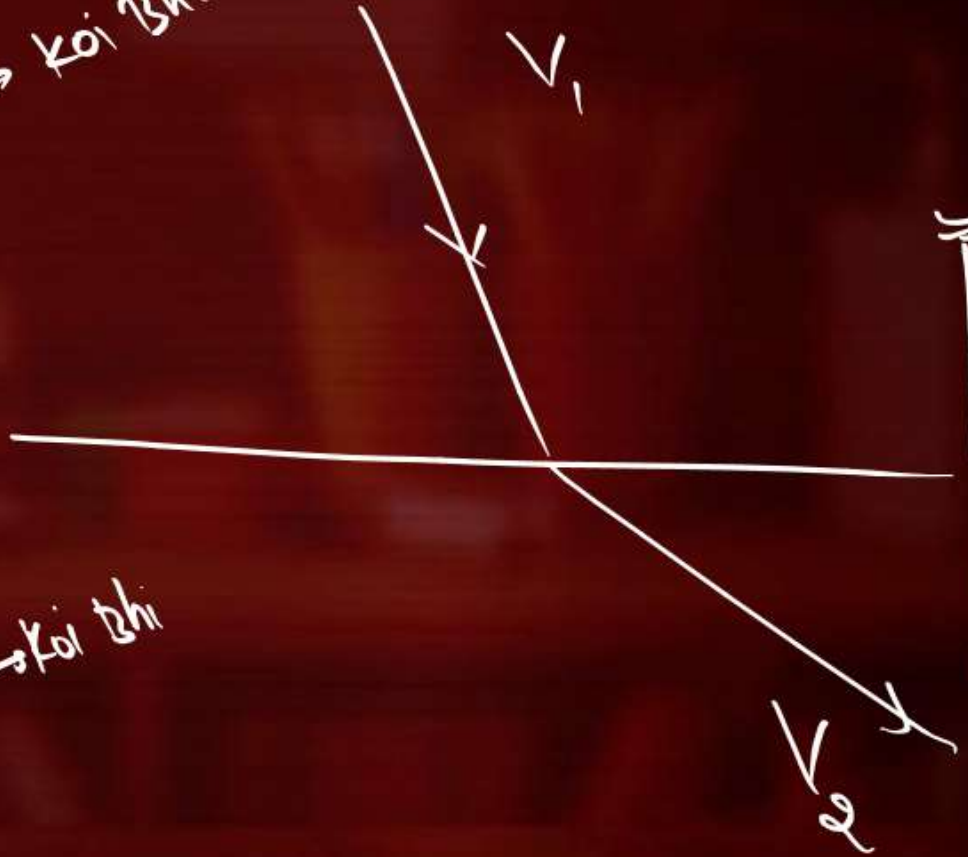


II → koi Bhi

(X)

② Relative R.I

I → koi Bhi

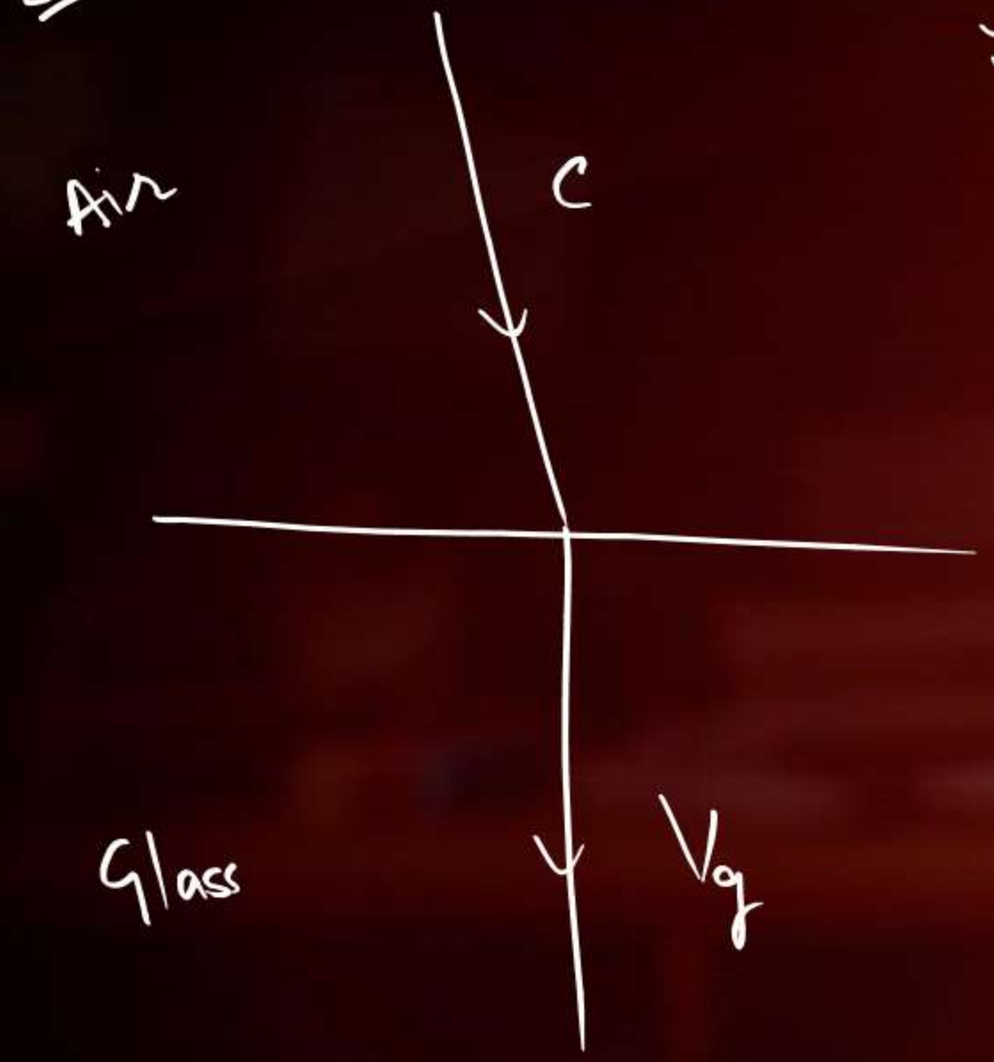


II → koi Bhi

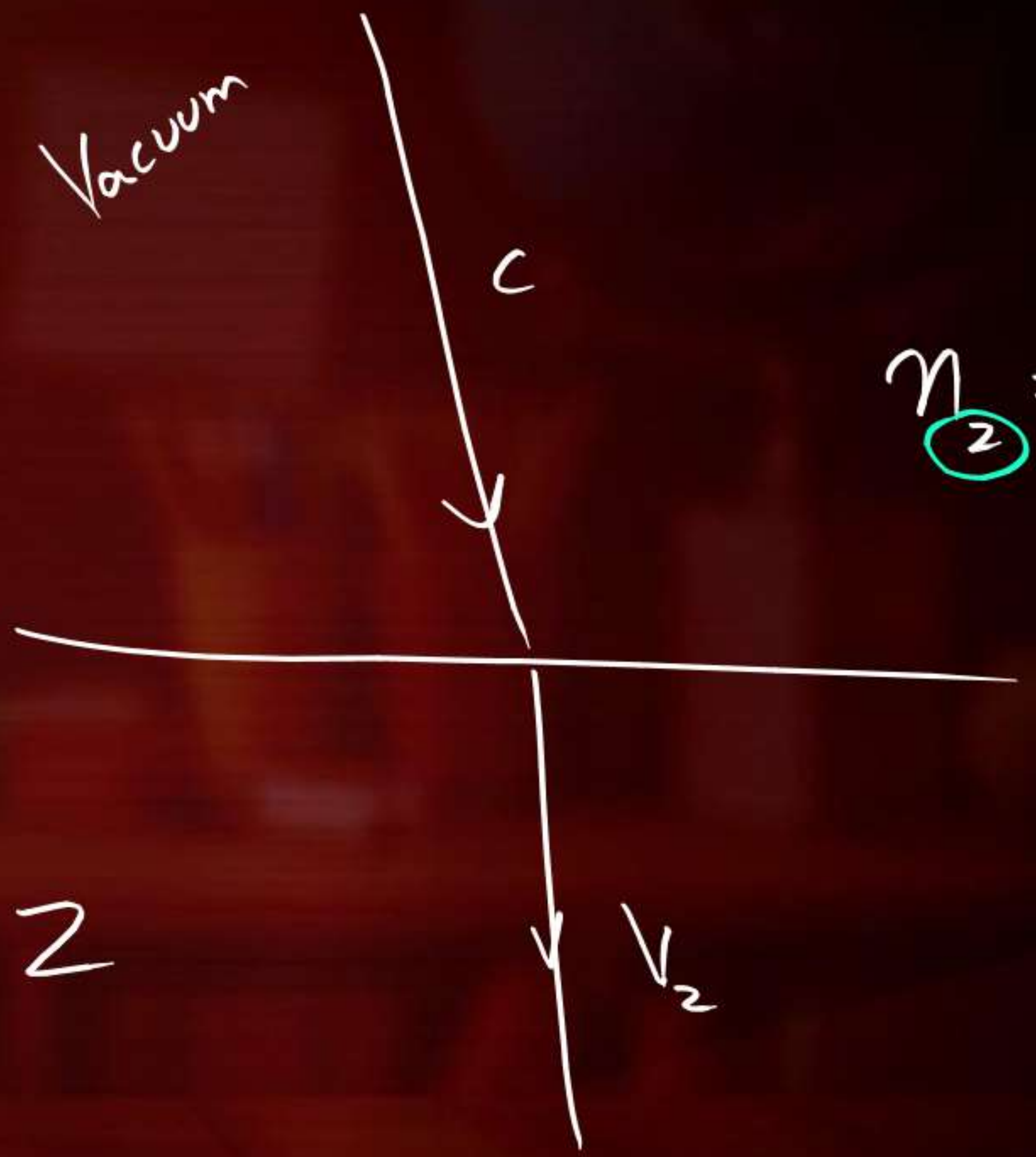
$$\boxed{n_{2,1} = \frac{V_1}{V_2}}$$

R.I of 2 w.r.t. 1

Ex -



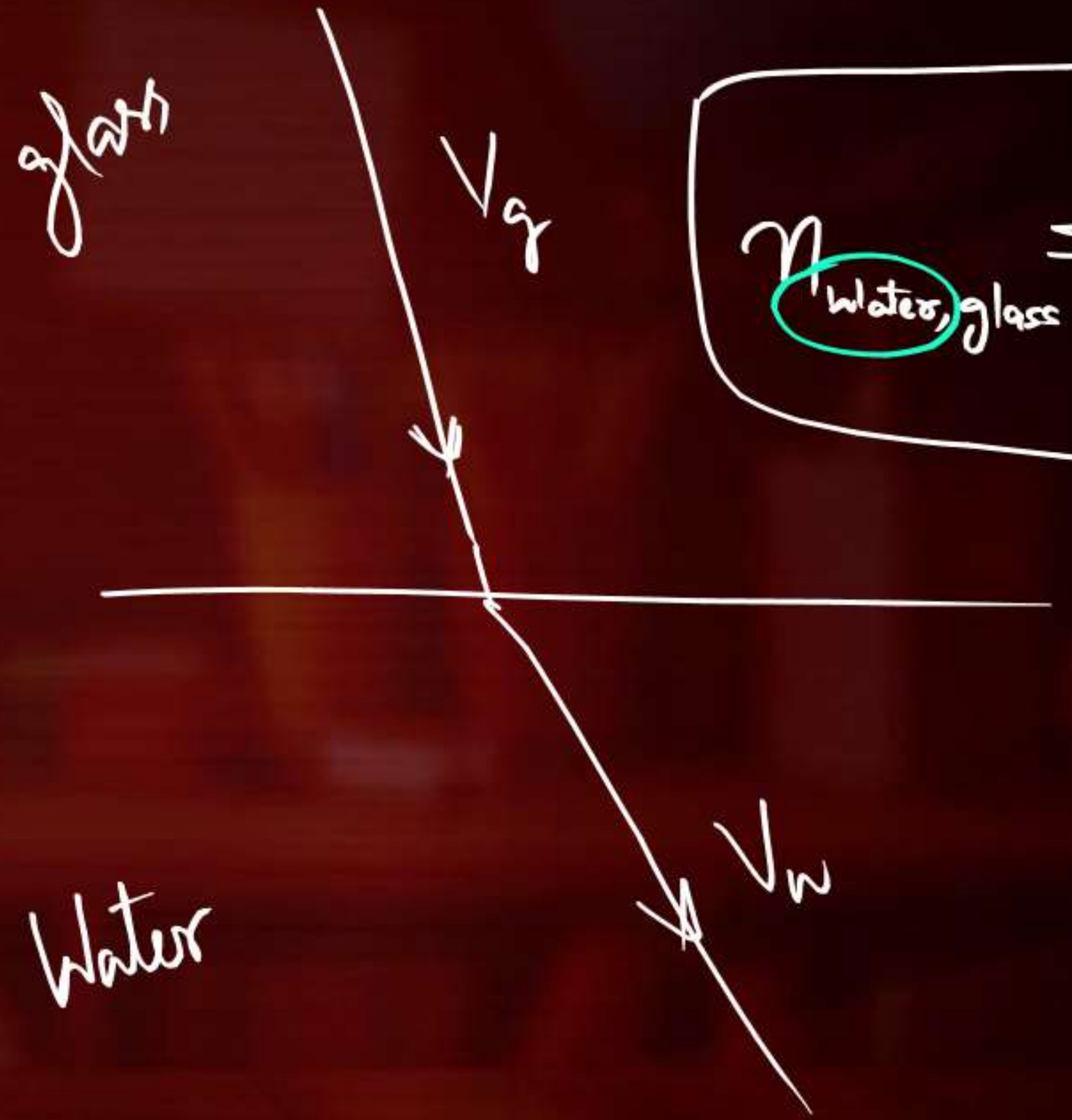
$$\boxed{n_g = \frac{c}{V_g}}$$



$$n_z = \frac{c}{V_z}$$

Ex

$$\boxed{\eta_{2,1} = \frac{V_1}{V_2}}$$



$$\boxed{\eta_{\text{water, glass}} = \frac{V_g}{V_w}}$$

Ex A ray of light enters $\boxed{\text{glass } (n = 2)}$ from $\boxed{\text{Water } (n = 1.5)}$ find R.I. of $\boxed{\text{glass w.r.t. Water}}$

Sol^n Given :-

Absolute ← $\begin{cases} n_g = 2 \\ n_W = 1.5 \end{cases}$

Relative ← $\{ n_{g,W} = ?$

$$n_g = \frac{c}{V_g} \qquad 2 = \frac{3 \times 10^8}{V_g} \Rightarrow V_g = \frac{3}{2} \times 10^8 \text{ m/s}$$

$$n_W = \frac{c}{V_W} \qquad 1.5 = \frac{3 \times 10^8}{V_W} \Rightarrow V_W = \frac{3}{1.5} \times 10^8 \text{ m/s}$$

$$n_{g,W} = \frac{V_W}{V_g} = \frac{\frac{\cancel{3}}{1.5} \times \cancel{10^8}}{\frac{\cancel{3}}{2} \times \cancel{10^8}} = \frac{20}{15} = \frac{4}{3} = 1.33 ✓$$

Ex R.I. of X $\left(\frac{3}{2}\right)$ and that of Y $\left(\frac{2}{3}\right)$. find R.I. of X w.r.t. Y and Y w.r.t. X

Given :-

$$n_x = \frac{3}{2} \quad n_x = \frac{c}{v_x} \quad \frac{3}{2} = \frac{c}{v_x} \rightarrow v_x = \frac{2c}{3}$$

$$n_y = \frac{2}{3} \quad n_y = \frac{c}{v_y} \quad \frac{2}{3} = \frac{c}{v_y} \rightarrow v_y = \frac{3c}{2}$$

To find :-

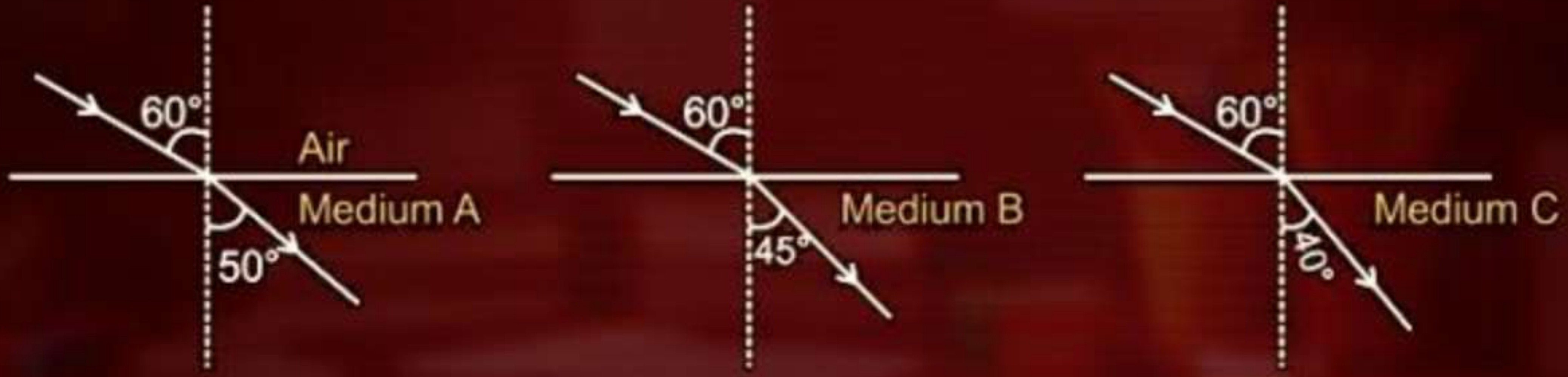
$$n_{x,y} = \quad n_{x,y} = \frac{v_y}{v_x} = \frac{\frac{3\cancel{c}}{2}}{\frac{2\cancel{c}}{3}} = \frac{\frac{3}{2}}{\frac{2}{3}} = \frac{3}{2} \times \frac{3}{2} = \frac{9}{4} \checkmark$$

$$n_{y,x} = \quad n_{y,x} = \frac{v_x}{v_y} = \frac{4}{9} \checkmark$$

Lateral Shift

QUESTION

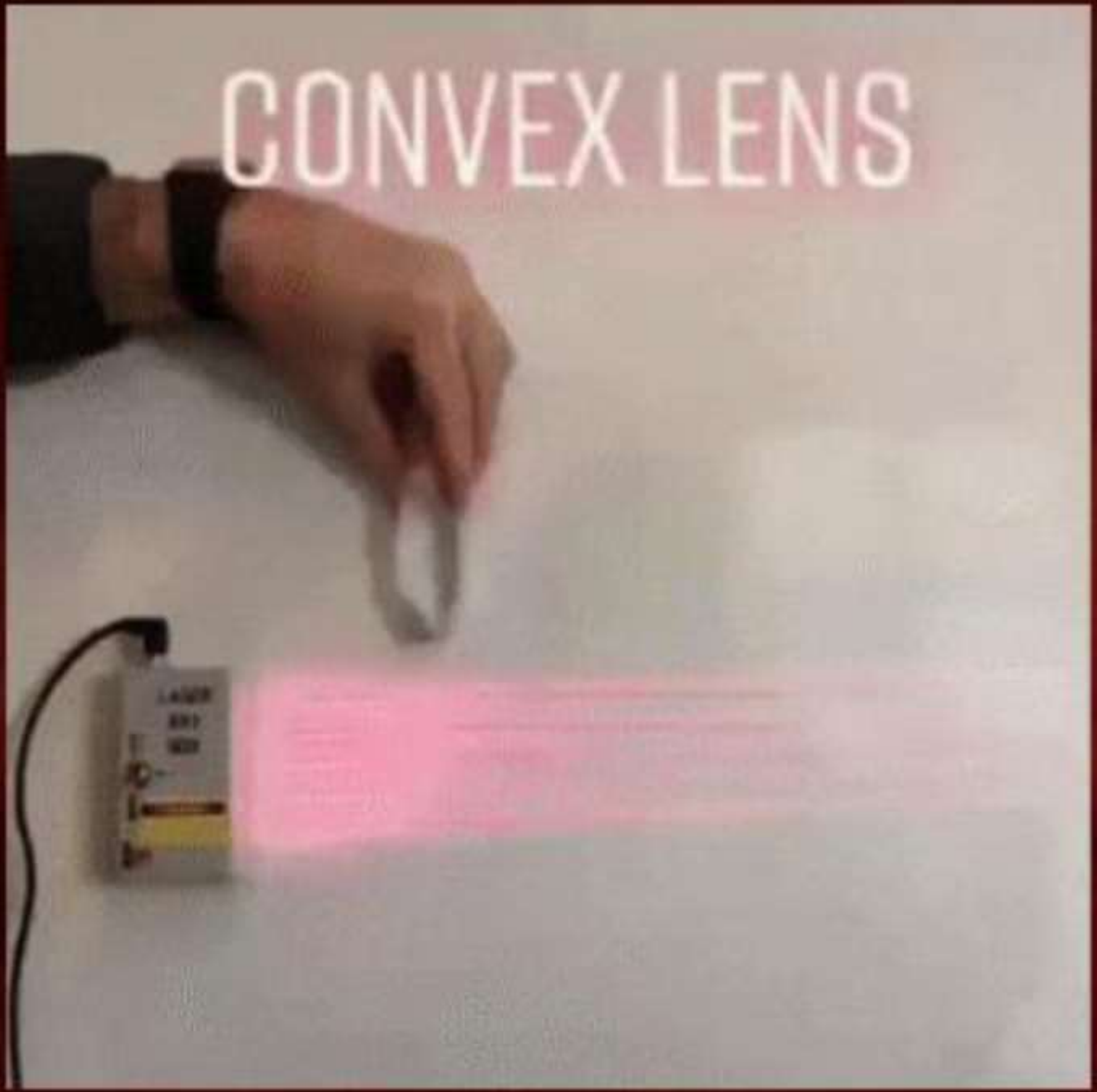
The path of a light ray from three different media A, B and C for a given angle of incidence is shown below. Study the diagrams and answer the following questions.



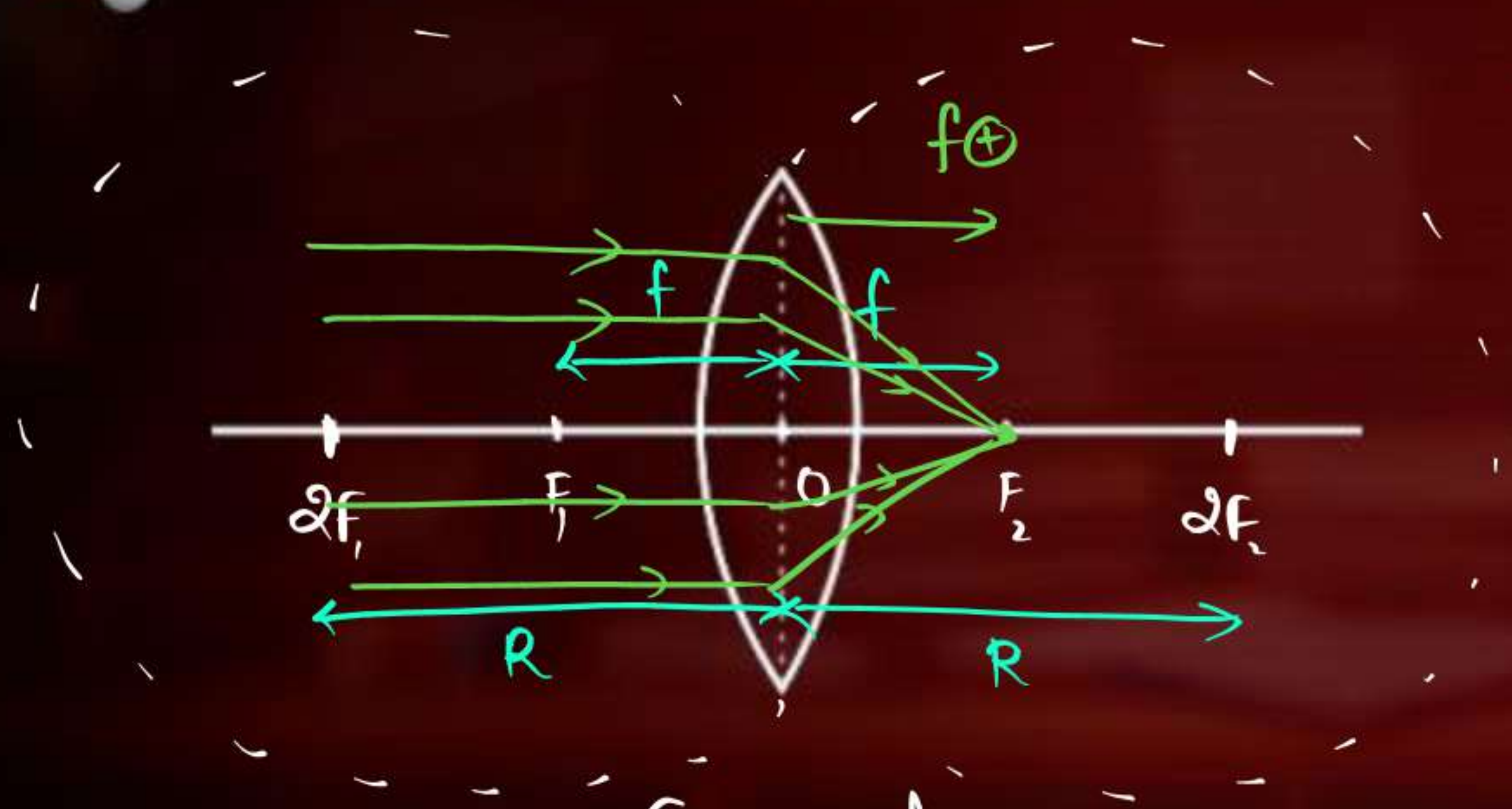
(a) Which of the three media A, B or C has maximum optical density?

(b) Through which of the three media, will the speed of light be maximum?

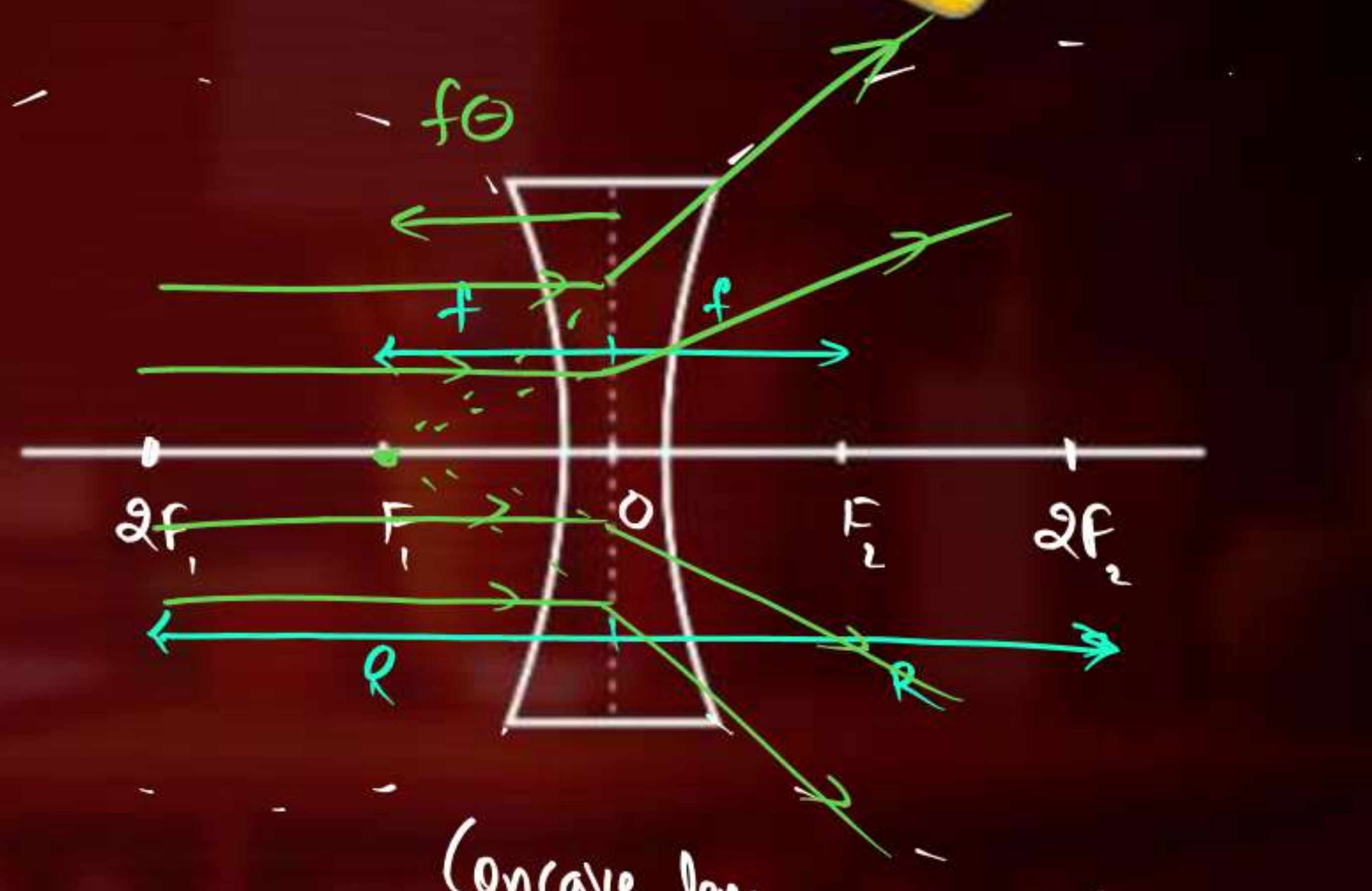
(c) Will the light travelling from A to B bend towards or away from the normal?


CONVEX LENS

REFRACTION THROUGH SPHERICAL LENSES



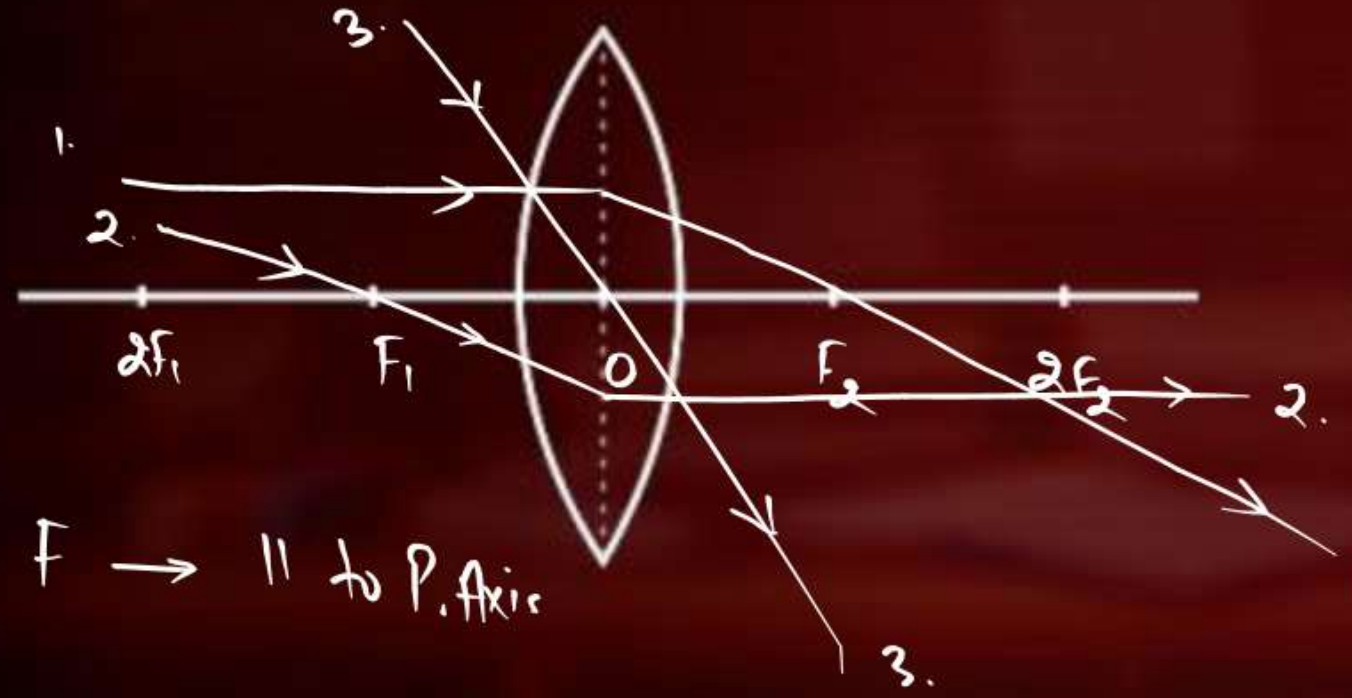
Convex lens
(converging)

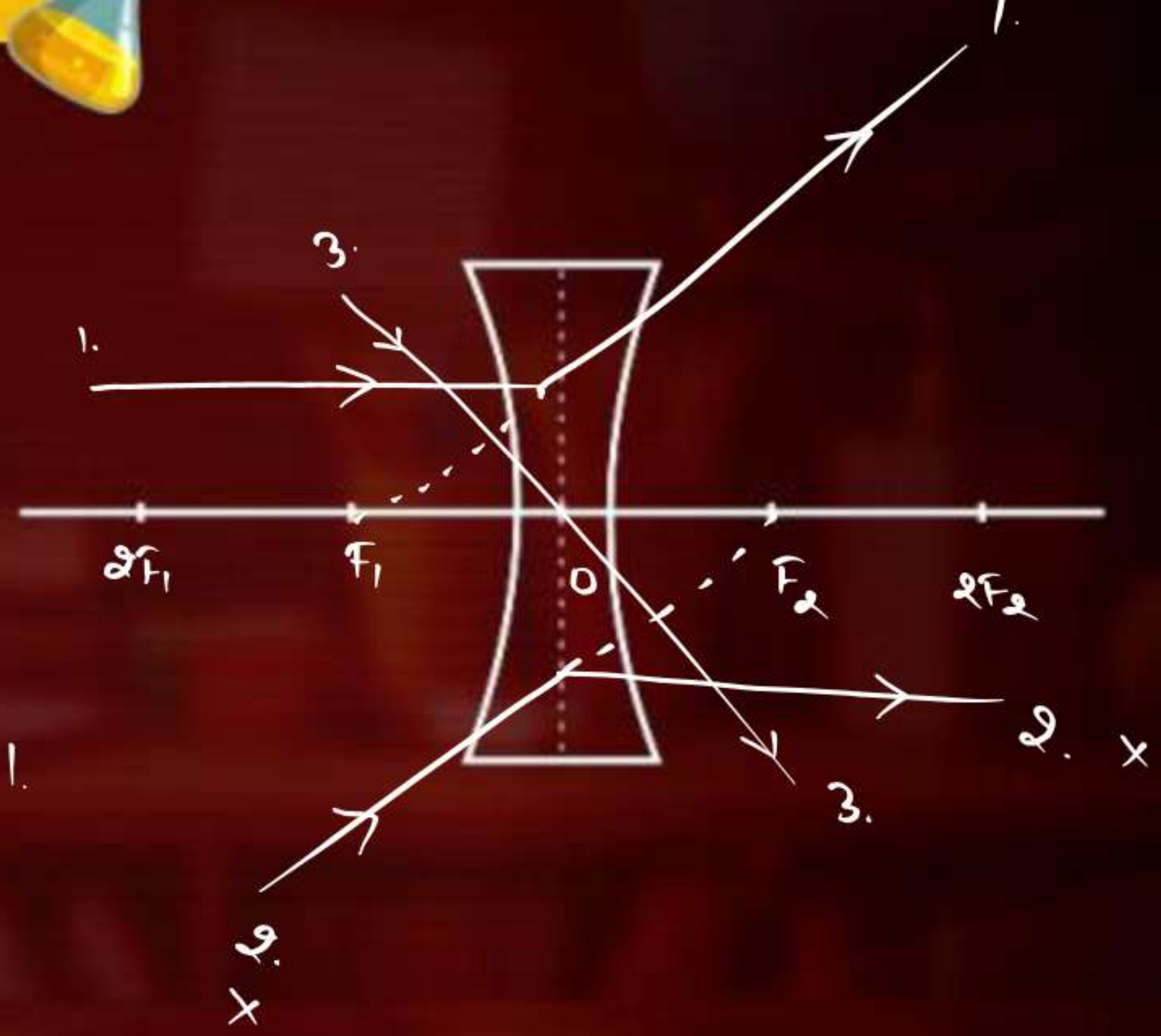


Concave lens
(Diverging)

RULES TO OBTAIN IMAGE

1. || to P. Axis → F_2



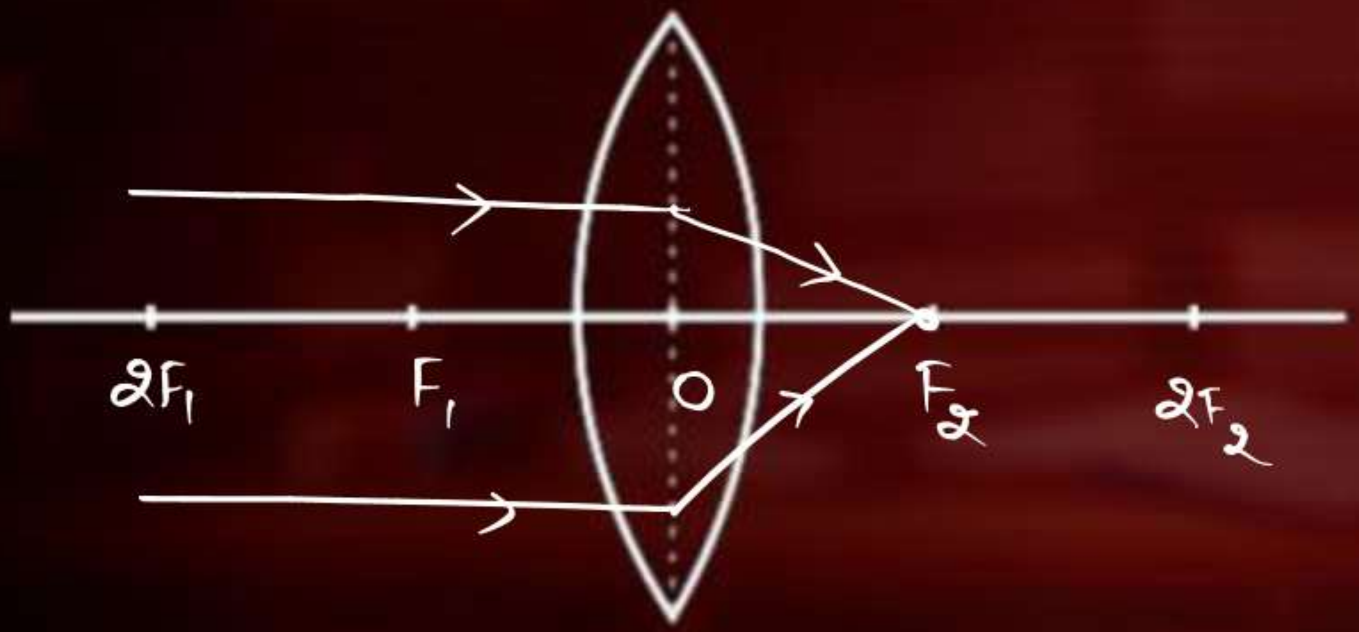


2. F → || to P. Axis

3. O → Undeviated

IMAGE FORMATION : CONVEX LENS (1)

1. Object at Infinity



(1) At F_2

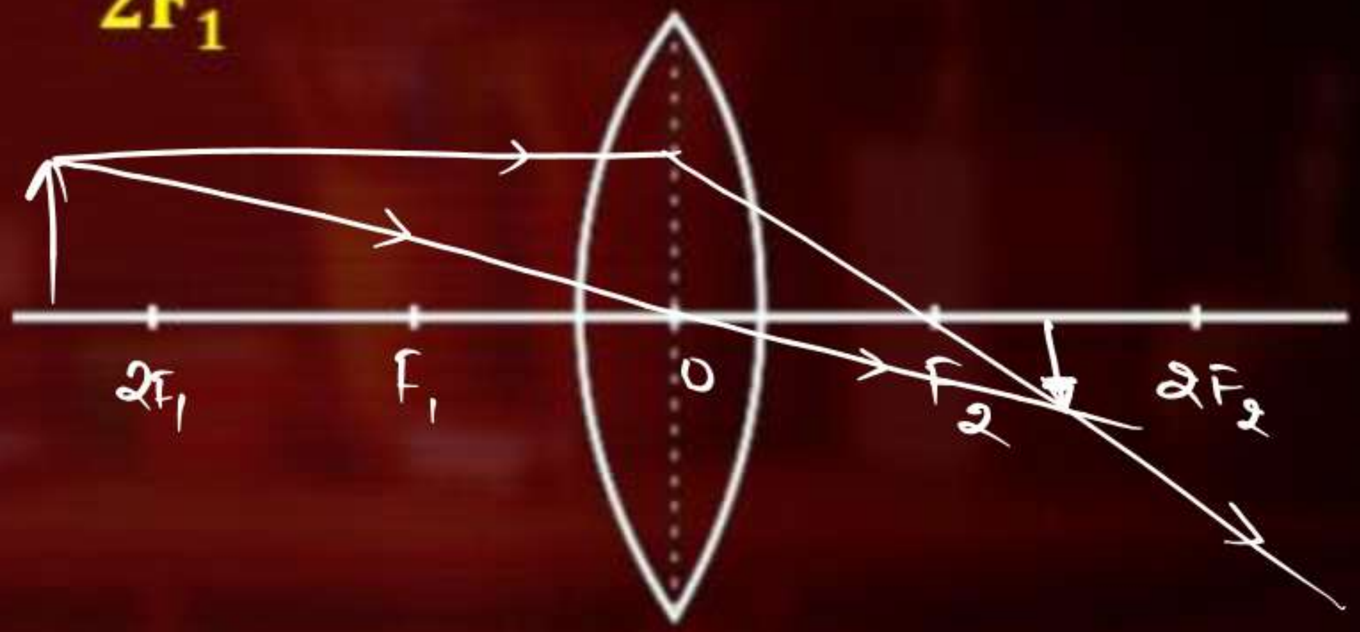
(2) Highly diminished

Nature of Image

(3) Real

(4) Inverted

2. Object beyond $2F_1$



(1) B/w F_2 and $2F_2$

(2) Diminished

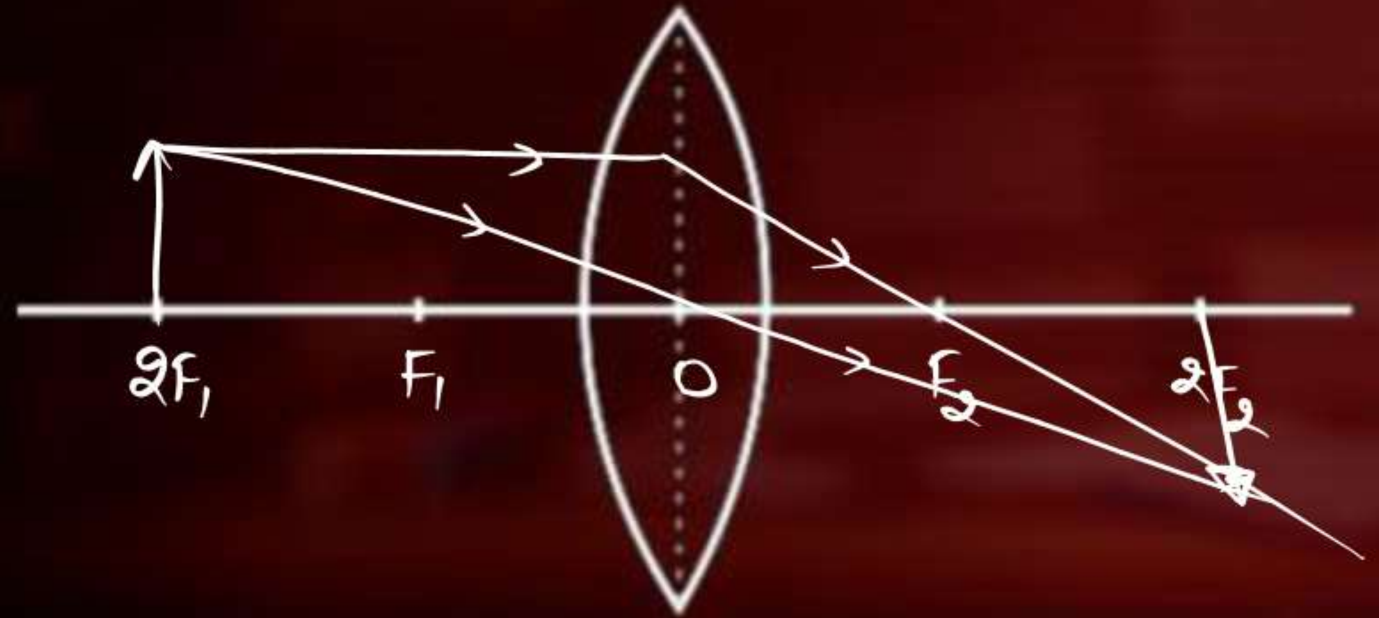
Nature of Image

(3) Real

(4) inverted

IMAGE FORMATION : CONVEX LENS (2)

3. Object at $2F_1$



① At $2F_2$

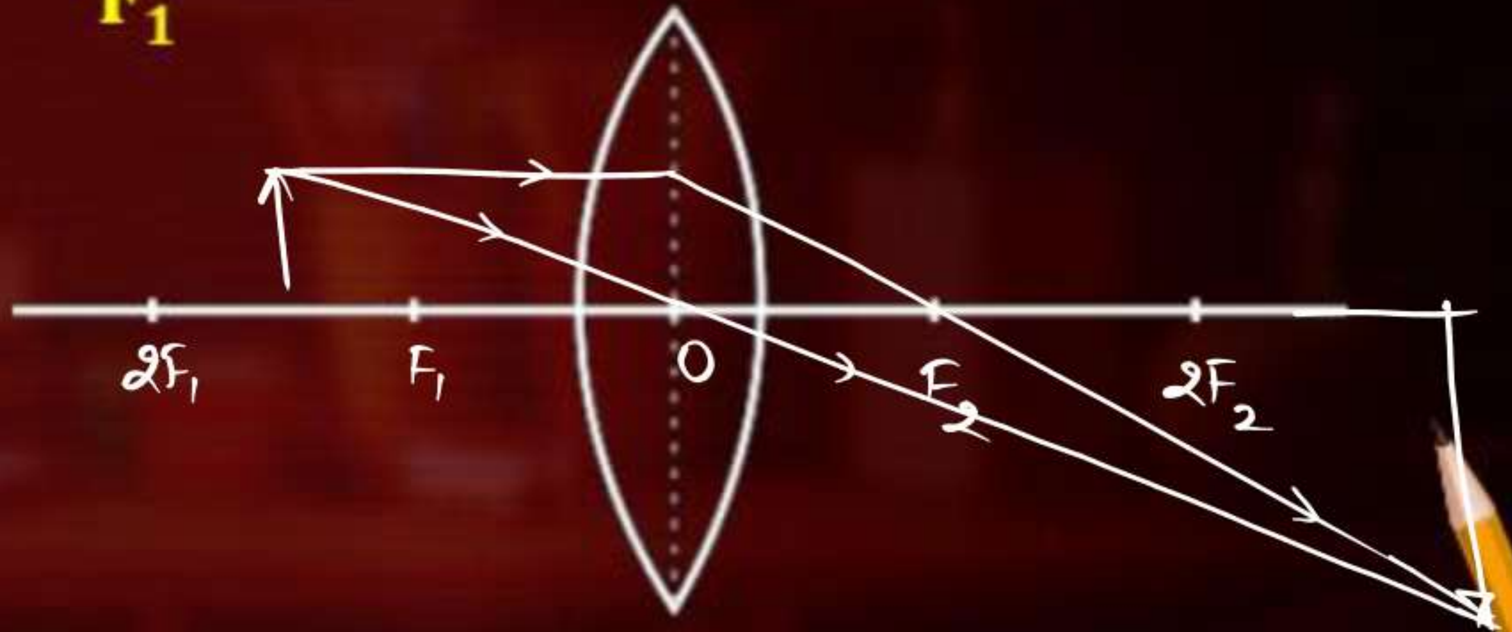
② Same Size

Nature of Image

③ Real

④ inverted

4. Object between $2F_1$ and F_1



① Beyond $2F_2$

② Enlarged

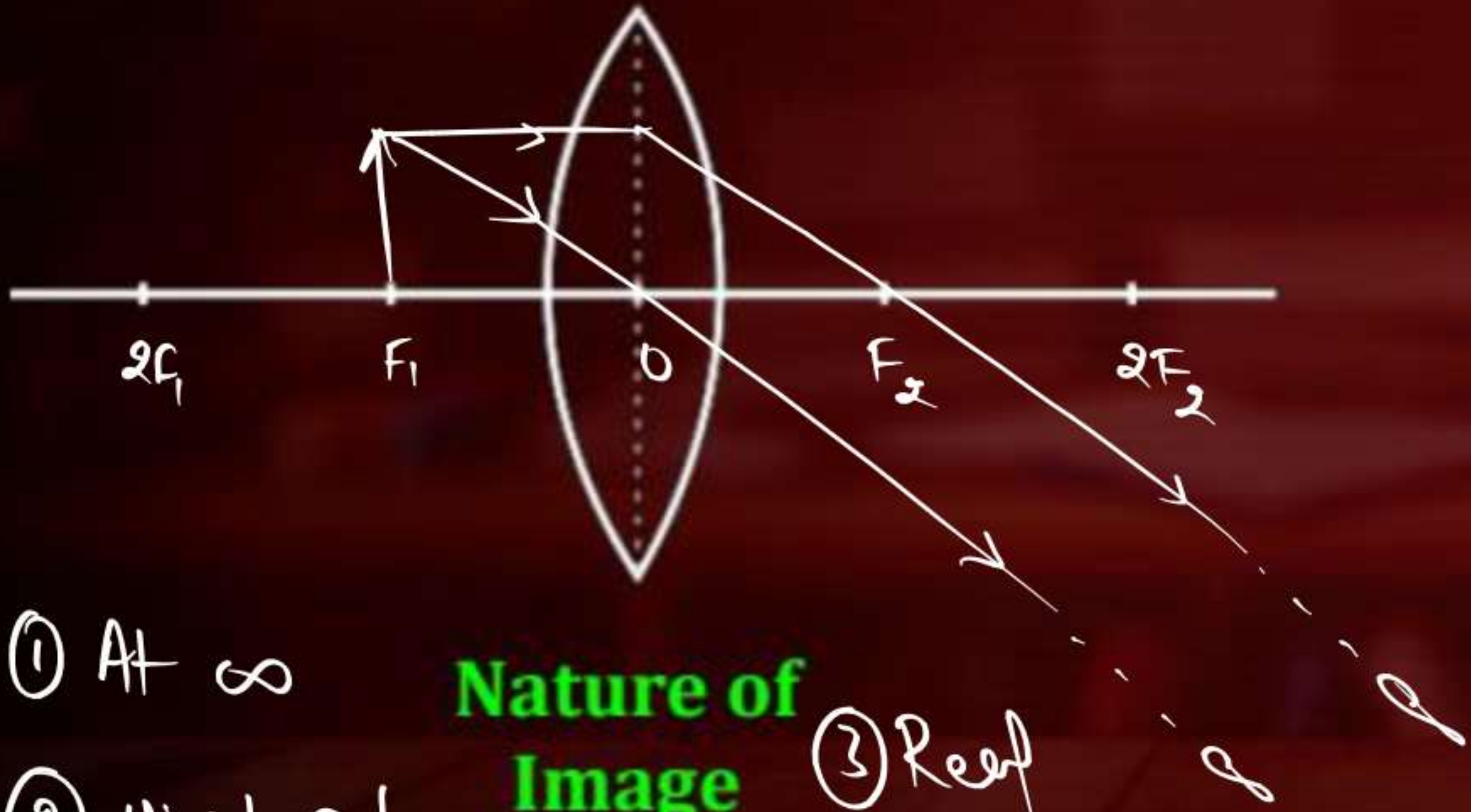
Nature of Image

③ Real

④ inverted

IMAGE FORMATION : CONVEX LENS (3)

5. Object at F_1



① At ∞

② Highly Enlarged

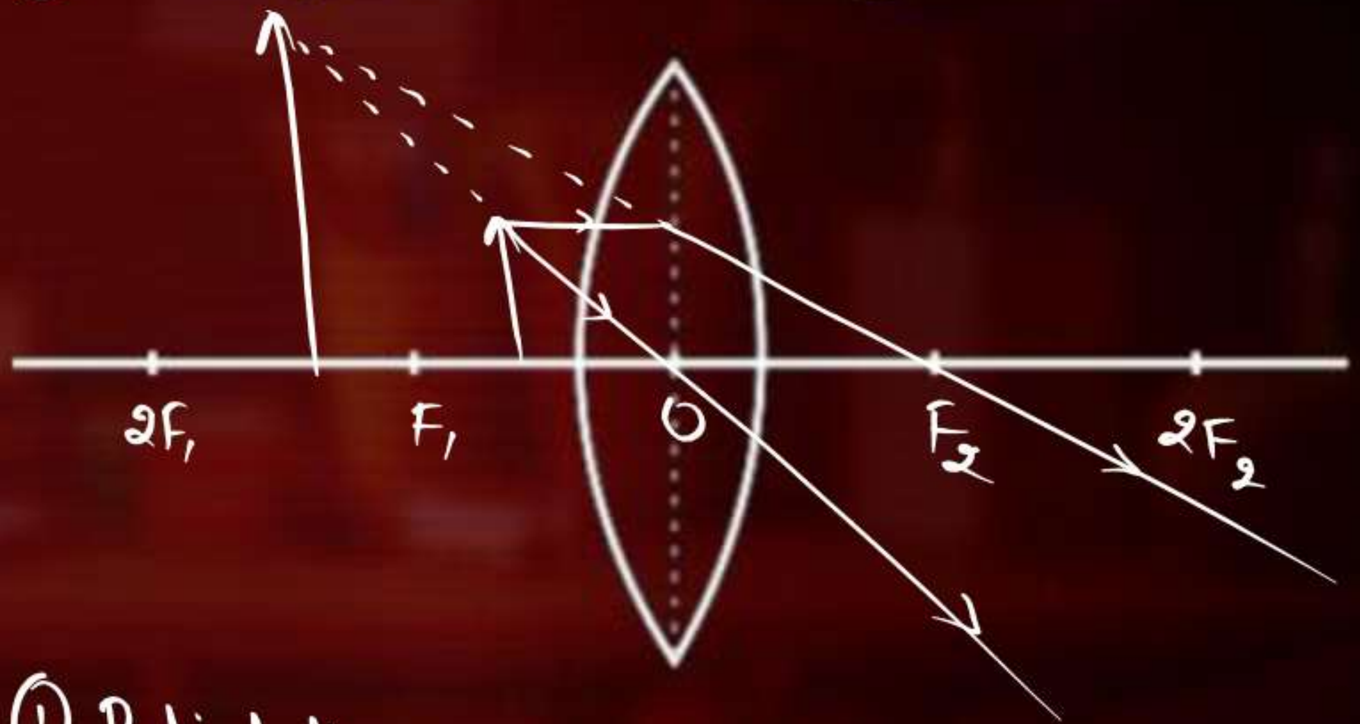
Nature of Image

③ Real

④ inverted

V.V.I.P.

6. Object between F_1 and O



① Behind the lens

② Enlarged

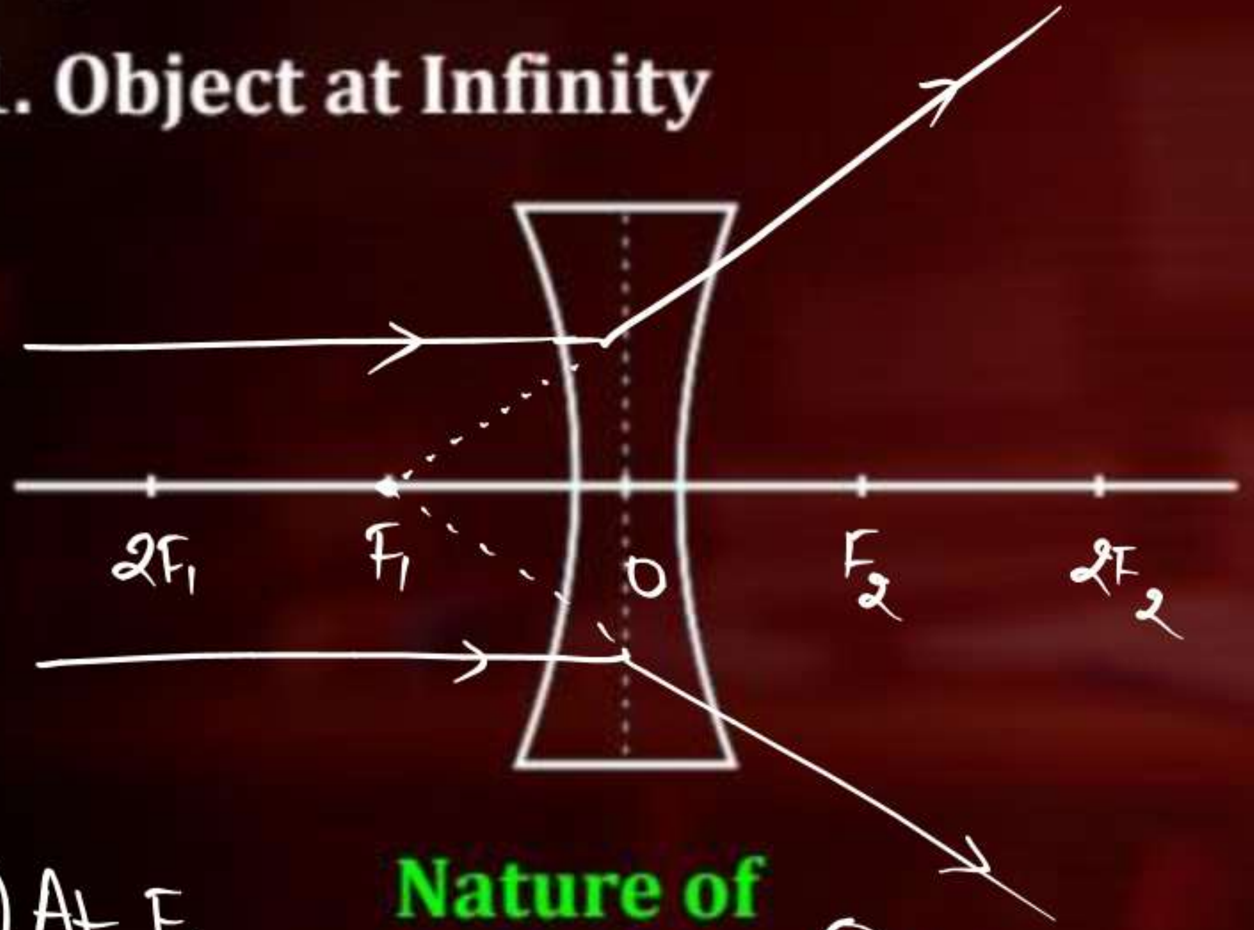
Nature of Image

③ Virtual

④ Erect

IMAGE FORMATION : CONCAVE LENS

1. Object at Infinity



Nature of Image

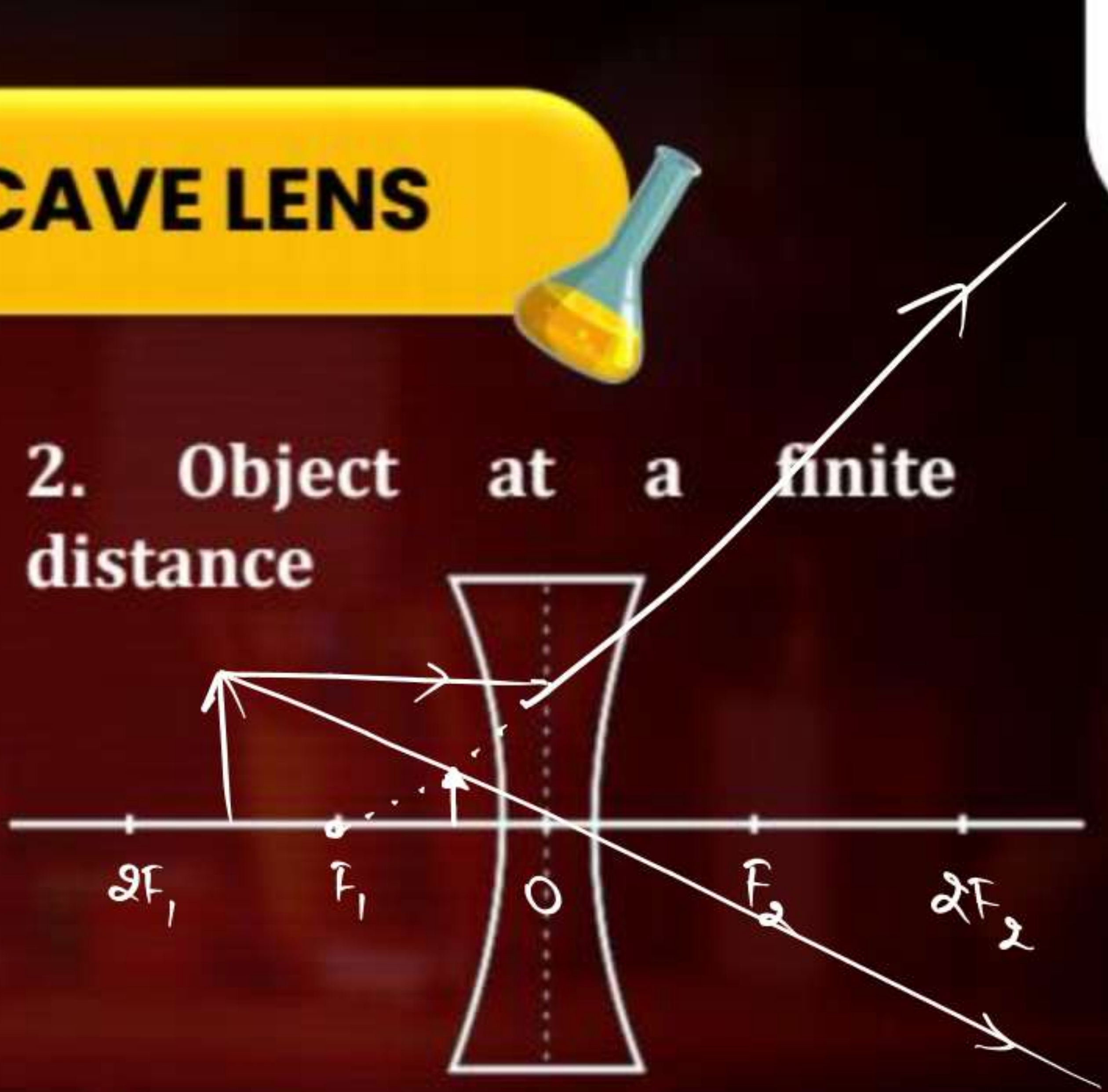
(1) At F_1

(2) Highly diminished

(3) Virtual

(4) Erect

2. Object at a finite distance



Nature of Image

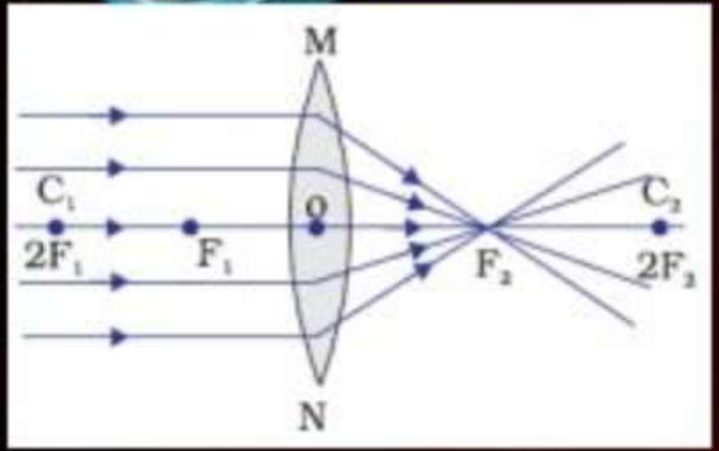
(1) B/w F_1 and O

(2) Diminished

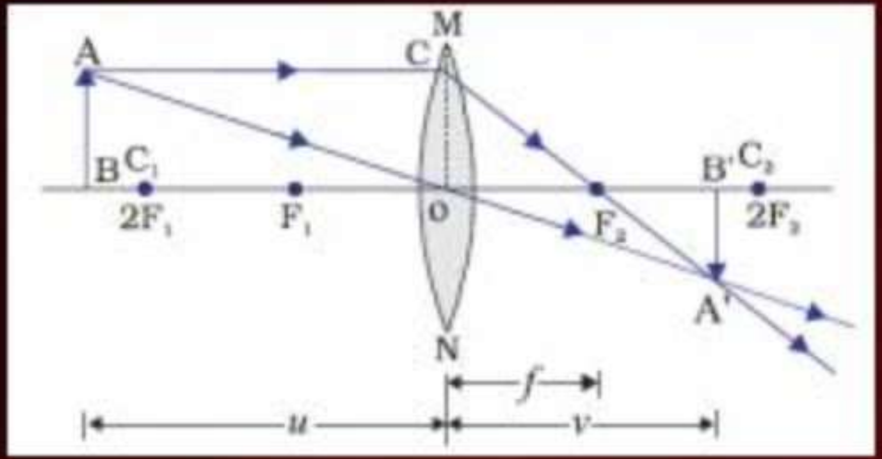
(3) Virtual

(4) Erect

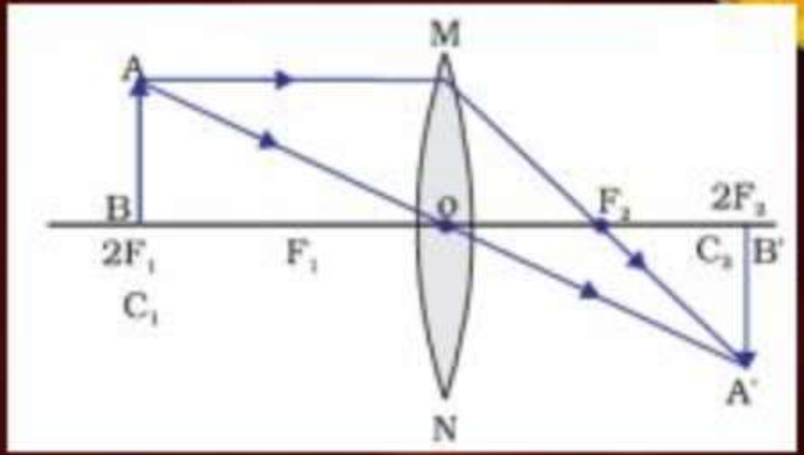
ALL RAY DIAGRAMS : SPHERICAL LENSES



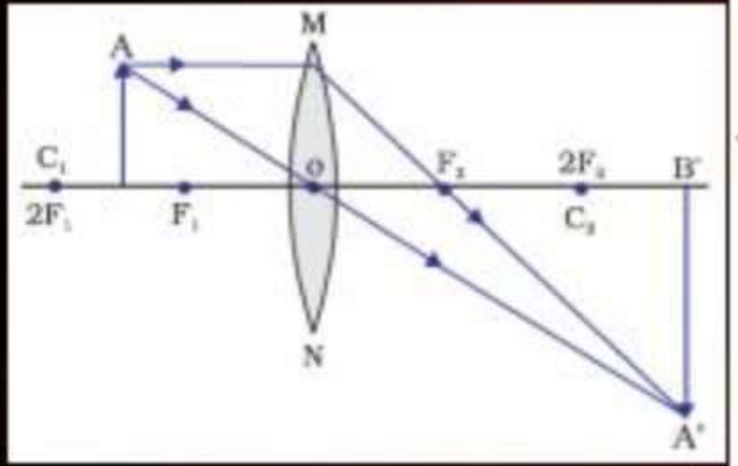
1. Object at Infinity



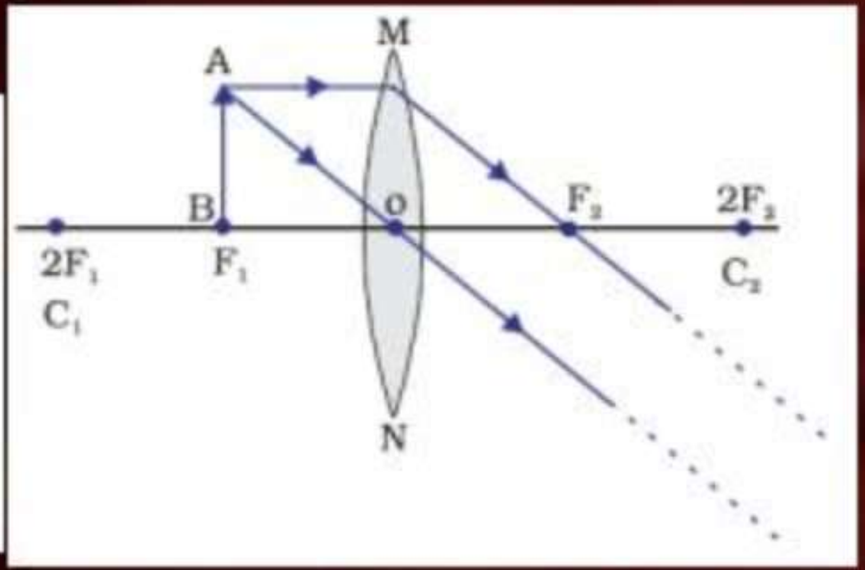
2. Object beyond $2F_1$



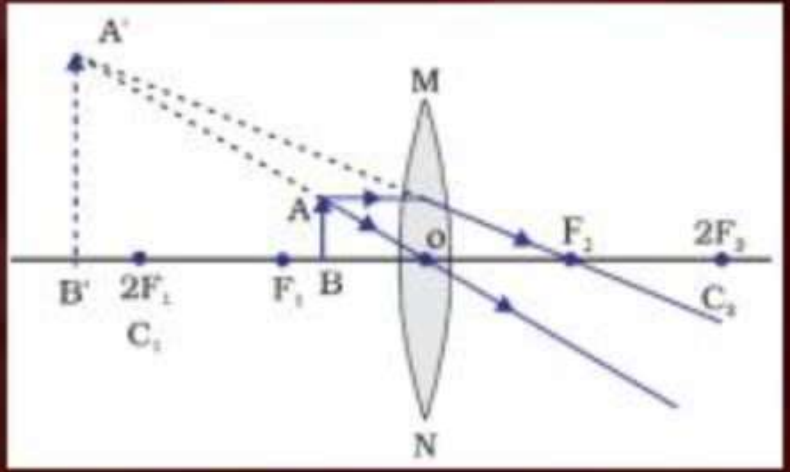
3. Object at $2F_1$



4. Object between $2F_1$ and F_1

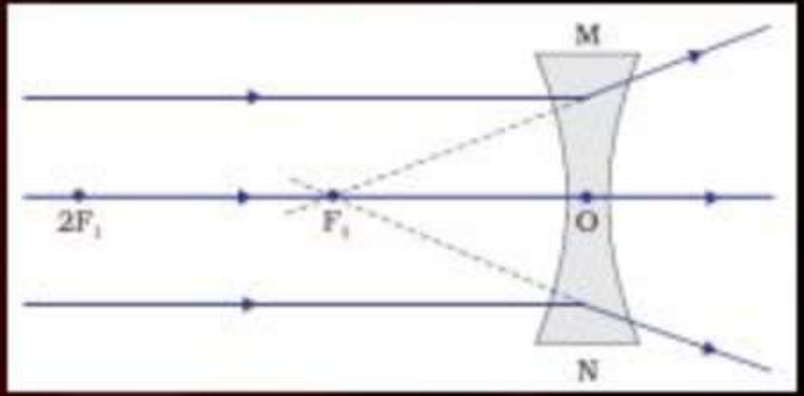


5. Object at F_1

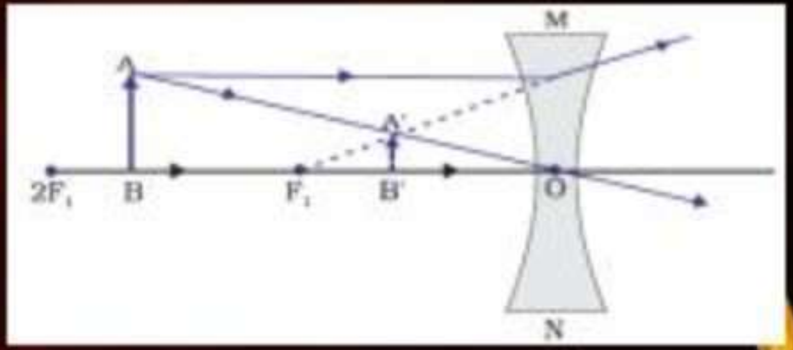


6. Object between F_1 and O

Convex Lens



1. Object at Infinity



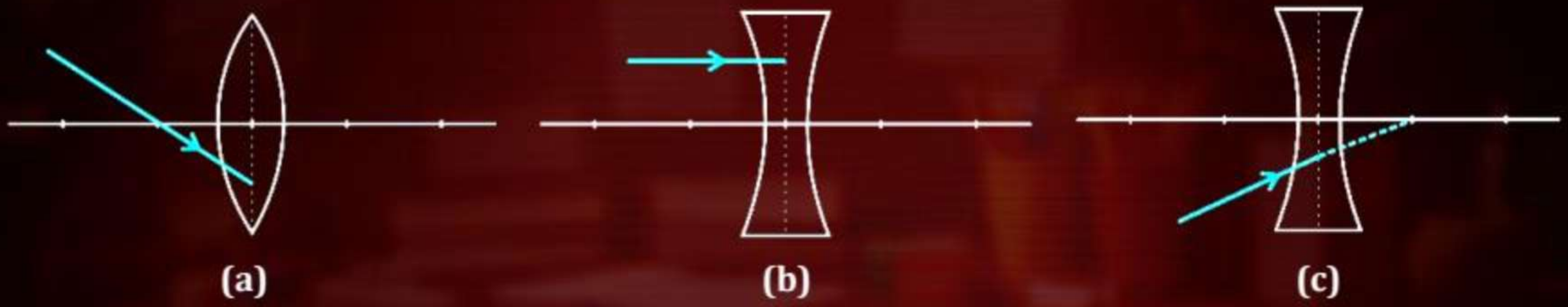
2. Object at a finite distance

Concave Lens

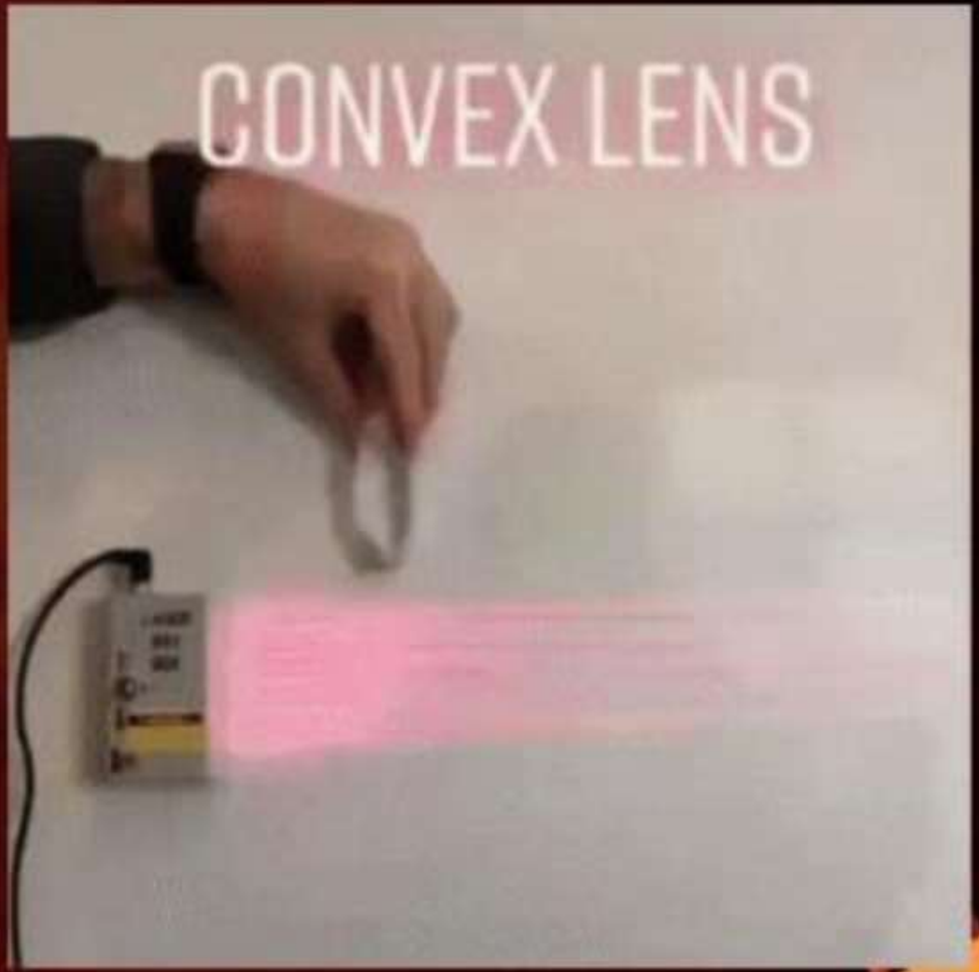
USES OF LENSES

QUESTION

Complete the Ray Diagram.



POWER OF THE LENS : MEANING



POWER OF THE LENS

Definition : The degree of convergence and divergence of the parallel incident light on the surface of the lens.

Formula : $P = \frac{1}{f_{\text{(in metre)}}}$

$\boxed{P = \frac{1}{f(m)}}$ (Dioptre)

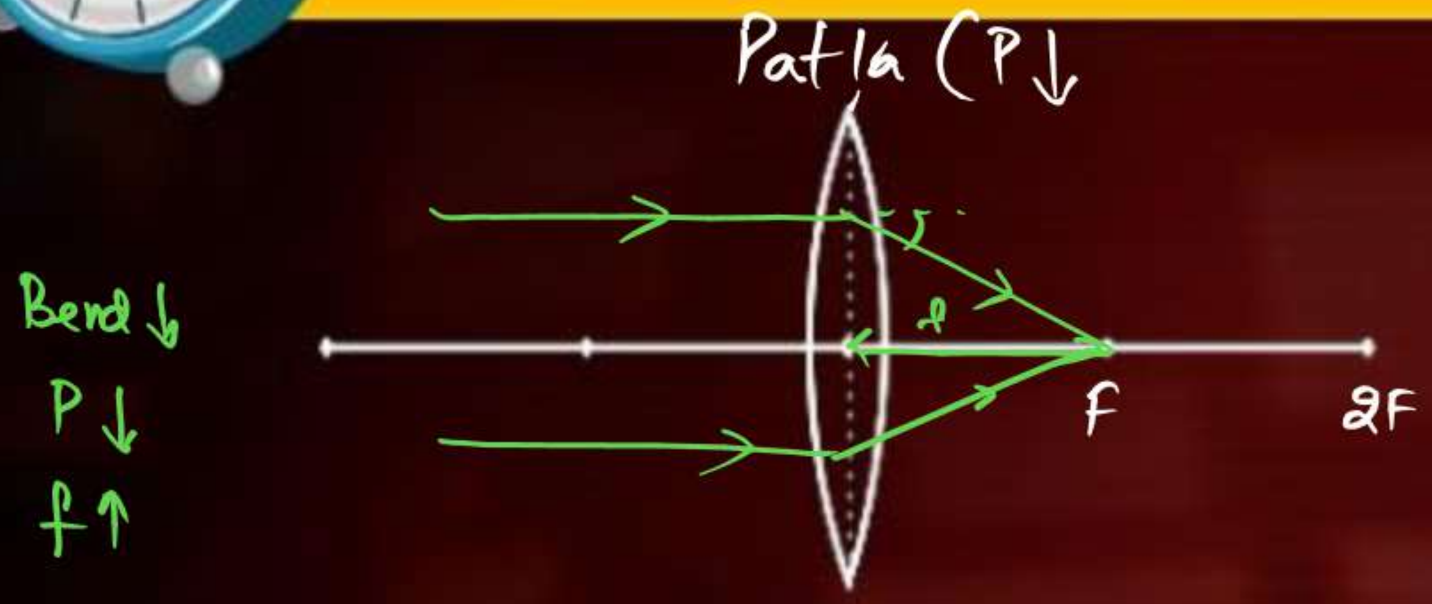
$\boxed{P = \frac{100}{f(cm)}}$ (Dioptre)

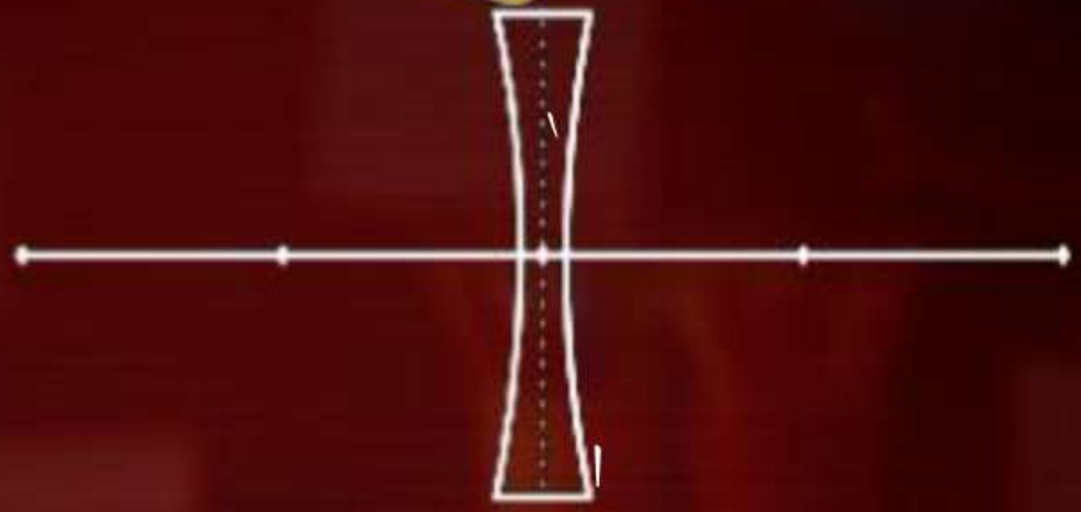
SI Unit : Dioptre (D)

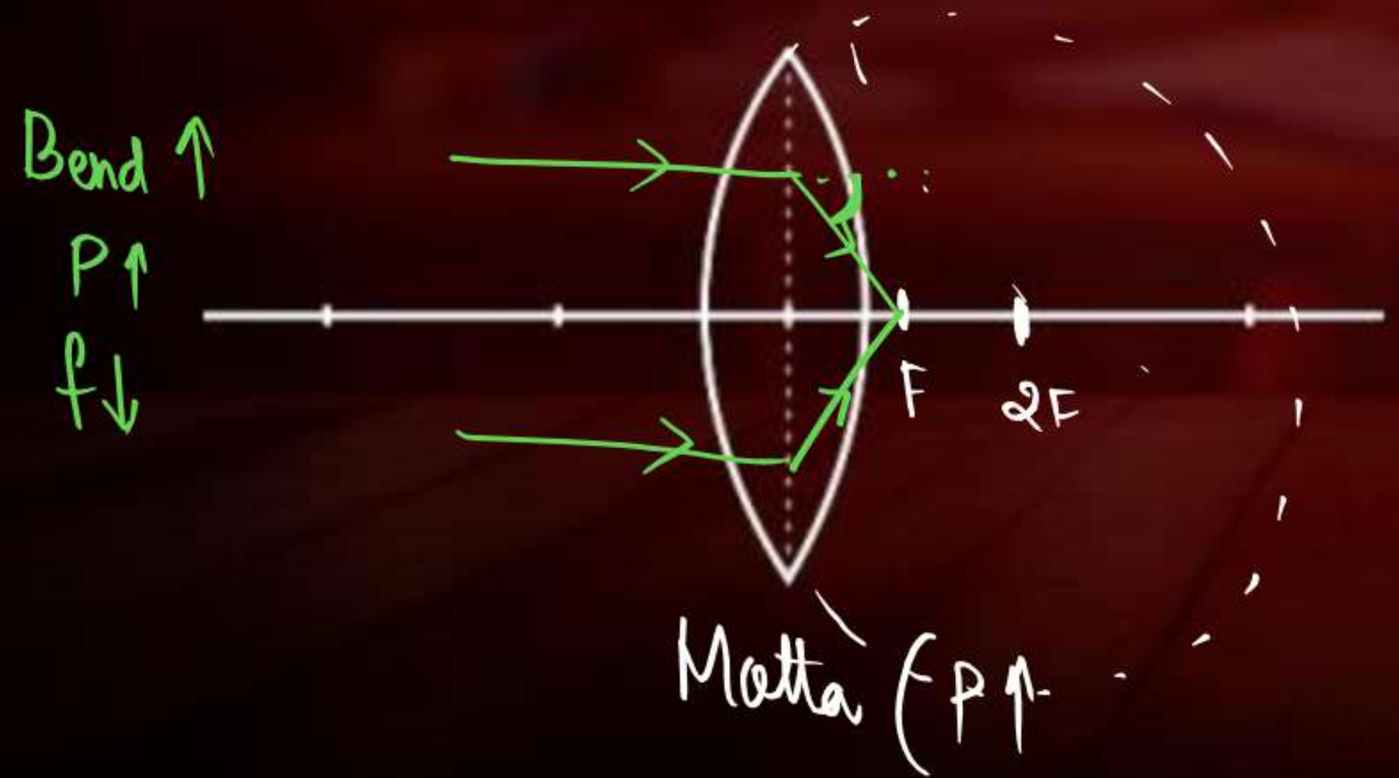
$P = \frac{1}{1} = 1D$

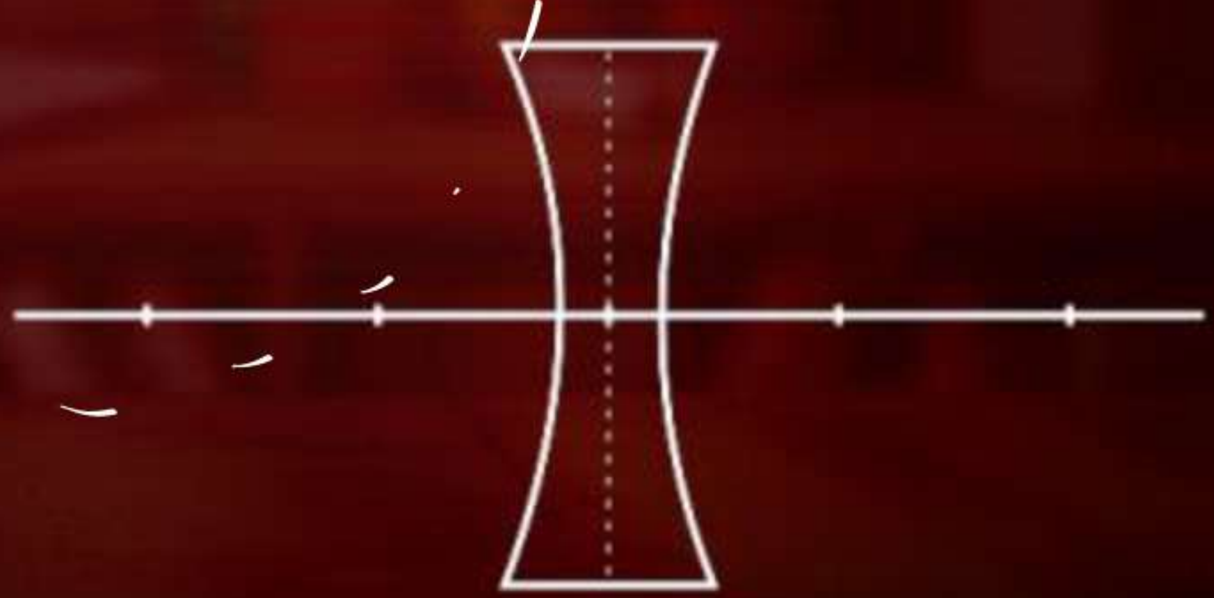
Define 1 Dioptre : focal length of lens is 1m, Power of the lens is 1D.

POWER OF THE LENS : MEANING

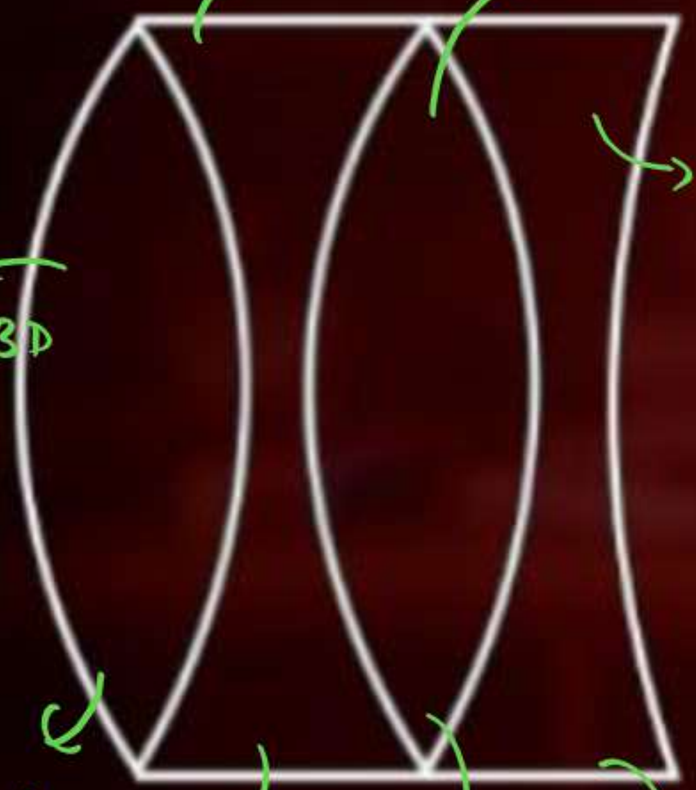








COMBINATION OF LENSES



Total Power of the combo $= P_1 + P_2 + P_3 + P_4 \ldots$

① $P_{total} = P_1 + P_2 + P_3 + P_4$

$= +3 - 1.5 + 3.5 - 0.5$

$\boxed{P_{total} = +4.5D}$

② $f_{total} = ?$

$P = \dfrac{100}{f\,(cm)}$

$4.5 = \dfrac{100}{f} \rightarrow f = \dfrac{100}{4.5}\,(cm)$

QUESTION

Find the total power and net focal length of the combination of the lenses also state the nature of the combination.

$P_1 = -2D \quad P_2 = 3D \quad P_3 = -4D$

$$P_{Total} = P_1 + P_2 + P_3$$
$$= -2 + 3 - 4$$

(1) $P_{total} = -3D$

(2) $f_{total} = ?$

$$P = \frac{100}{f(cm)}$$

$$-3 = \frac{100}{f} \rightarrow f = \frac{100}{-3} = -33.3\text{ cm}$$

$-ve\ f \rightarrow$ Concave lens

(Diverging)

Nature

One Step Ahead : Sign Convention in Lenses

Always

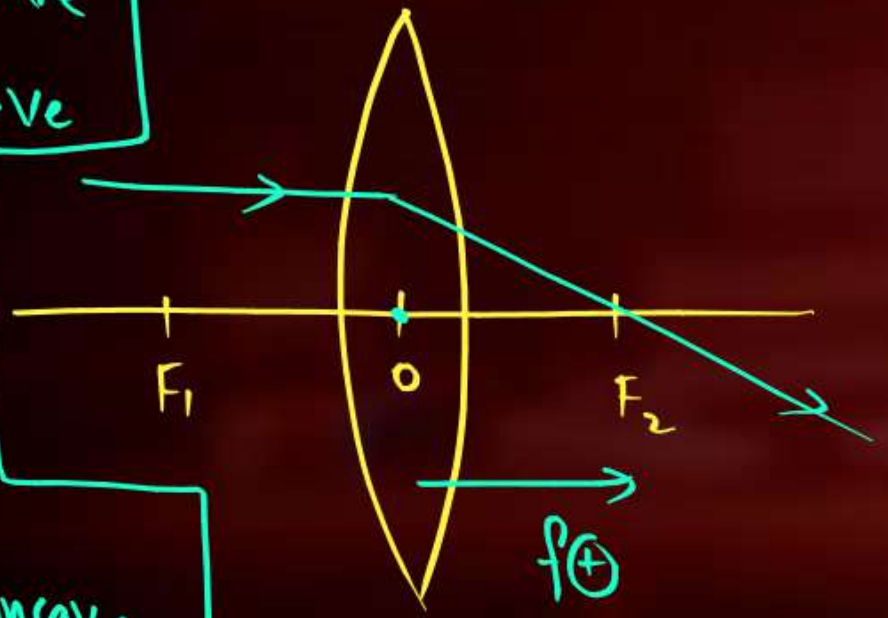
$u \rightarrow -ve$

$h_0 \rightarrow +ve$

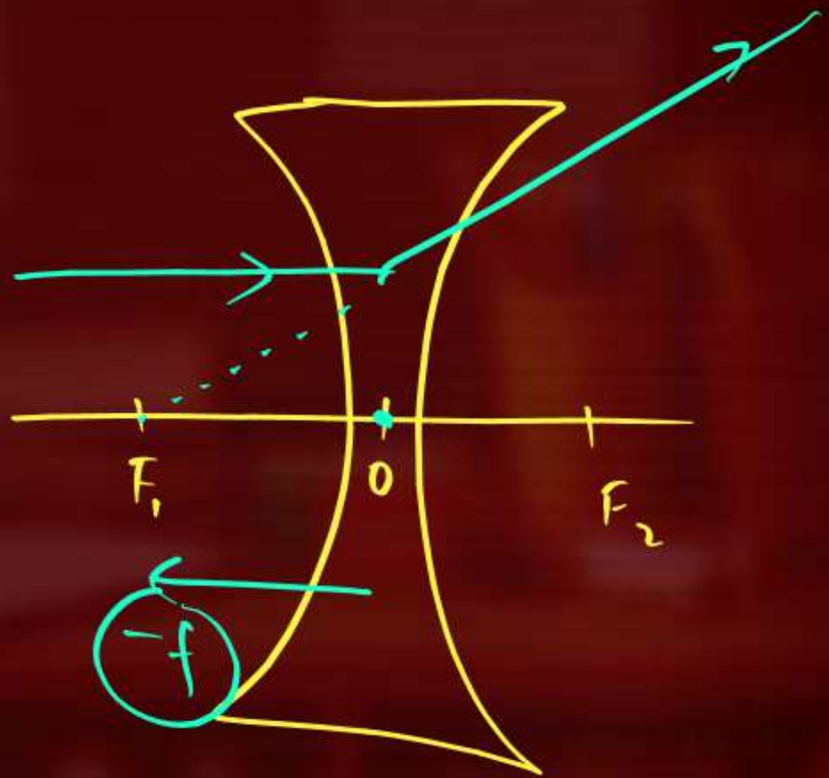
f

+ convex

− concave



Convex



ONE STEP AHEAD : FORMULAE

Weapons

- Lens Formula :

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

- Magnification Formula :

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

$$m = \frac{h_{\text{image}}}{h_{\text{object}}}$$

$0 < m < 1$: Diminished

$m = 1$: Same size

$m > 1$: Enlarged

m → + : ERECT + Virtual

m → – : INVER~~ECT~~ted + Real

QUESTION

An object is placed at a distance of 10 cm from a converging lens of focal length 5 cm. find the nature and position of the image.

Convex

$u = -10\,cm$

$f = +5\,cm$

$v = ?$

$m = ?$

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

$\frac{1}{5} = \frac{1}{v} + \frac{1}{10}$

$\frac{1}{5} - \frac{1}{10} = \frac{1}{v}$

$\frac{2-1}{10} = \frac{1}{v}$

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

$\boxed{v = 10\,cm}$

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

$= \frac{\cancel{10}\,1}{-\cancel{10}\,1}$

$\boxed{m = -1}$

$m = -1$

Real + Inv

$m = 1$

Same size

QUESTION

An object is placed at a distance of 15 cm from a diverging lens of focal length 6 cm. find the nature and position of the image.

QUESTION

An object 2 cm tall is placed at 10 cm from a converging lens of focal length 6 cm. find the size, nature and position of the image.

$h_0 = +2cm$

$u = -10cm$

$f = +6cm$

$h_i =$

$m =$

$V =$

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

$$\frac{1}{6} = \frac{1}{V} + \frac{1}{10}$$

$$\frac{1}{6} - \frac{1}{10} = \frac{1}{V}$$

$$\frac{5-3}{30} = \frac{1}{V}$$

$$\frac{1}{\cancel{30}_{15}} = \frac{\cancel{2}}{} \quad \frac{1}{15} = \frac{1}{V}$$

$$\boxed{V = 15cm}$$

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

$$= \frac{\cancel{15}\,3}{-\cancel{10}\,2}$$

$$\boxed{m = -1.5}$$

nature $m = -1.5$

Real + Inv

$m > 1$ Enlarged

$$m = \frac{h_i}{h_o}$$

$$-1.5 = \frac{h_i}{+2}$$

$$-3cm = h_i$$

Chapter No. – 02

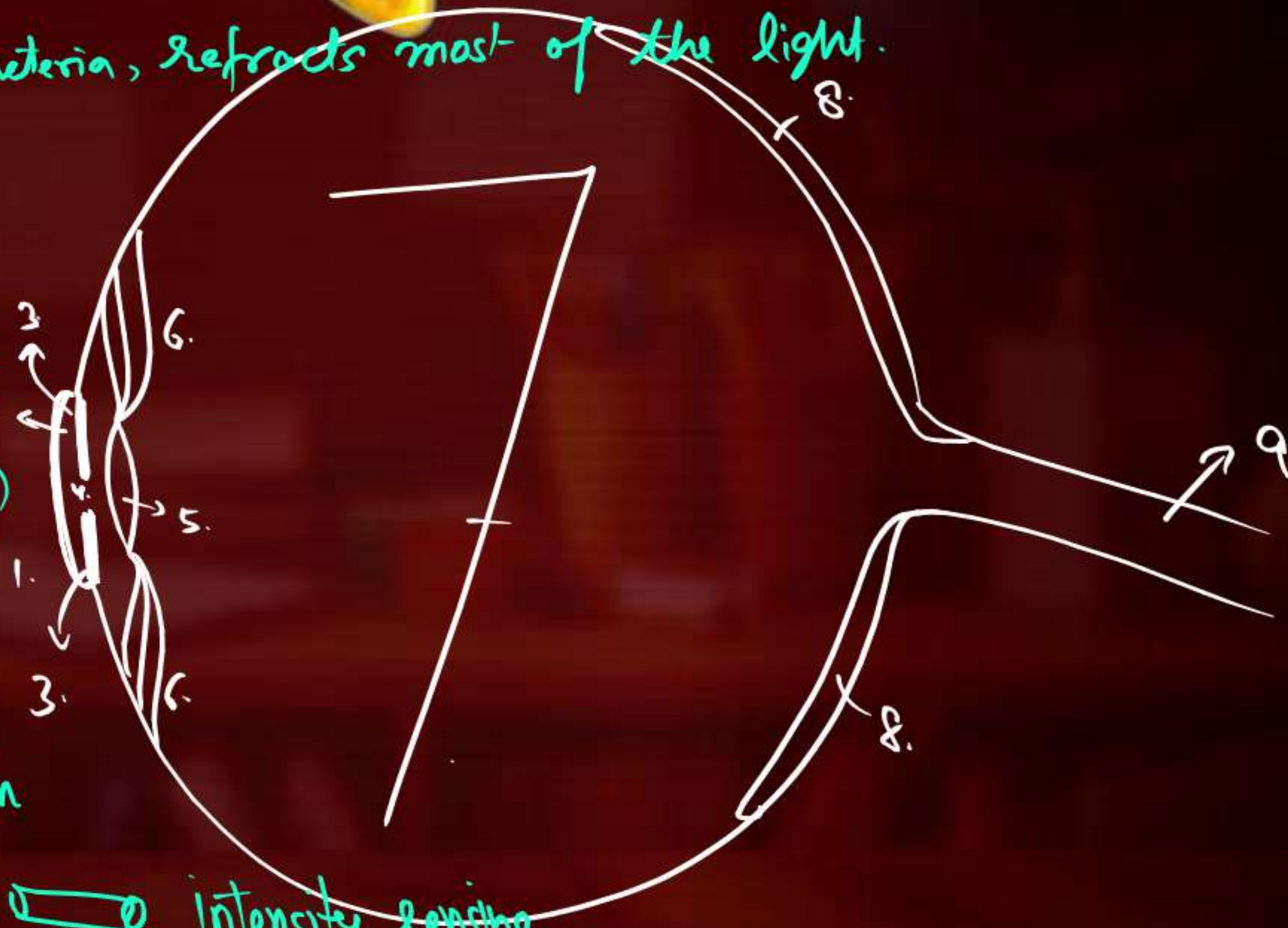
Eye Defects

Human Eye and The Colorful World

Dispersion A.R. Scattering

HUMAN EYE AND ITS PARTS

1. CORNEA - outermost part, protect eye from Bacteria, refracts most of the light.
2. AQUEOUS HUMOR - Water like, pressure balance.
3. IRIS - controls pupil size
4. PUPIL - opening, regulates the amount of light
5. EYE LENS - image formation on retina, (R&I)
6. CILIARY MUSCLES - adjust the focal length of flexible eye lens.
7. VITREOUS HUMOR - Honey like, spherical shape maintain
8. RETINA - Photo-sensitive screen at the back of eye.
   → Rod — intensity sensing
   → Cone — colour sensing
9. Optic Nerve. - Electrical impulses, to brain

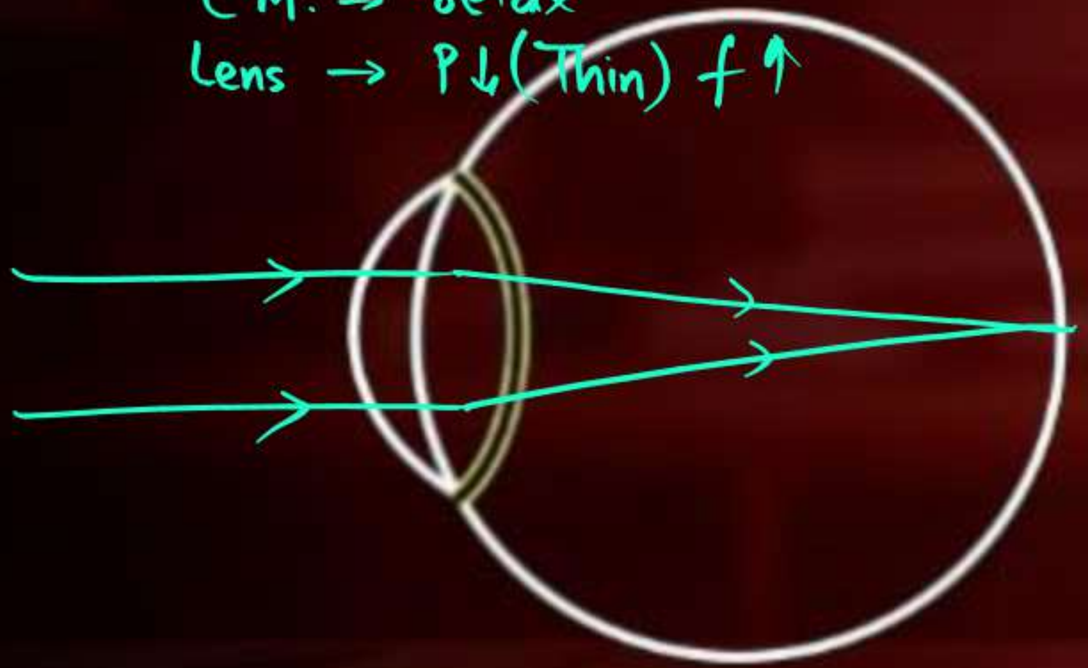


POWER OF ACCOMMODATION

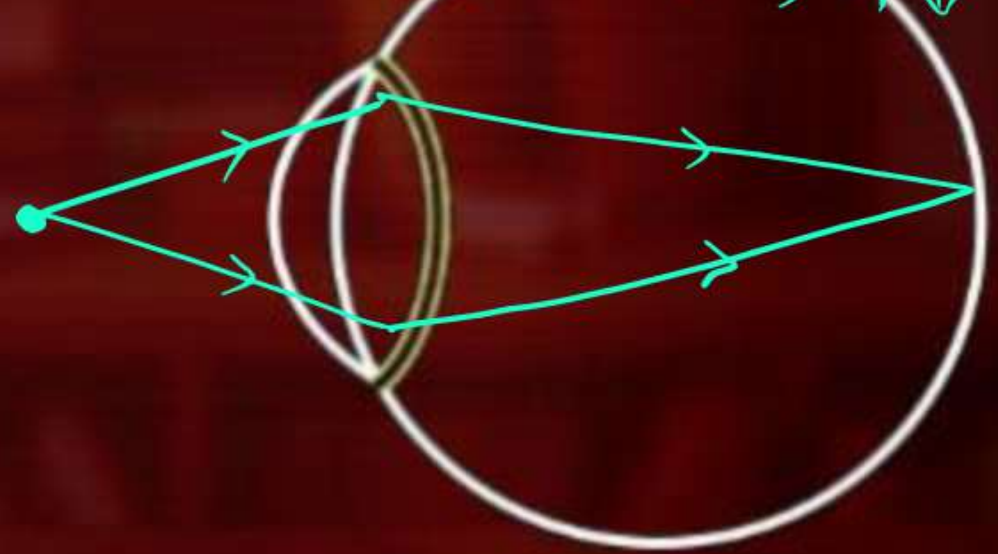
by Cilliary Muscles

- The ability of the eye lens to $\boxed{\text{adjust}}$ its focal length as the distances is called power of accommodation.

C.M. → relax
Lens → P↓ (Thin) f↑



C.M. → Contract
Lens → Motta (P↑) f↓



far point = ∞

L.D.D.V. (least Distance of Distinct Vision) or Near point = 25 cm

QUESTION

An object is placed at a distance of 10 cm from a converging lens of focal length 5 cm. find the nature and position of the image.

(A) A convex lens with power +4D has a focal length –0.25 m.

(B) A convex lens with power –4D has a focal length + 0.25.

(C) A concave lens with power +4D has a focal length + 0.25.

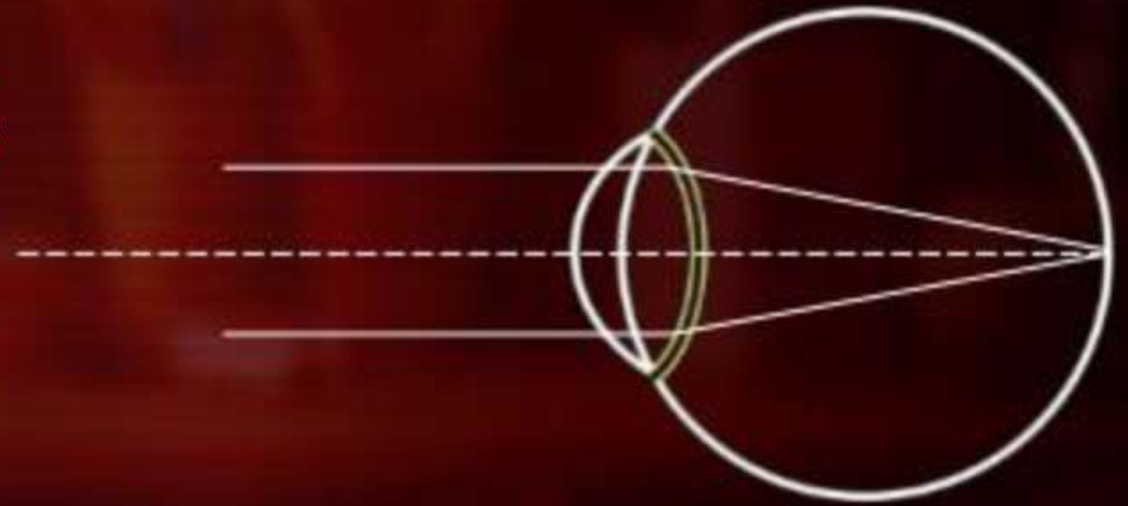
(D) A concave lens with power –4D has a focal length –0.25 m

DEFECTS : MYOPIA (Near-sightedness)

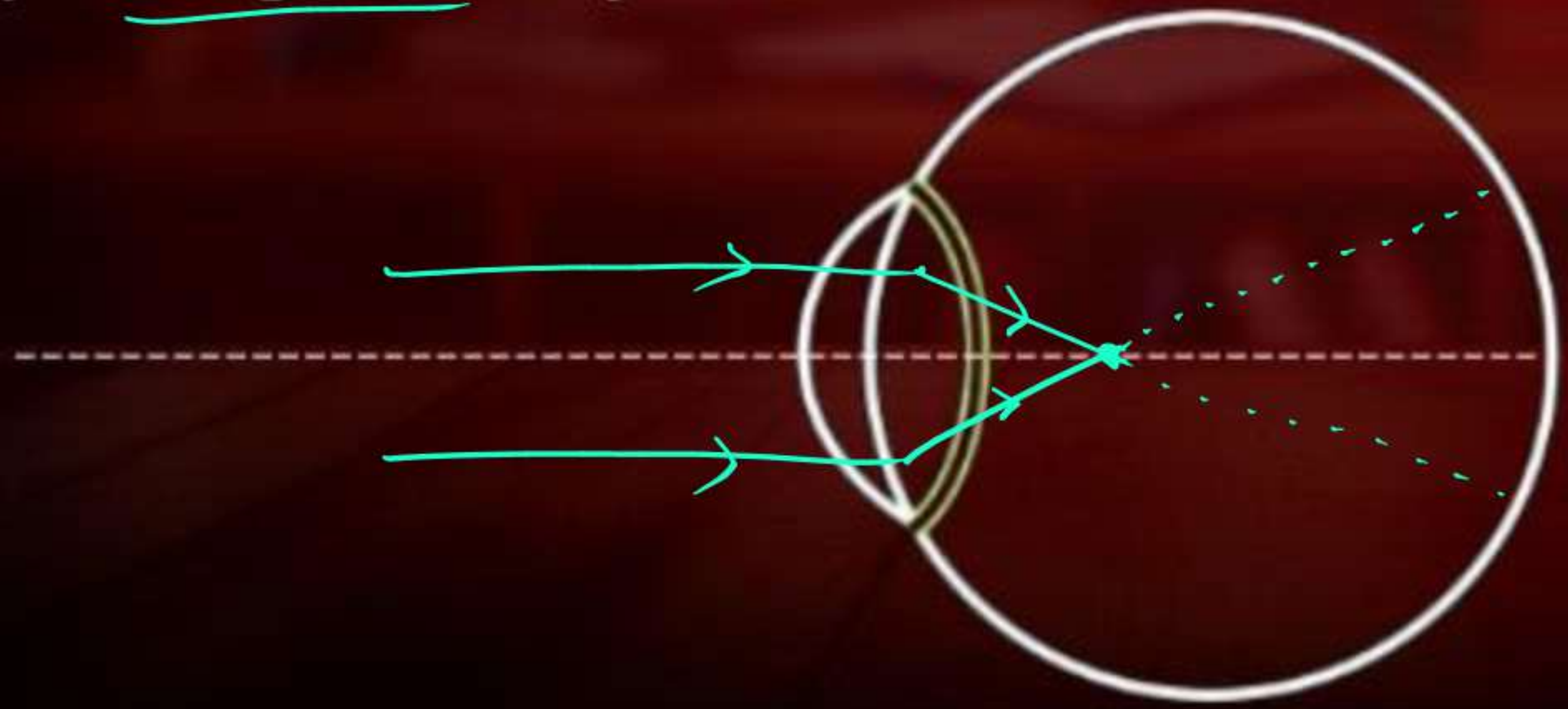
- It is kind of defect in the human eye Due to which a person can see near objects clearly but he cannot see the distant objects clearly. The image forms before the retina. Myopia is due to

(i) Excessive curvature of the eye lens. P↑ f↓

(ii) Elongation of eyeball.

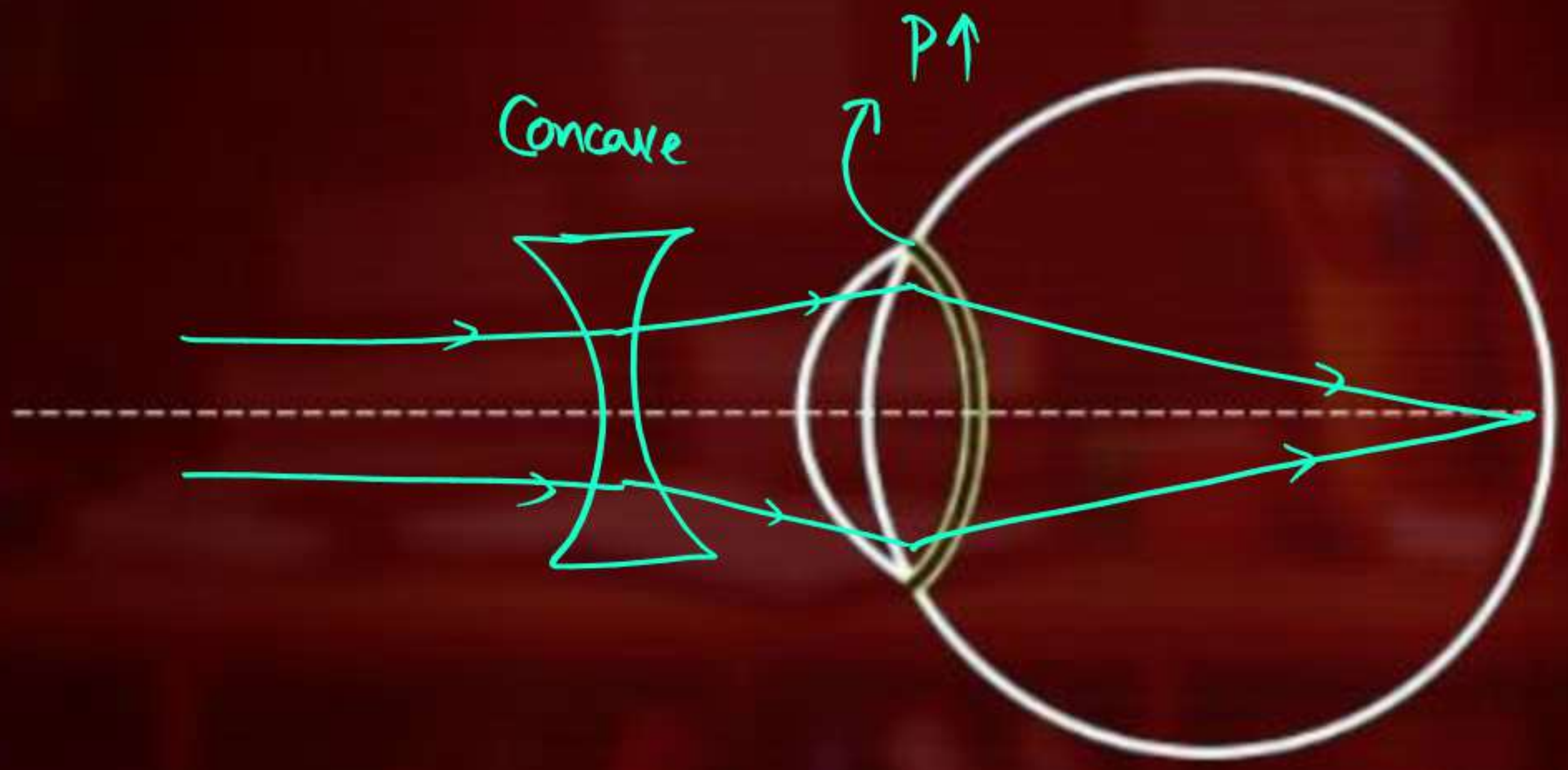


Healthy eye



Myopic Eye

CORRECTION : MYOPIA (NEAR-SIGHTEDNESS)



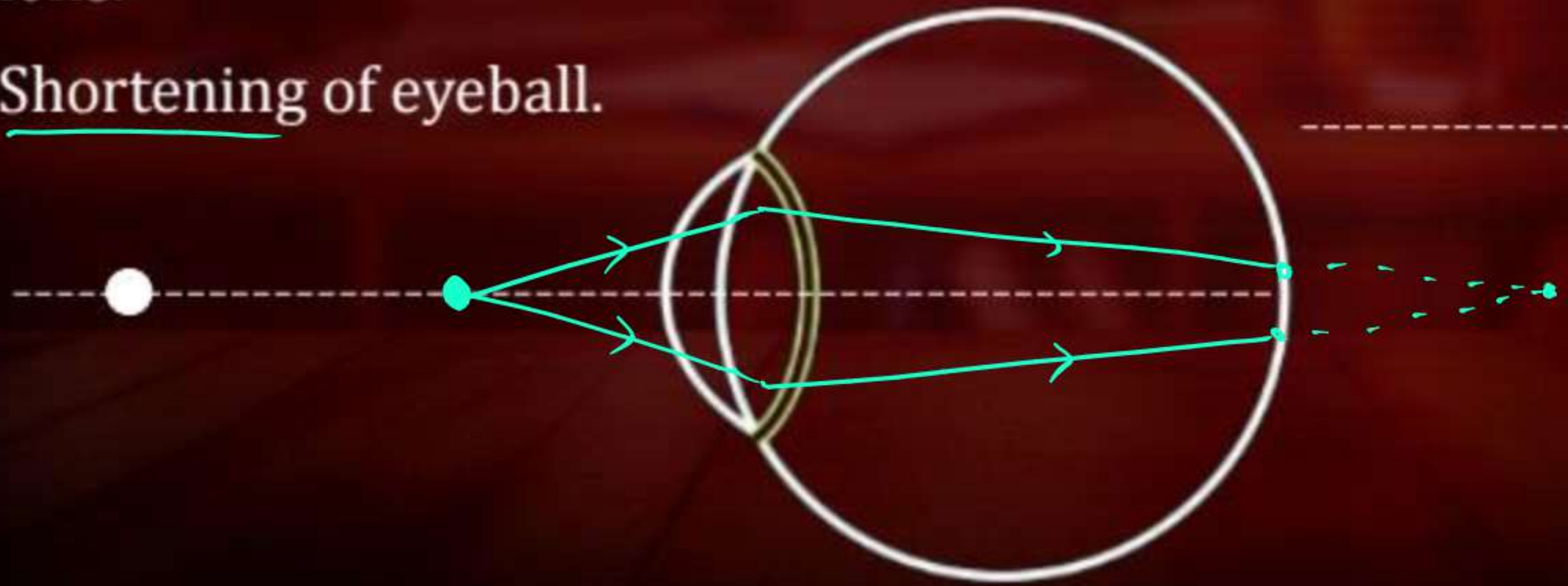
DEFECTS : HYPERMETROPIA (FAR-SIGHTEDNESS)

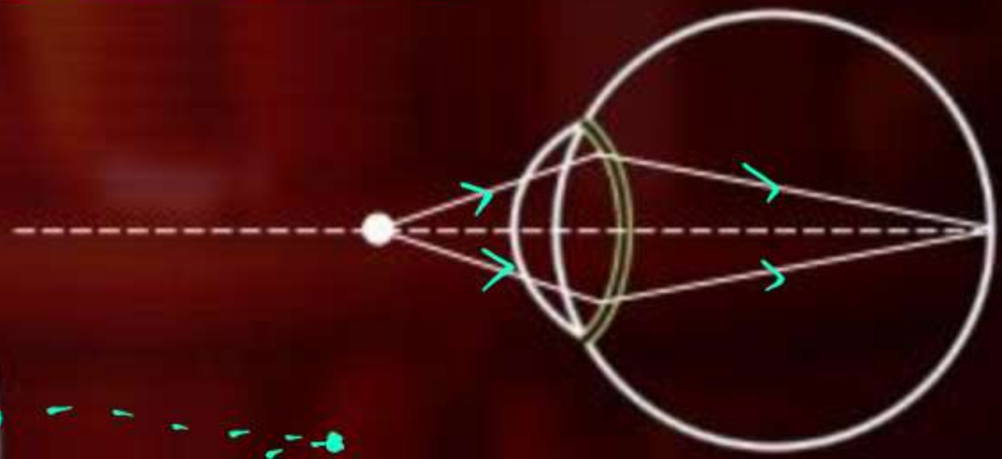
- It is a kind of defect in the human eye due to which, a person can see distant objects properly but cannot see the nearby objects clearly. It happens due to

  $P \downarrow \; f \uparrow$

  (i) Decrease in the power of eye lens i.e. increase in focal length of eye lens.

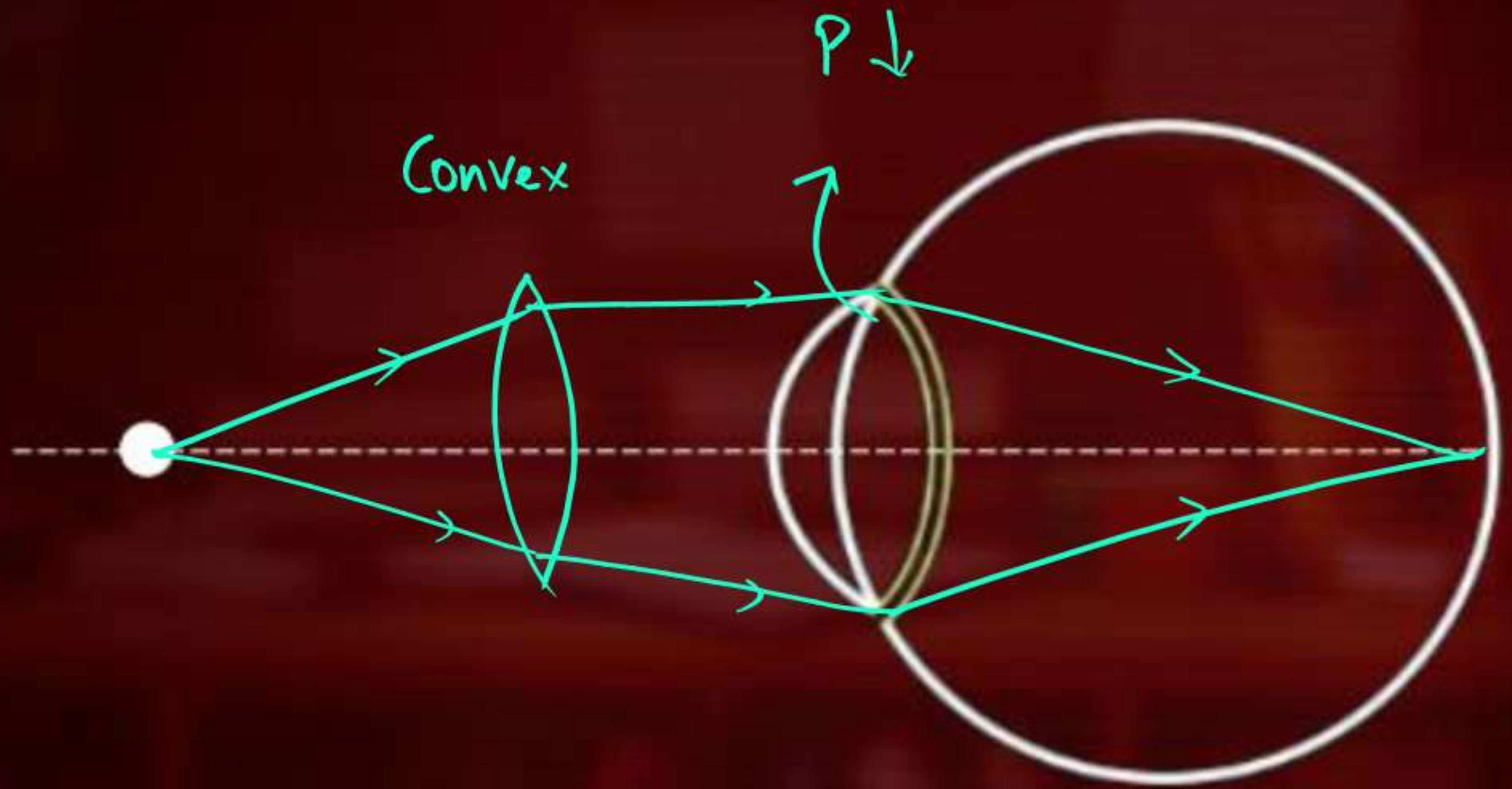
  (ii) Shortening of eyeball.





Healthy eye

CORRECTION : HYPERMETROPIA (FAR-SIGHTEDNESS)

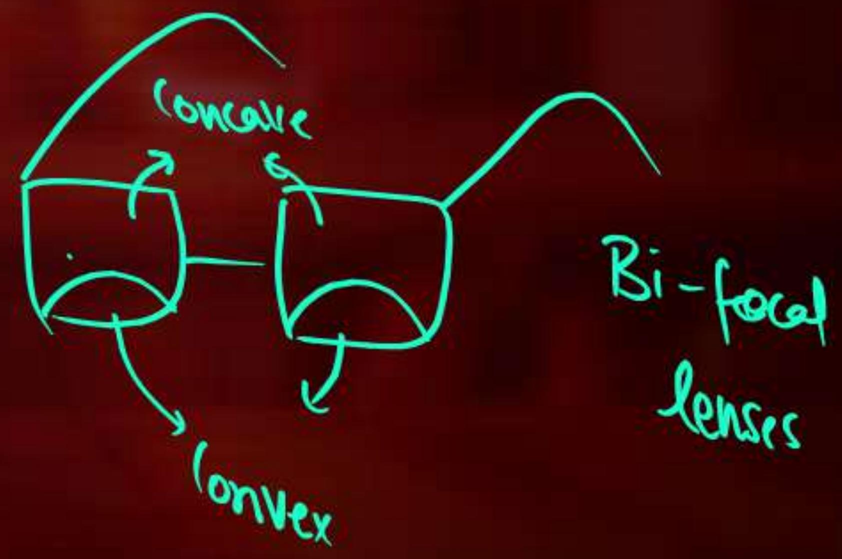


DEFECTS : PRESBYOPIA (OLD AGE HYPERMETROPIA)

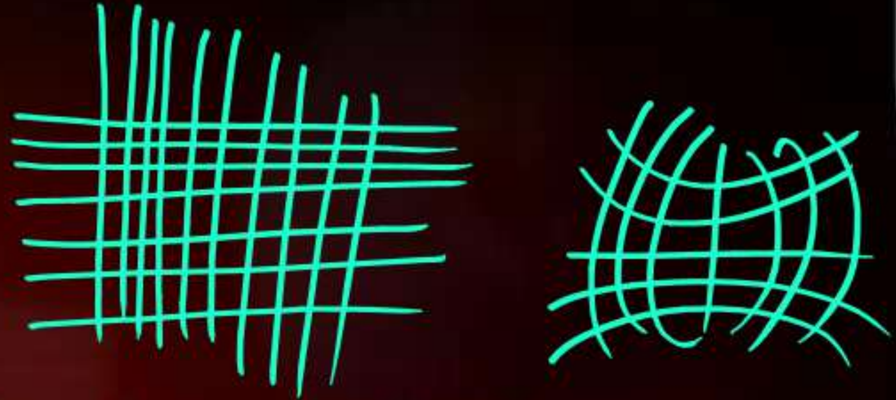
➢ It is a kind of defect in human eye which occurs due to ageing. It happens due to the following reasons

(i) Decrease in flexibility of eye lens.

(ii) Gradual weakening of ciliary muscles. In this, a person may suffer from both myopia and hypermetropia.



DEFECTS : ASTIGMATISM



- In this defect a person cannot focus on both horizontal as well as vertical lines at the same time so the person can see objects clearly only in one plane.

Causes:- Astigmatism is caused by an irregularly shaped cornea or distorted lens.

Correction:- This defect can be corrected using cylindrical lens.

DEFECTS : CATARACT

मोतियाबिन्द

Total Loss of Vision

'opaque'

※ Numerical to find suitable Power of lens :-

Myopia ✓

(healthy) $u = -\infty$

(Dikkat) $v = -70cm$
Given

$f = ?$

$P = ?$

Hypermetropia ✓

(healthy) $u = -25cm$

(Given $v = -80cm$
Dikkat)

$f = ?$

$P = ?$

QUESTION

'Myopia'

A person can not clearly see objects at a distance more than 40 cm. He is advised to use lens of power. $= ?$

$u = -\infty$

$v = -40\,cm$

$f = ?$

$P = ?$

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

$$\frac{1}{f} = \frac{1}{-40} - \left(\frac{1}{-\infty}\right)$$

$$\frac{1}{f} = -\frac{1}{40} + \cancel{\frac{1}{\infty}}\ 0$$

$$\frac{1}{f} = -\frac{1}{40}$$

$$\boxed{f = -40\,cm}$$

$$P = \frac{100}{f\,(cm)}$$

$$P = \frac{100}{-40}$$

$$P = -2.5\,D$$

Concave or Diverging Nature

QUESTION

Hypermetropia

An old aged person can read the newspaper by keeping it at 80 cm in front of his eye. What is the nature and power of the lens required to correct the problem?

$u = -25\,cm$

$v = -80\,cm$

$f = ?$

$P = ?$

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

$$\frac{1}{f} = \frac{1}{-80} - \frac{1}{-25}$$

$$\frac{1}{f} = -\frac{1}{80} + \frac{1}{25}$$

$$\frac{1}{f} = \frac{-5+16}{400} = \frac{11}{400}$$

$$f = \frac{400}{11}\,cm$$

$$P = \frac{100}{f(cm)}$$

$$= \frac{100}{\frac{400}{11}} = \frac{11\cancel{00}}{4\cancel{00}}$$

$$\boxed{P = \frac{11}{4}\,D} \rightarrow \text{Convex}$$

Glass Prism

R
O
Y
G
B
I
V

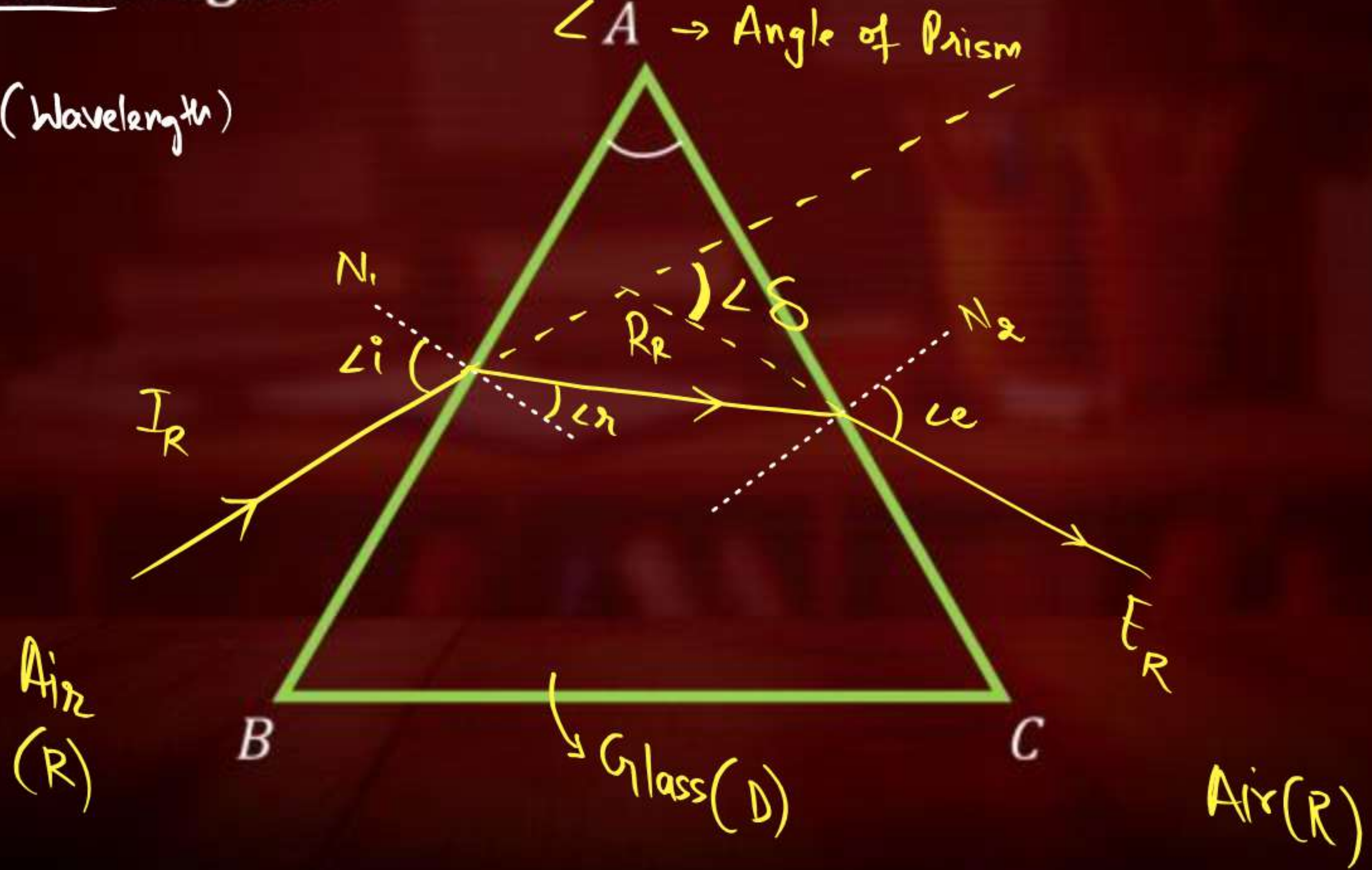
REFRACTION THROUGH PRISM

Using monochromatic Light :

mono → one, chromatic → colour (Wavelength)

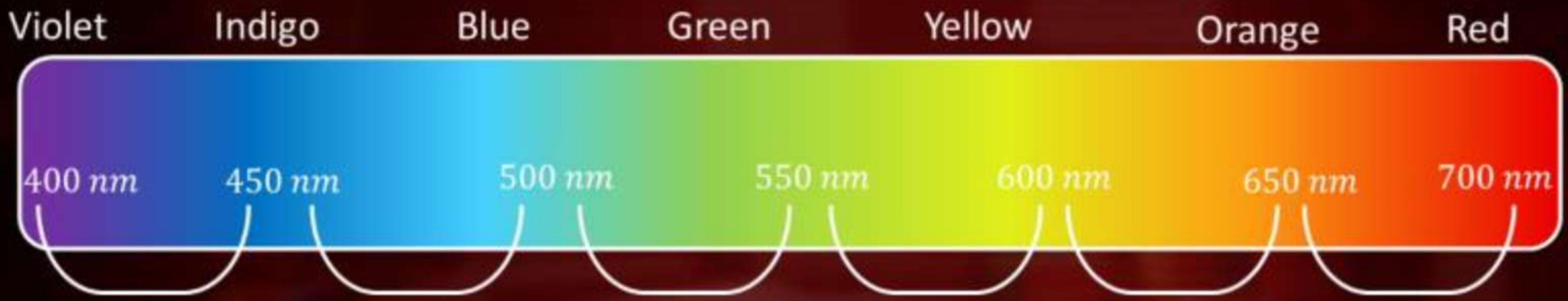
I_R
R_R
E_R
$\angle i$
$\angle r$
$\angle e$
$\angle A \rightarrow$ Angle of Prism
$\angle \delta \rightarrow$ Angle of Deviation (Bhatkan)

N_1
N_2

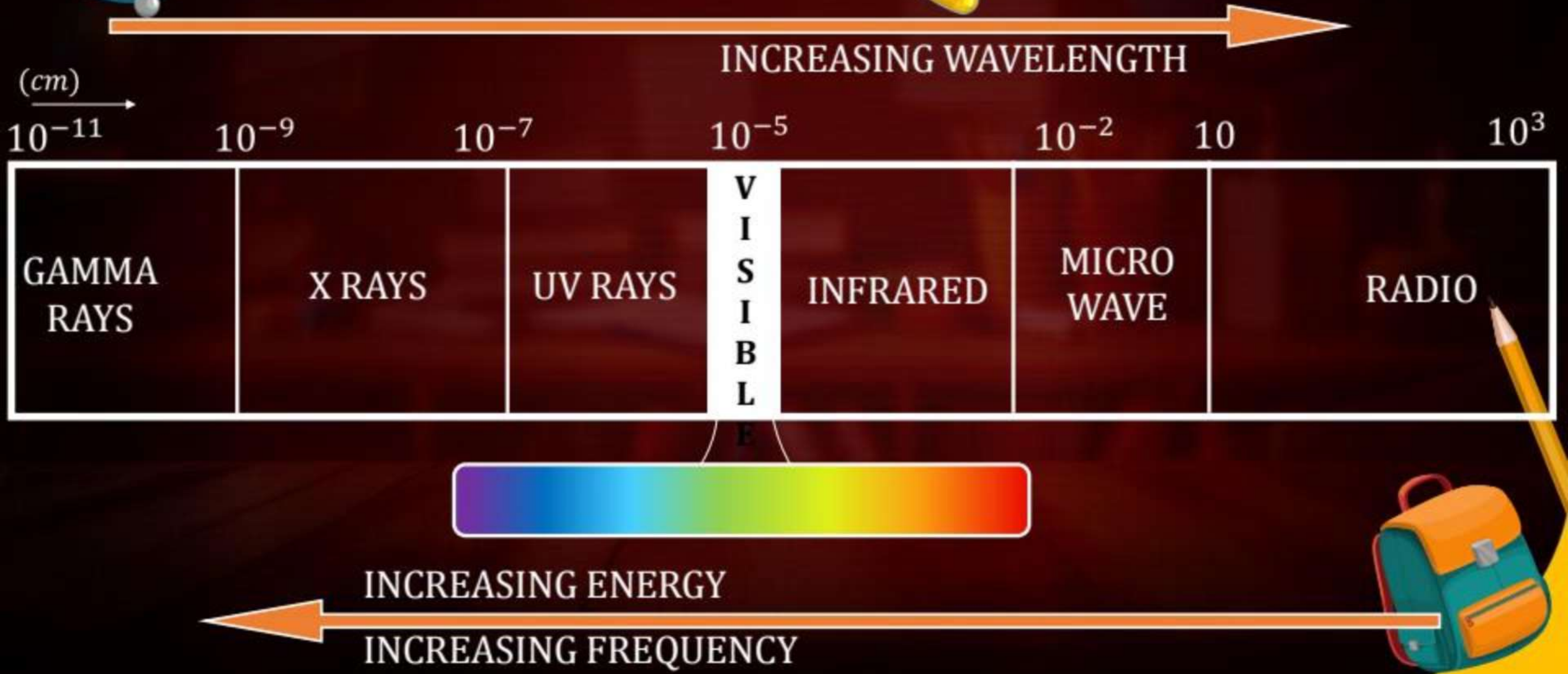


VIBGYOR

VISIBLE REGION : (400nm —— 700nm)



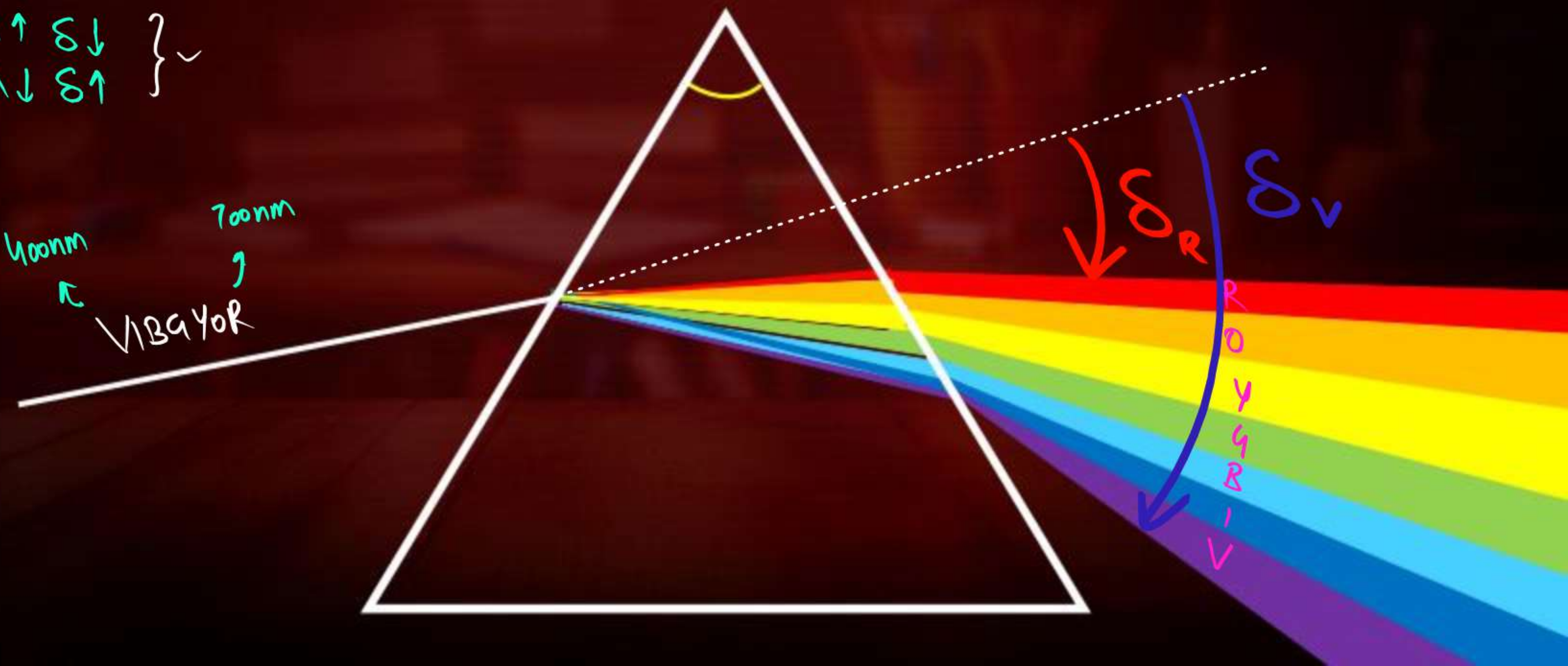
ELECTROMAGNETIC SPECTRUM



DISPERSION OF LIGHT THROUGH PRISM

The phenomenon of splitting of white light into its seven constituent colours when it passes through a glass prism is called dispersion of white light.

Concept : $\left.\begin{array}{l} \lambda\uparrow\ \delta\downarrow \\ \lambda\downarrow\ \delta\uparrow \end{array}\right\}$ ✓



SPECTRUM

Visible

- The band of seven colors is called the spectrum.
- The sequence of colors remembers as VIBGYOR.

V - Violet

I - Indigo

B - Blue

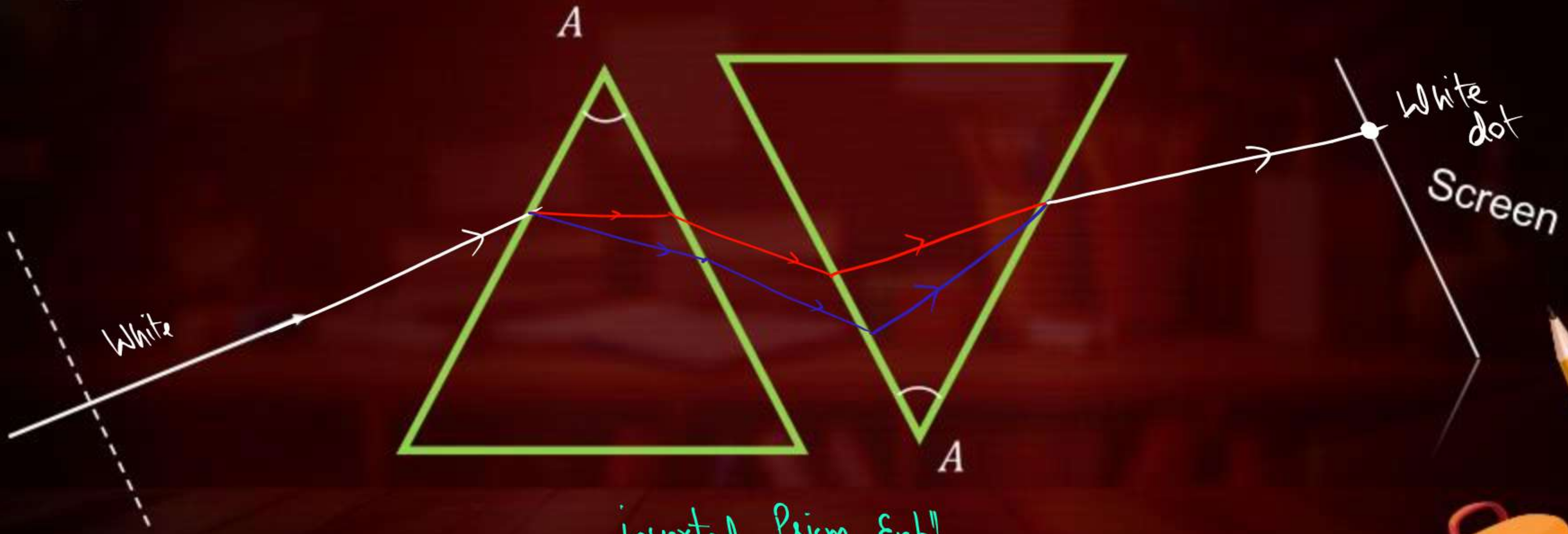
G - Green

Y - Yellow

O - Orange

R - Red

RECOMBINATION OF DISPERSED LIGHT

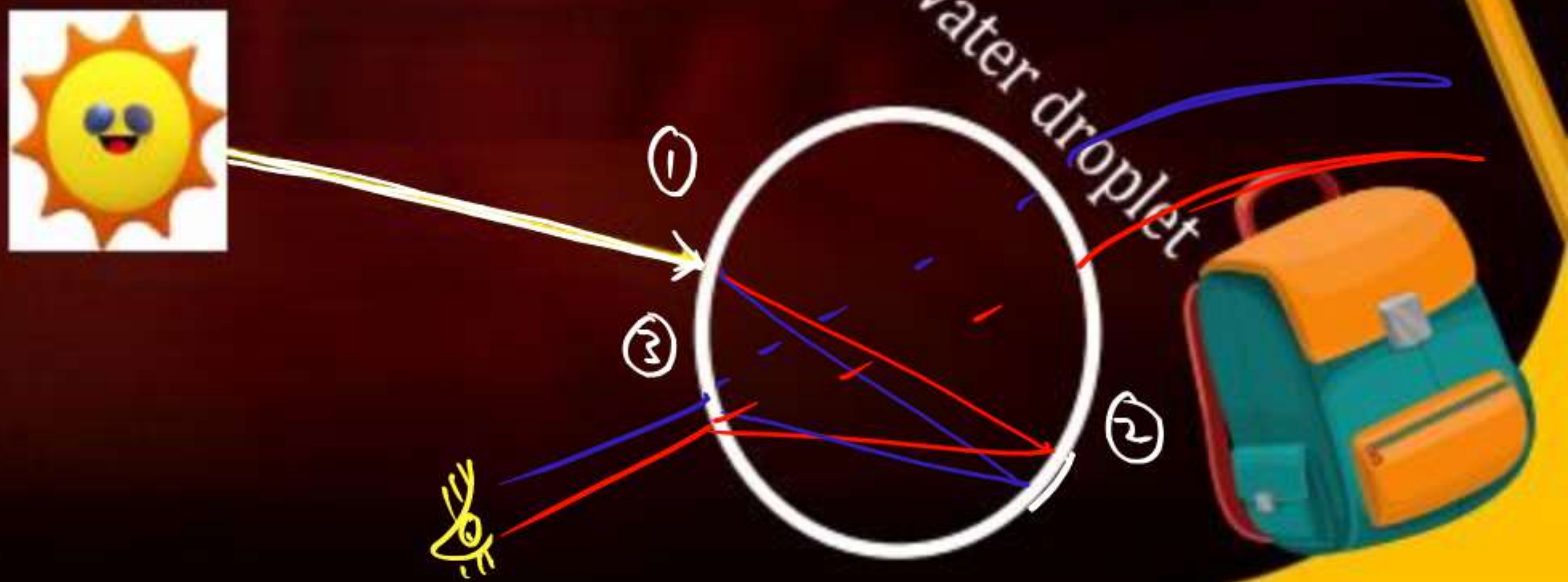


inverted Prism Expt

RAINBOW

- The water droplets act like small prism.
- They refract and disperse the incident sunlight, then reflect it internally and refract it again when it comes out of the raindrop.
- Due to the dispersion of light and internal reflection, different colors reach the observer's eye.
- Red color appears on top and violet at the bottom of rainbow.
- A rainbow is always formed in a direction opposite to that of Sun.

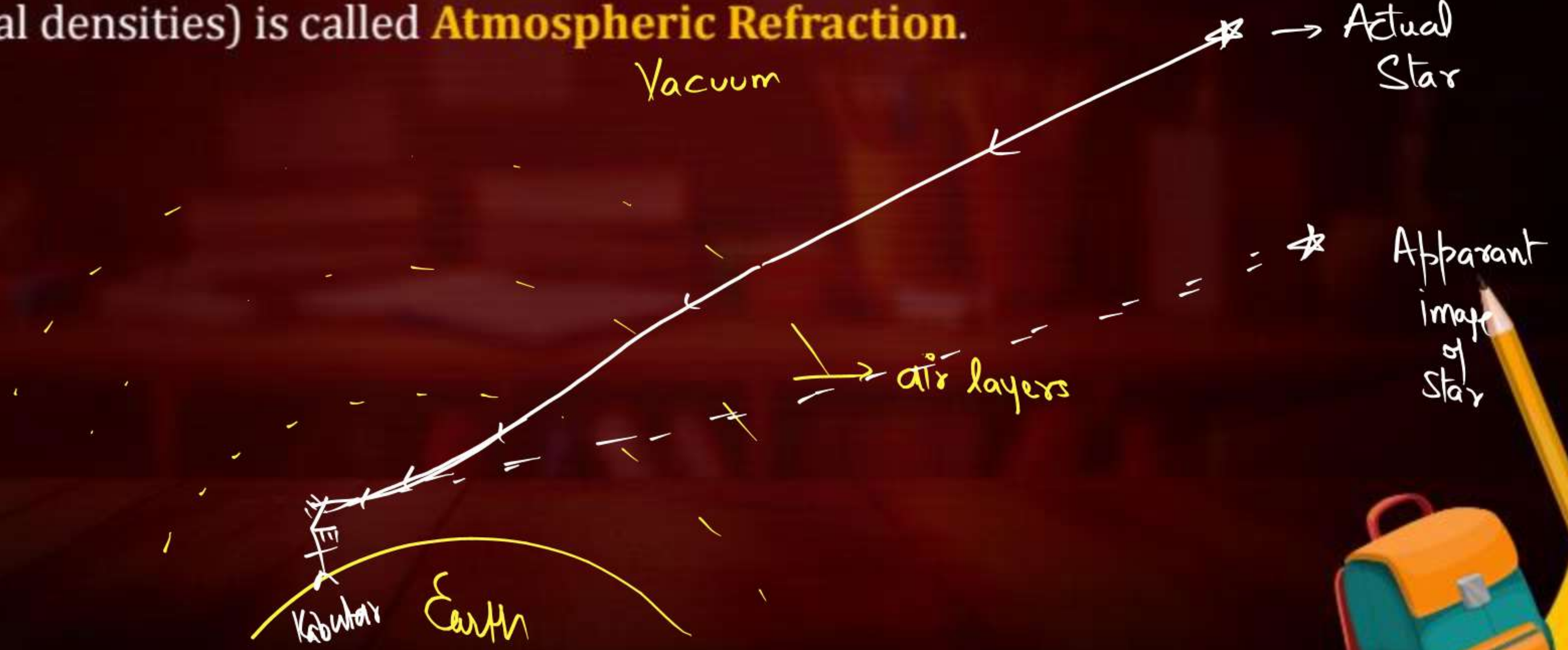
(1) Dispersion ✓
(2) Internal Reflection ✓
(3) Refraction ✓



ATMOSPHERIC REFRACTION

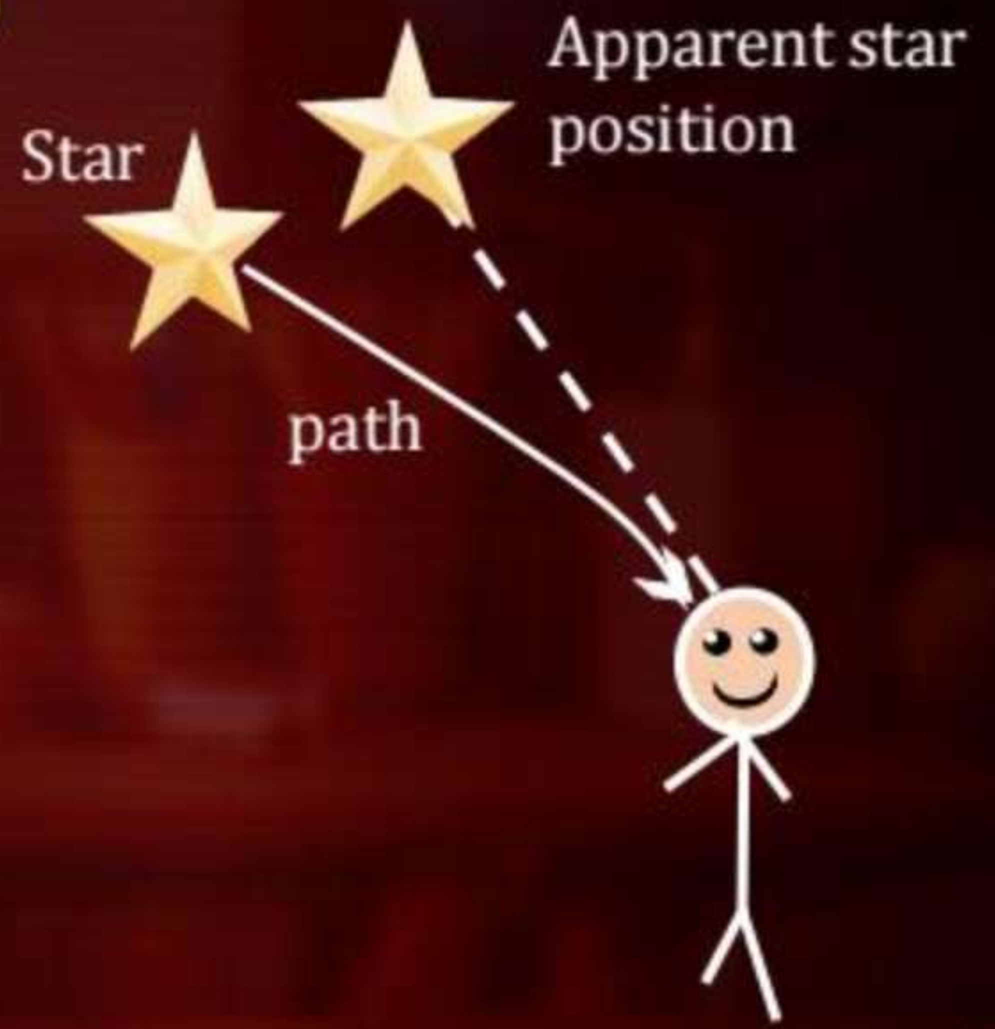
↳ Air (1.003) Vacuum (1)

The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is called **Atmospheric Refraction**.

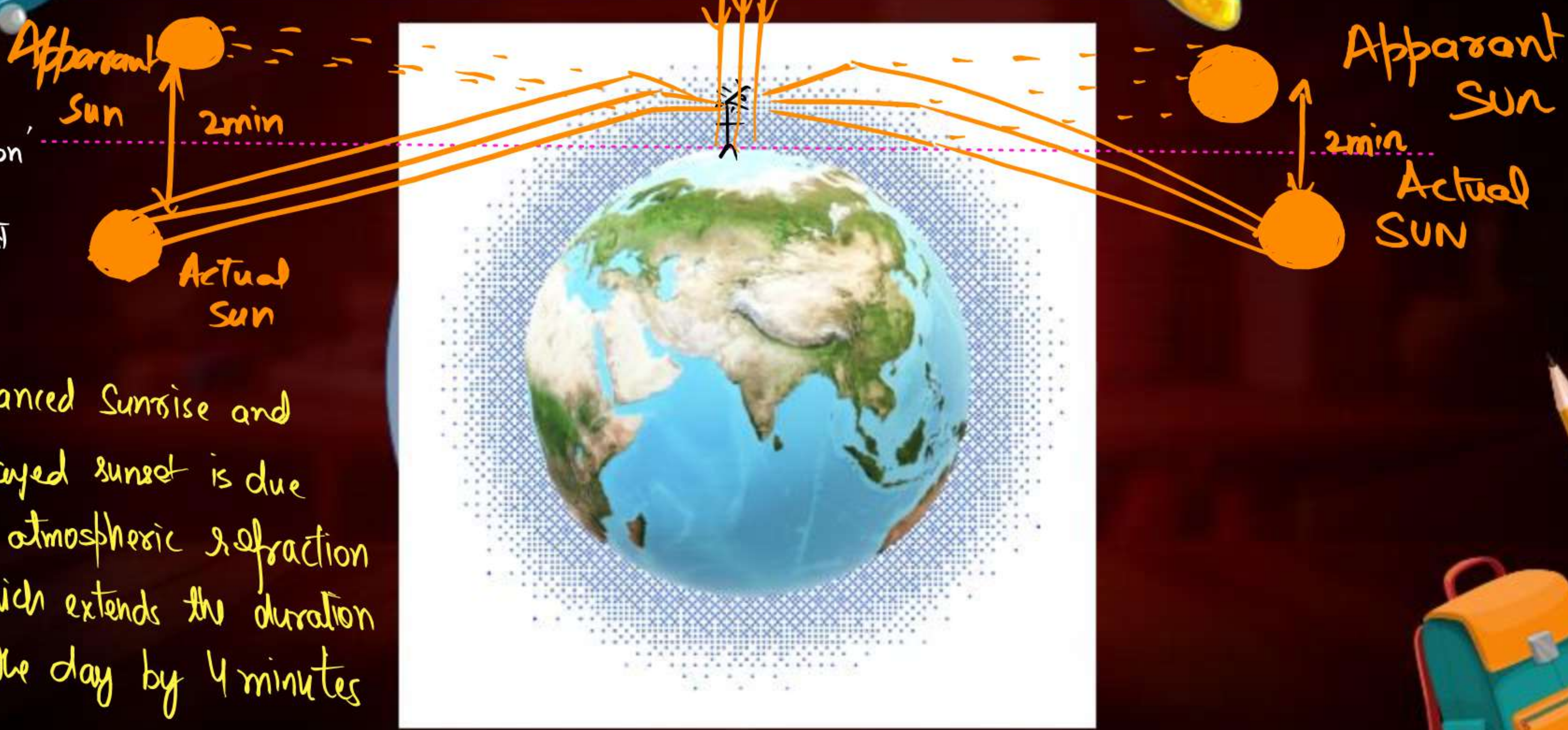


Why do stars twinkle?

It is due to atmospheric refraction. Distant star act like a point source of light. As the beam of starlight keeps deviating from its path, the apparent position of star keeps on changing because physical condition of earth's atmosphere is not stationary. Hence, the amount of light enters our eyes fluctuate sometimes bright and sometime dim. This is the "Twinkling effect of star"



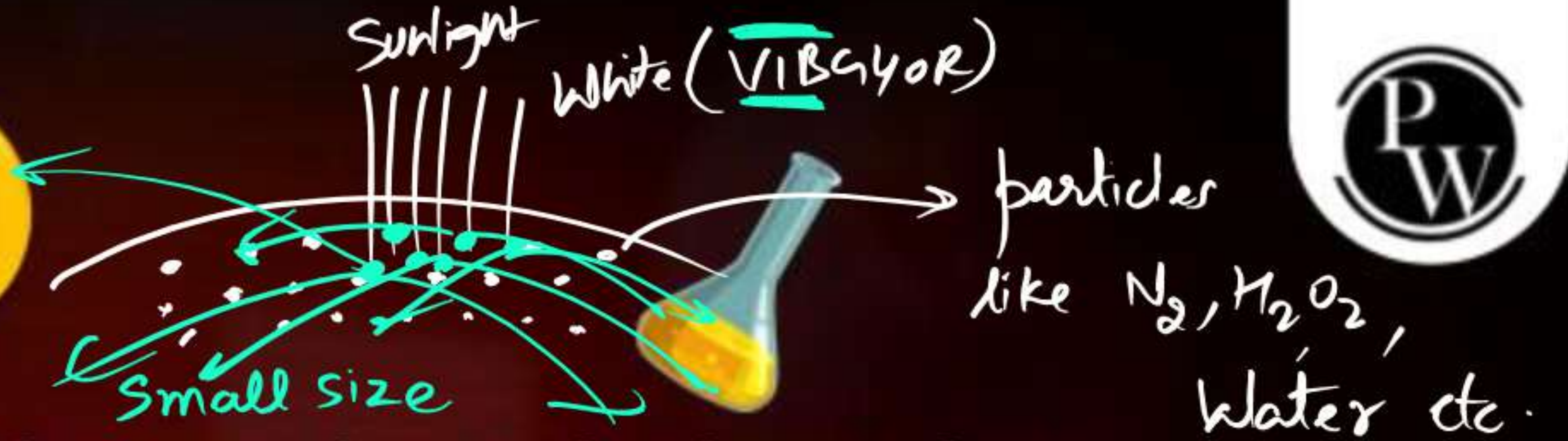
ADVANCED SUNRISE & DELAYED SUNSET



Advanced Sunrise and delayed sunset is due to atmospheric refraction which extends the duration of the day by 4 minutes

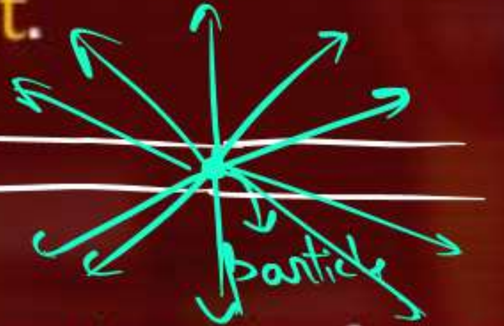
FUN & ILLUSION

SCATTERING OF LIGHT



This happens because light is absorbed by the particles in the form of energy. Then the particles reflect and emit the light again in all directions. This phenomenon is called the scattering of light.

Scattering ↑ λ ↓



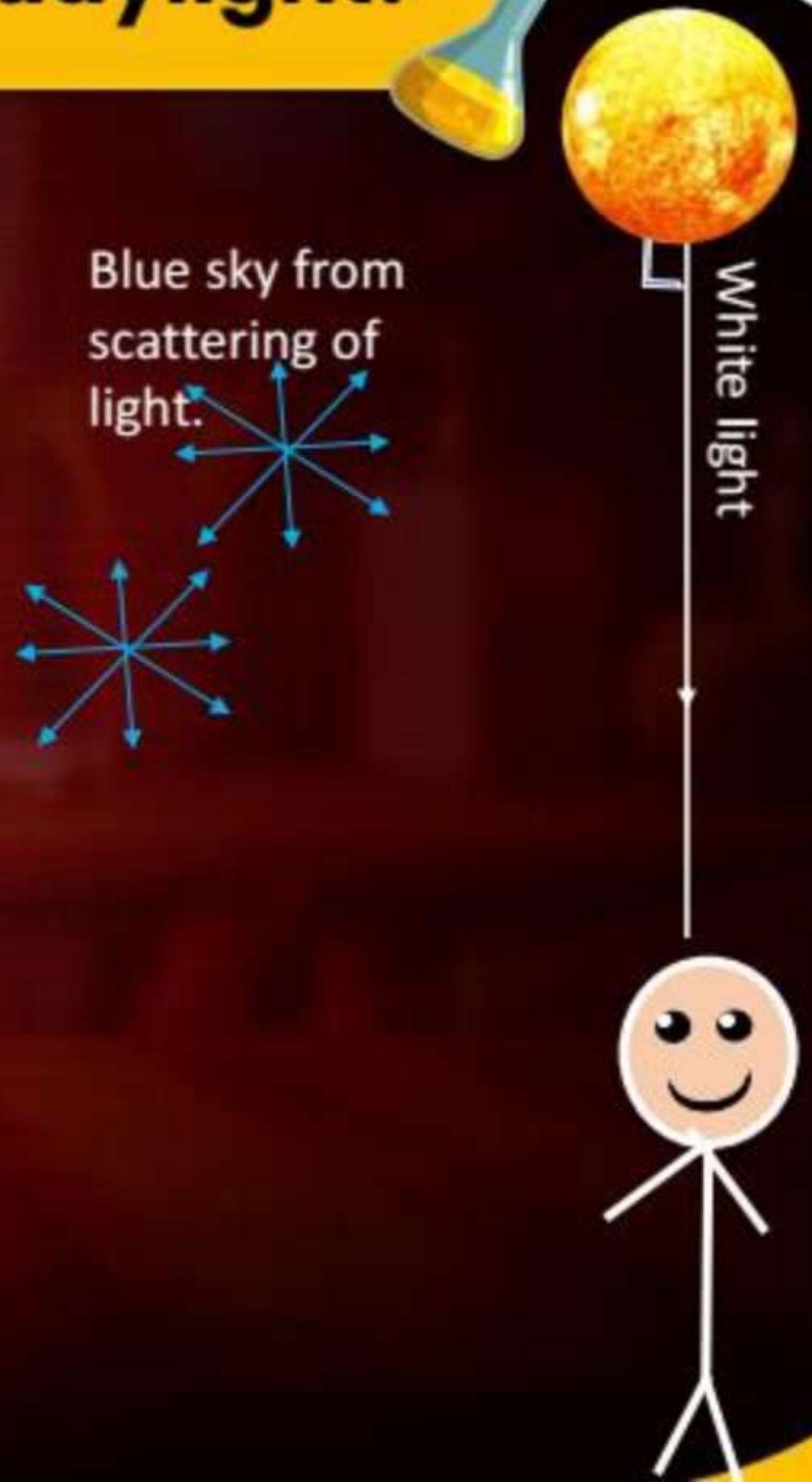
λ ↑ Scatter ↓

For examples :-

- ❖ The blue color of the sky, color of water in deep sea, the reddening of the sun at sunrise and the sunset are some of the wonderful phenomena we are familiar with
- ❖ The path of a beam of light passing through a true solution is not visible. However, its path becomes visible through a colloidal solution where the size of the particles is relatively larger.

Why does the sky appear blue at daylight?

Because of the phenomenon of scattering. Sunlight gets scattered by small air molecules and other fine particles in the atmosphere during its passage. Scattering is inversely proportional to wavelength, i.e. Blue with the shortest wavelength will scatter more compared to the red. Therefore, this greater scattering of blue light by the air molecules in all directions make the atmosphere appear blue during cloudless daytime.



Chapter No. – 03

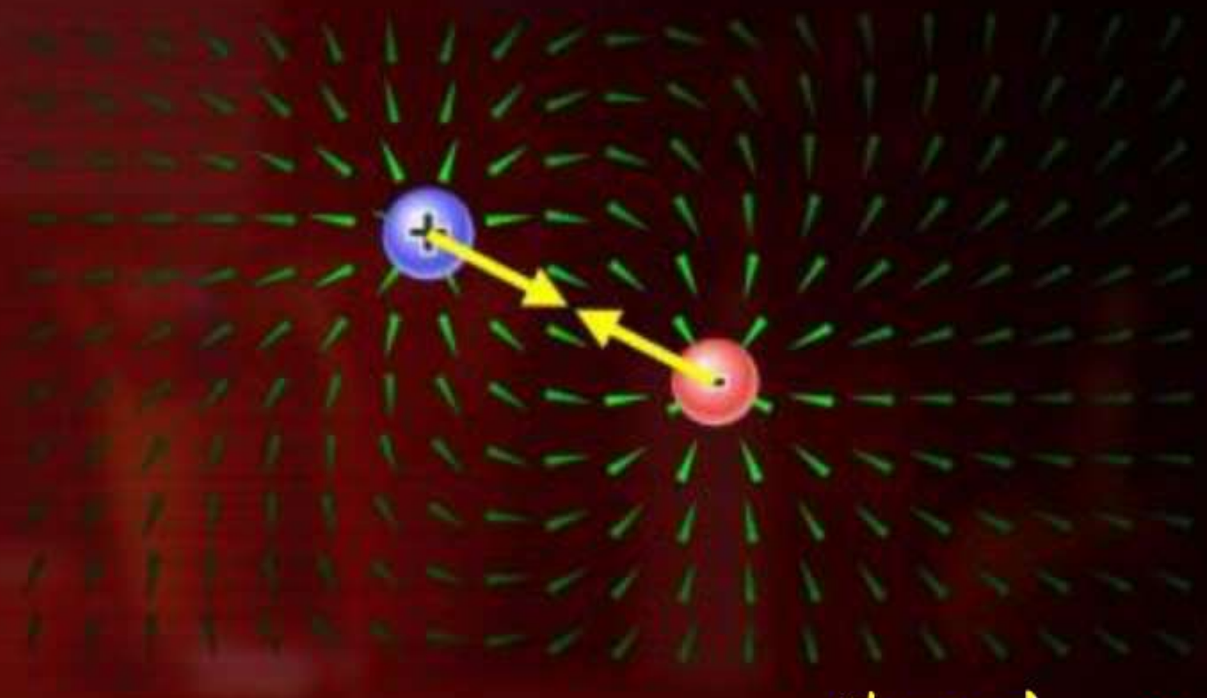
ELECTRICITY

ELECTRIC CHARGE

$\Rightarrow Q$

$\leftarrow + \quad + \rightarrow$
$\leftarrow - \quad - \rightarrow$
$\overset{+}{\rightarrow} \quad \overset{-}{\leftarrow}$

- Charge is the property associated with matter due to which it produces and Experience Electrical and Magnetic Effects. ✓



SI Unit of charge : Coulomb (C)

$1\,mC = 10^{-3}\,C$
$1\,\mu C = 10^{-6}\,C$

$Q = 3\,mC$
$= 3 \times 10^{-3}\,C$

Neutron → chargeless ✗
Neutron → Neutral ✓

Que. Where does the charge present in the universe?

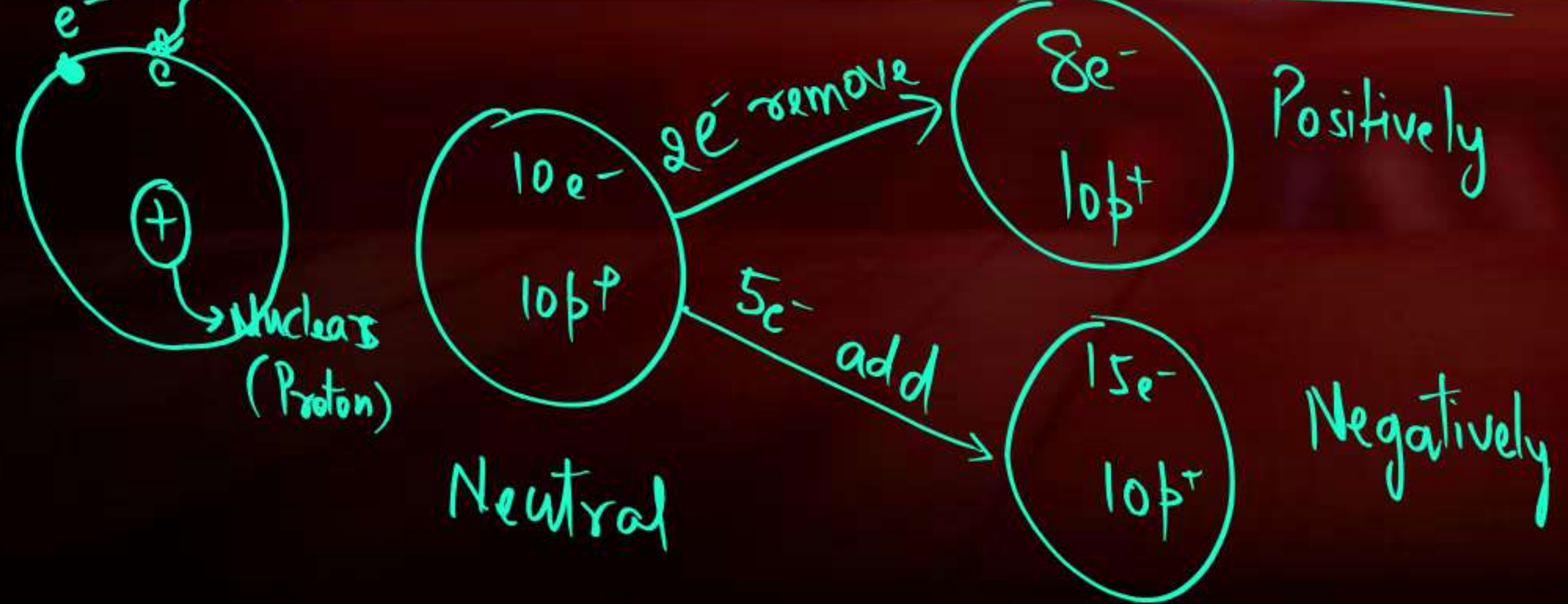
Ans. Charge is fundamentally present on the elementary particles, Electrons (–) and Protons (+) and Neutrons are Neutral in nature. All of them are present inside the Atom and Atoms constitute to become molecules, of which the substances of the universe are made.

APPEARANCE OF CHARGE

Que. **How does Charge appear on a body?**

Ans. Charged Bodies/Particles can be created by disturbing the neutrality of an atom. Just like Ions are created out of Neutral Atoms

* **Loss of electrons**	→	**Positive charge**
* **Gain of electron**	→	**Negative charge**



PROPERTIES OF CHARGES

$+3C$, $-2C$, $+1.5C$, $-0.5C$ $\rightarrow$ $Q_{net} = q_1 + q_2 + q_3 + q_4$

1. **Additivity of charge:** Total charge on a body is the algebraic sum of all the charges located anywhere on the body.

$= +3 - 2 + 1.5 - 0.5$

$Q_{net} = +2C$

NOTE: Charge is a scalar quantity

2. **Charge is conserved:** Charge can neither be created nor be destroyed that means for an isolated system total charge is conserved/constant.

3. **Charge is Invariant:** The numerical value of an elementary charge is independent of velocity. 'Relativity'

Packet + Process

4. Quantization of Charge :

Charge ke Packets Banane ki Prakriya

Smallest Packet → $1e^- = 1.6 \times 10^{-19} C$

$2e^- = 2 \times 1.6 \times 10^{-19} C$

$3e^- = 3 \times 1.6 \times 10^{-19} C$

$\vdots$

$Q_{net} = ne^- = n \times \underbrace{1.6 \times 10^{-19} C}$

electronic charge

- The smallest charge that can exist in nature is the charge of an electron.
- If the charge of an electron ($= 1.6 \times 10^{-19}$ C) is taken as elementary unit, *i.e.* the quanta of charge, the charge on any body will be some integral multiple of e *i.e.* $Q = \pm ne$ with $n = 1, 2, 3, \ldots$

$$\boxed{Q = ne}$$

23 electrons

$Q_{net} = 23 \times 1.6 \times 10^{-19}$

$= 23e$

QUESTION

$$\boxed{Q = ne}$$

Find the Number of Electrons present in one coulomb of charge

$Q_{net} = 1\,C$

$n = ?$

$e = 1.6 \times 10^{-19}\,C$

$Q = ne$

$1 = n \times 1.6 \times 10^{-19}$

$$n = \frac{1}{1.6 \times 10^{-19}}$$

$$n = \frac{10 \times 10^{19}}{1.6}$$

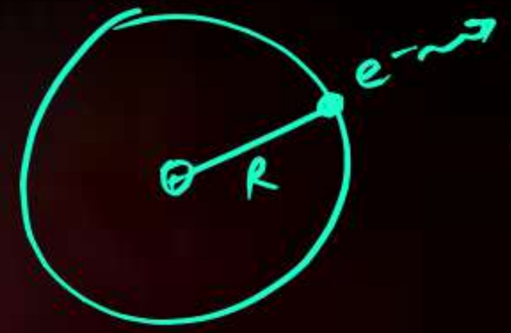
6.25

12.5

$$n = \frac{\cancel{100}^{25} \times 10^{18}}{\cancel{16}_{4}} = 6.25 \times 10^{18} \text{ electrons}$$

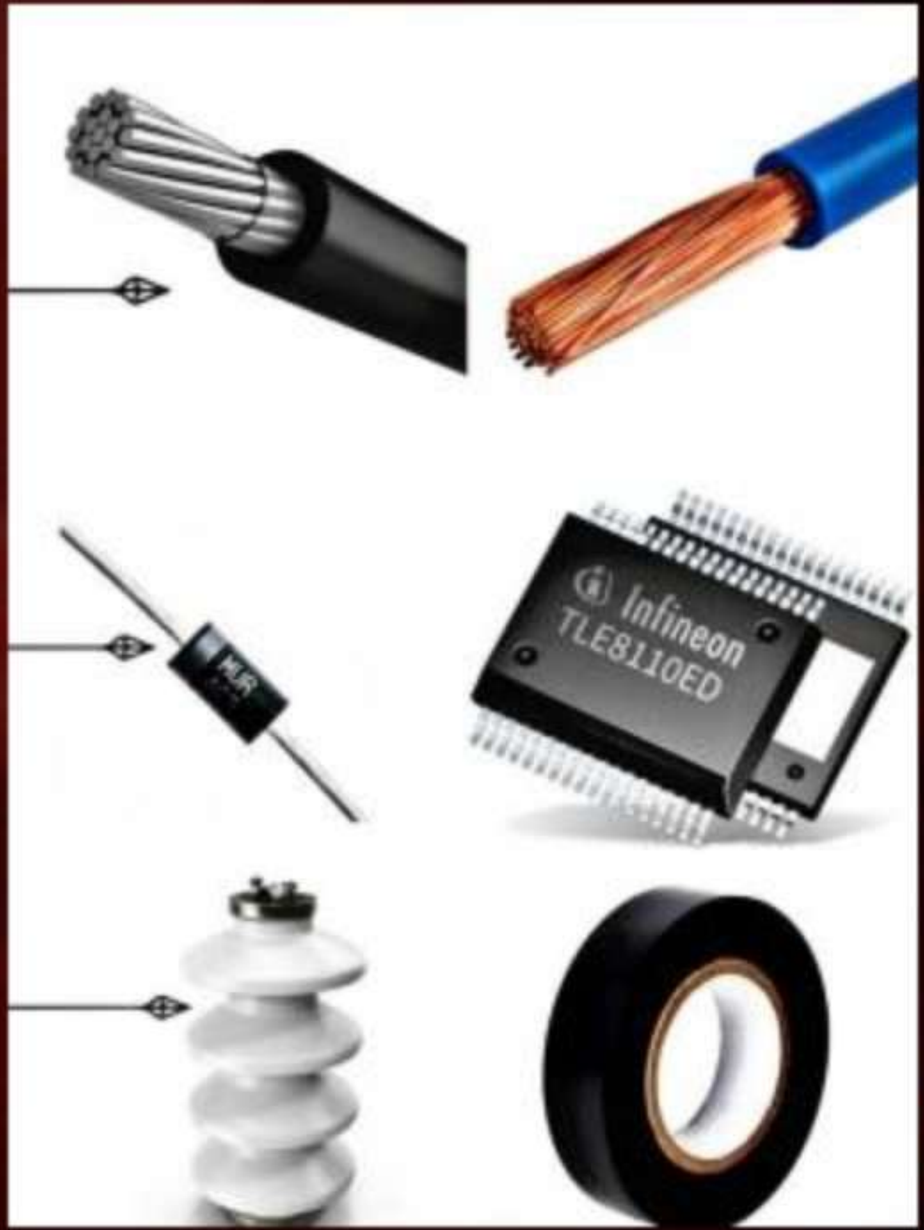
ELECTRICAL SUBSTANCES

Metals



1. Conductors :

- The substances or materials that permit electrons to flow freely from particle to particle. eg- Copper, Iron, Silver, Aluminium etc.
- This is due to presence of more loosely bound electrons (Free Electrons). See Electron Sea Model.



Concept: free electron ↑ conductor ↑

2. Semi Conductors :

- A material that has an electrical conductivity value falling between that of a conductor, such as metallic copper, and an insulator, such as glass. eg- SiAs, GaAs, Titanium Dioxide etc.
- This is due to the presence of less free electrons which are tend to move to conduct electricity

3. Insulators : Non-Metal → Atomic size ↓

e^-

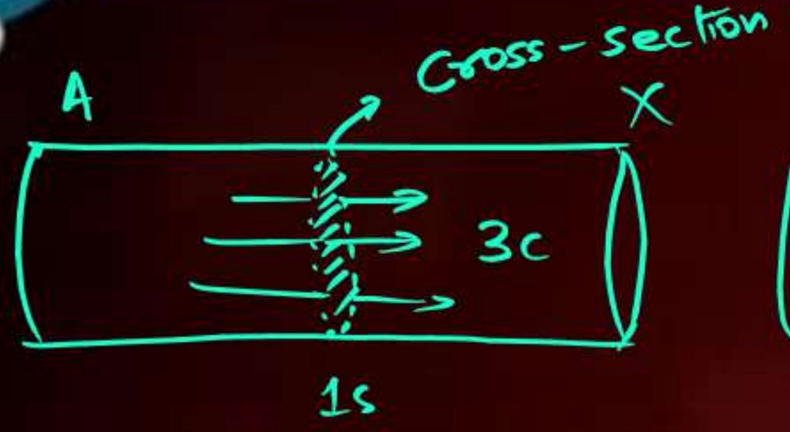
- The substances or materials that resist the free flow of electrons from atom to atom and molecule to molecule. eg- Wood, Glass, Cloth etc.
- This is due to the absence of more loosely bound electrons (Free Electrons)

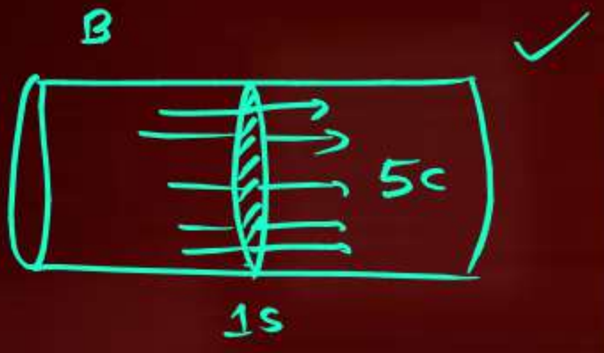
CHARGE IN MOTION : ELECTRIC CURRENT

→ I
→ Scalar
→ SI → Ampere(A)

$1\,mA = 10^{-3}A$

$1\,\mu A = 10^{-6}A$



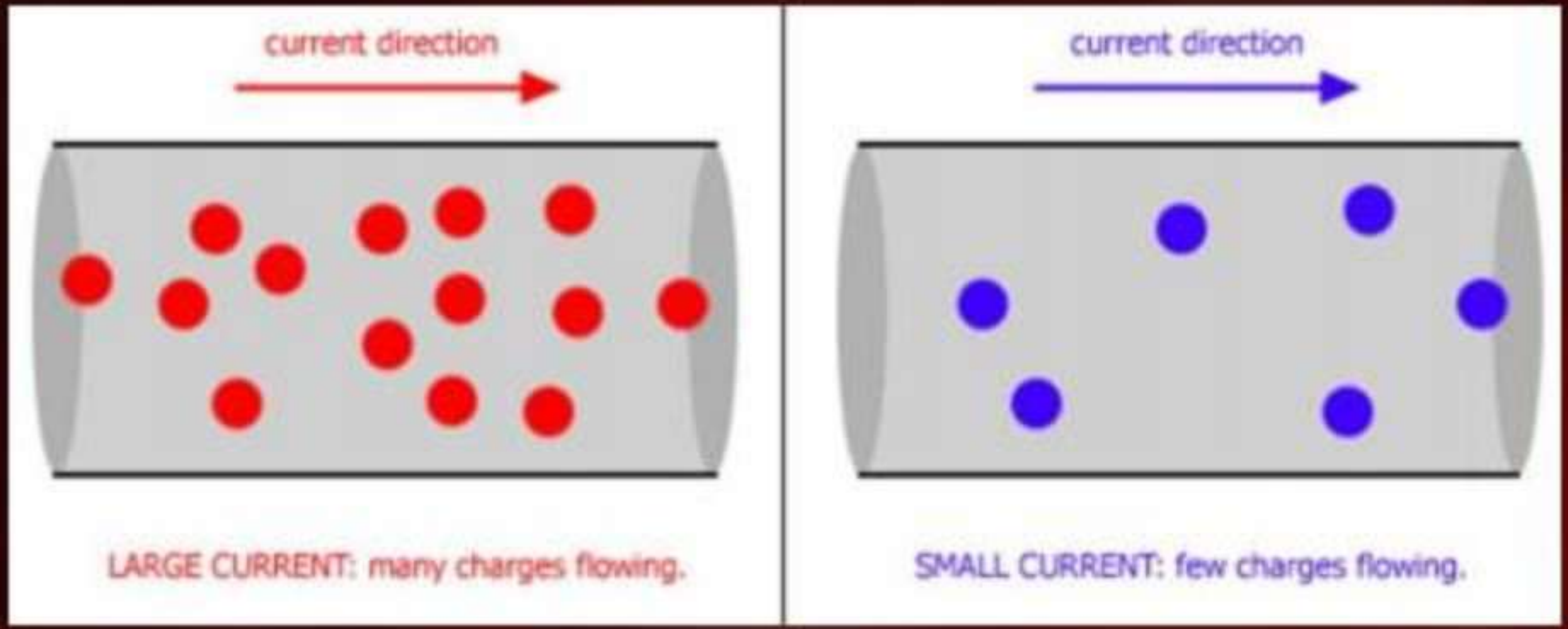


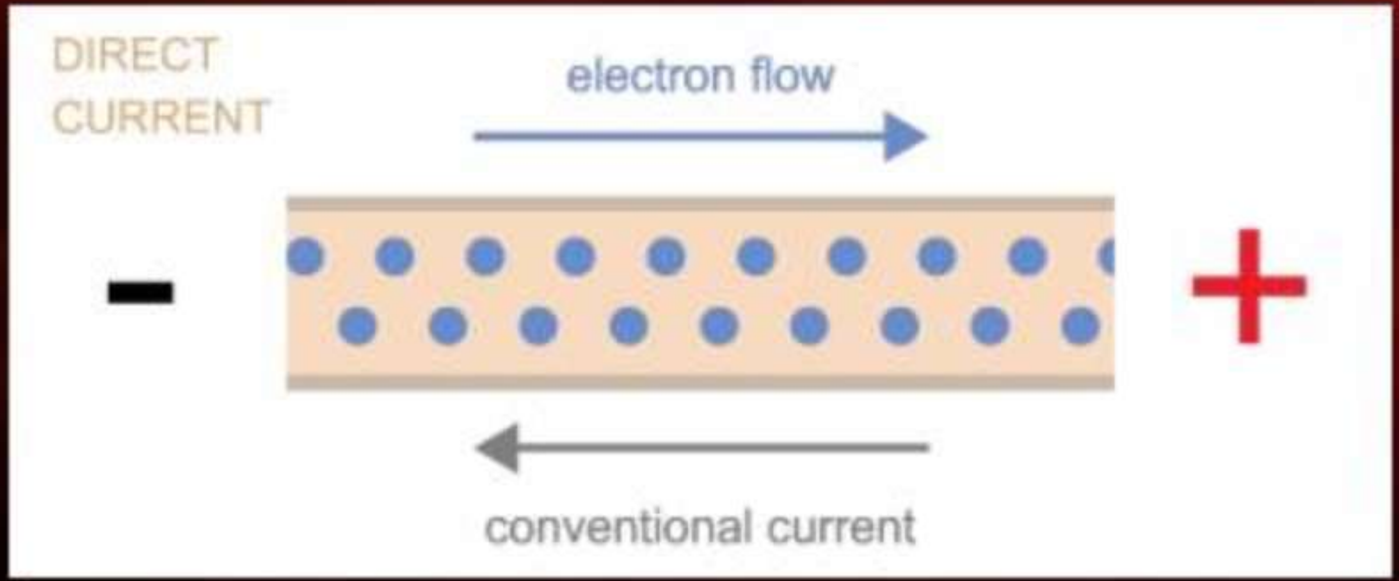
$$\boxed{\text{Current} = \frac{\text{Charge}}{\text{time}}}$$

rate of flow of charge through a cross-section of a conductor.

$$\boxed{I = \frac{Q}{t}} = \frac{ne}{t}$$

FLOW OF ELECTRIC CURRENT IN A CONDUCTOR





QUESTION

A current of 0.5 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

Given :-

$I = 0.5 A$

$t = 10 min \times 60 = 600 s$

$Q = ?$

$$I = \frac{Q}{t}$$

$$\frac{1}{2} = \frac{Q}{600}$$

$$\frac{\cancel{600}^{300}}{\cancel{2}} = Q$$

$$Q = 300 C$$

ELECTRIC CURRENT

* Electric Current is defined as the rate of flow of Charge through a cross-section of a conductor per unit time.

SI Unit of Current : ampere (A)

Que. What constitutes the electric current flowing in a conductor?

Ans. Due to some external agency (Potential Difference), free electrons present in the conductor, flow through the wire, which constitutes the flow of charge as electric current

THE CONCEPT OF VOLTAGE

Chemical Energy $\longrightarrow$ Electrical Energy

Que. Why does the electric charge flow?

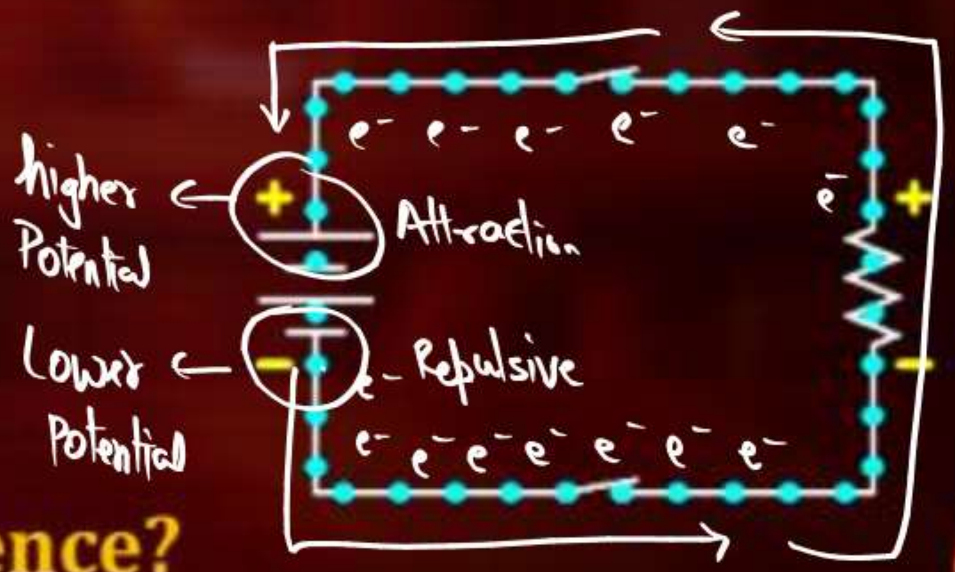
Ans. Electric Charges in a conductor flow due to presence of potential difference across the ends of the conductor, Potential difference, in other words, called Voltage.

$$V = 2\,\text{Volts} = \frac{2\ \text{Joule}}{1\ \text{coulomb}}$$

$$\boxed{\text{Voltage} = \frac{\text{Workdone}}{\text{Charge} \to 1C}}$$

$$10V = \frac{10J}{1C}, \quad 220V = \frac{220J}{1C}$$

Direction of electron motion



Que. Which entity provides the Potential Difference?

Ans. Cathode and Anode present at the ends of the Battery provides electric energy for the charge to flow in the wire.

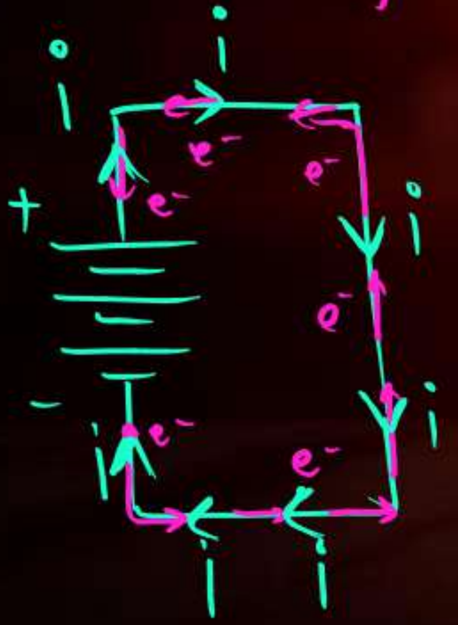
2. **Potential Difference:** The Amount of Work done required on a unit positive charge to move it from one potential point to another potential point, in other words, the work done on a charge by the battery to move it from higher potential to lower potential is called Potential Difference or VOLTAGE

higher Lower

$I \rightarrow \oplus \rightarrow \ominus$ ✓

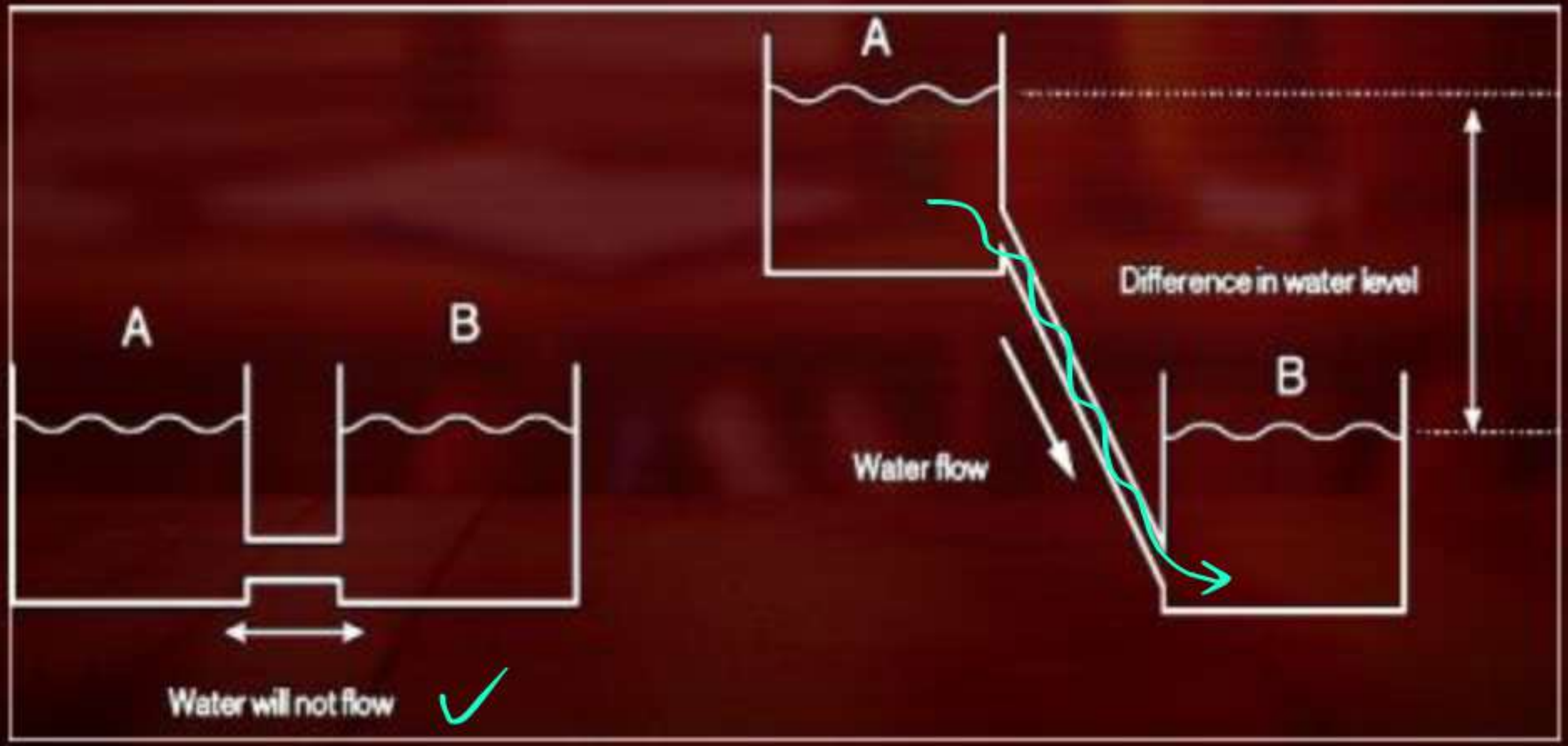
$e^- \rightarrow \ominus \rightarrow \oplus$ ×

Lower higher



Potential difference = 0

I = 0



DEFINE ONE VOLT

$V = 10V$

$= \frac{10J}{1C}$

$V = 1V$

$= \frac{1J}{1C}$

Define 1 Volt:

$Q = 1C$

When 1 Joule of Work is done on a unit positive charge to move it from one point to another point, then potential difference is said to be 1 volt

$$V = \frac{W}{Q}$$

$$1V = \frac{1J}{1C}$$

QUESTION

What is the work done required to move a charge of 2 C through a potential difference of 12 V?

Given :-

$V = 12V$

$Q = 2C$

$W = ?$

$$\boxed{V = \frac{W}{Q}}$$

$$12 = \frac{W}{2}$$

12×2

$24J = W$

ELECTRICAL CIRCUIT

Que. What is an Electric Circuit ?

Ans. A continuous and closed path made up of wires on which an electric current runs is called an electric circuit. An electric circuit consists of electric devices, a source of energy and wires that are connected with the help of a switch.

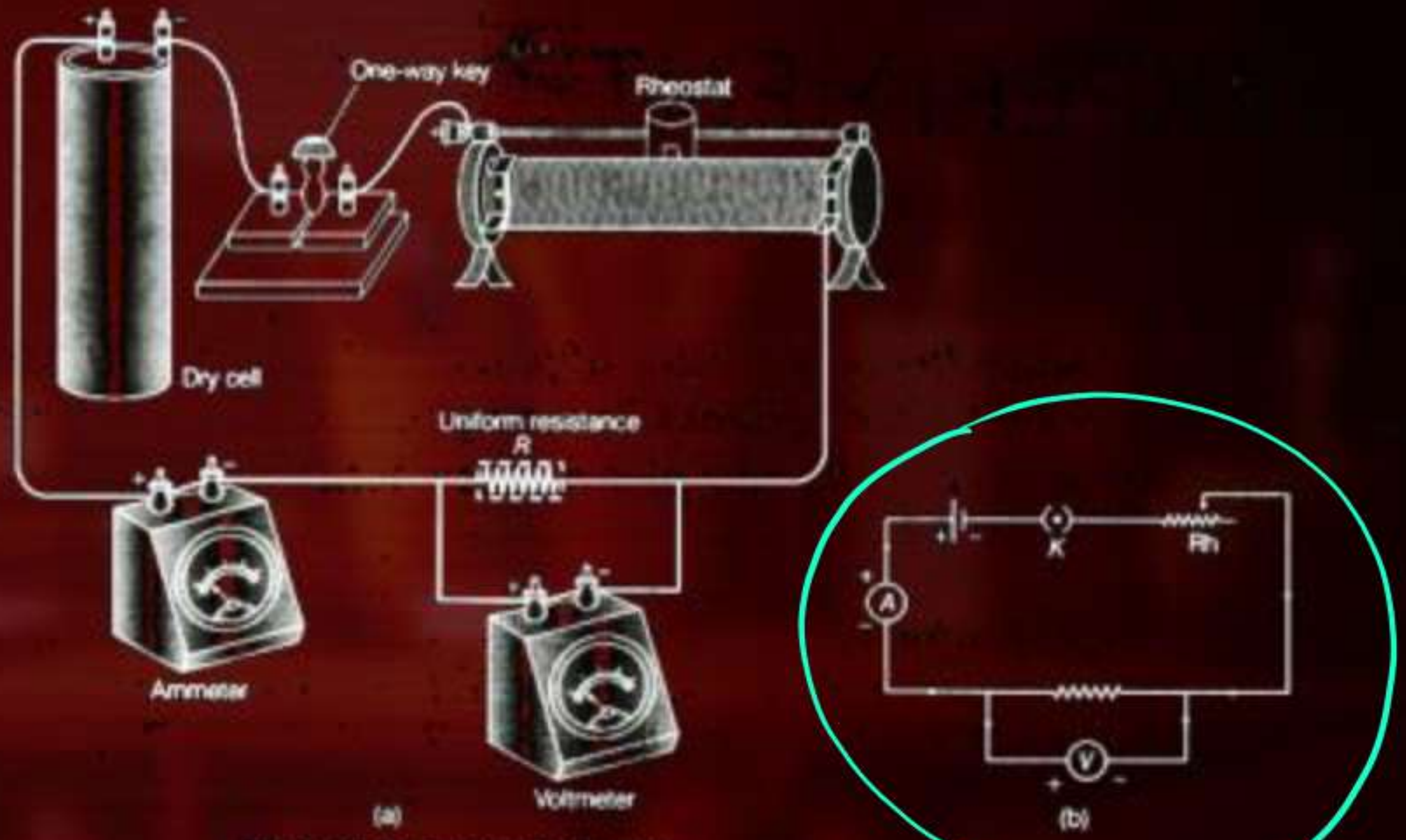


Fig.1 (a) Arrangement diagram
(b) Circuit diagram

CIRCUIT ELEMENTS

S. No.	Components	Symbols
1	An electric cell	 ✓
2	A battery or a combination of cells	 ✓
3	Plug key or switch (open)	 OFF
4	Plug key or switch (closed)	 ON
5	A wire joint	
6	Wires crossing without joining	
7	Electric bulb	 or 
8	A resistor of resistance R	
9	Variable resistance or rheostat	 or 
10	Ammeter	
11	Voltmeter	

CIRCUIT ELEMENTS

BATTERY ELIMINATORS


RESISTANCE BOX

VOLTMETER

AMMETER


PLUG KEY


RHEOSTAT


CONNECTING WIRE

AMMETER, VOLTMETER

AMMETER

→ Measures the Current in the Branch

→ Series connection

→ $R \approx 0$, Very less.

VOLTMETER

→ Measures Voltage across a device

→ Parallel connected

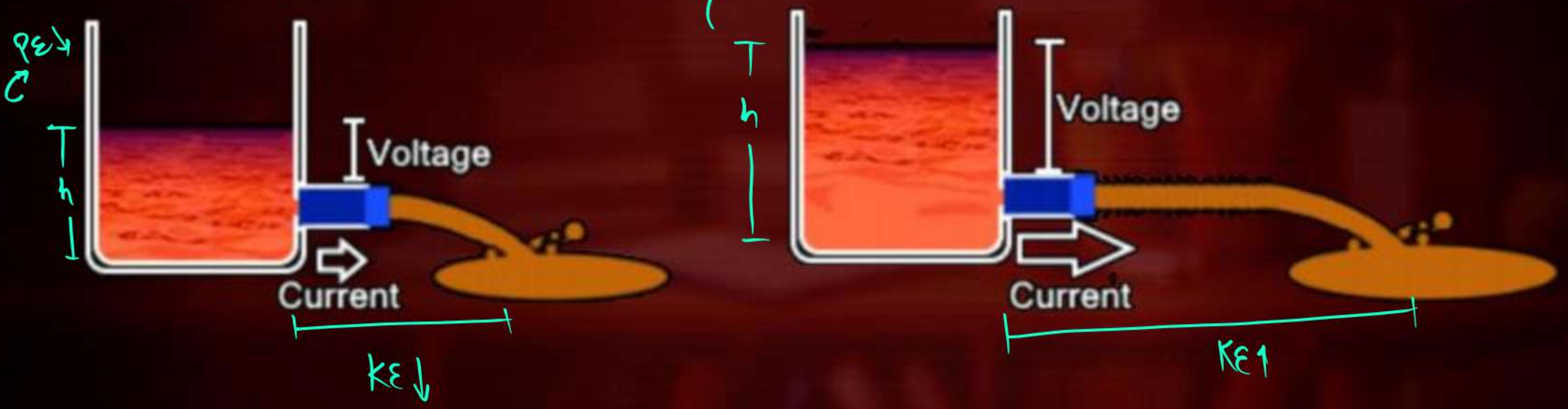
→ Resistance $\approx \infty$, V. high

OHM'S LAW

Voltage ↑ Current ↑

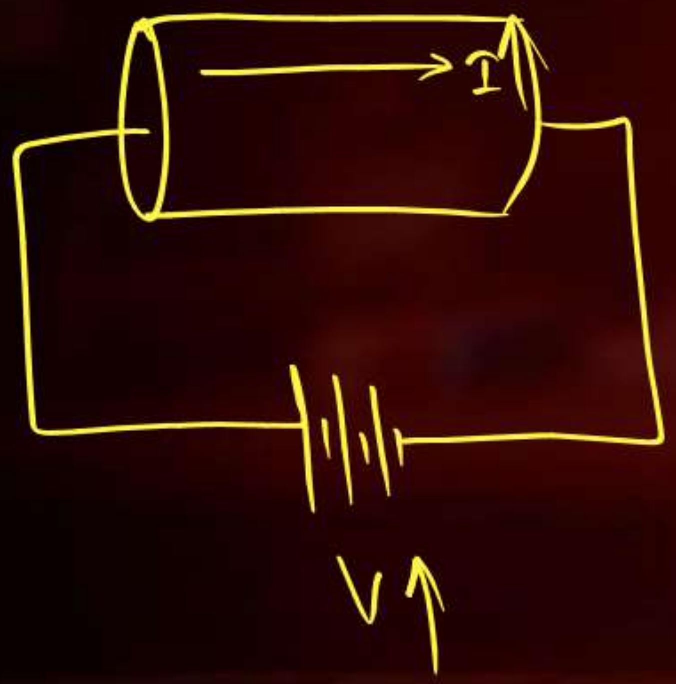
Voltage ↓ Current ↓

PE ↑



Ohm's Law - it states the current flowing through a conductor is directly proportional to potential difference across the ends of the conductor, at constant temperature.

① Conductor ✓
② Temp = const. ✓



Voltage $\propto$ Current

$$V \propto I$$

$$\boxed{V = IR}$$

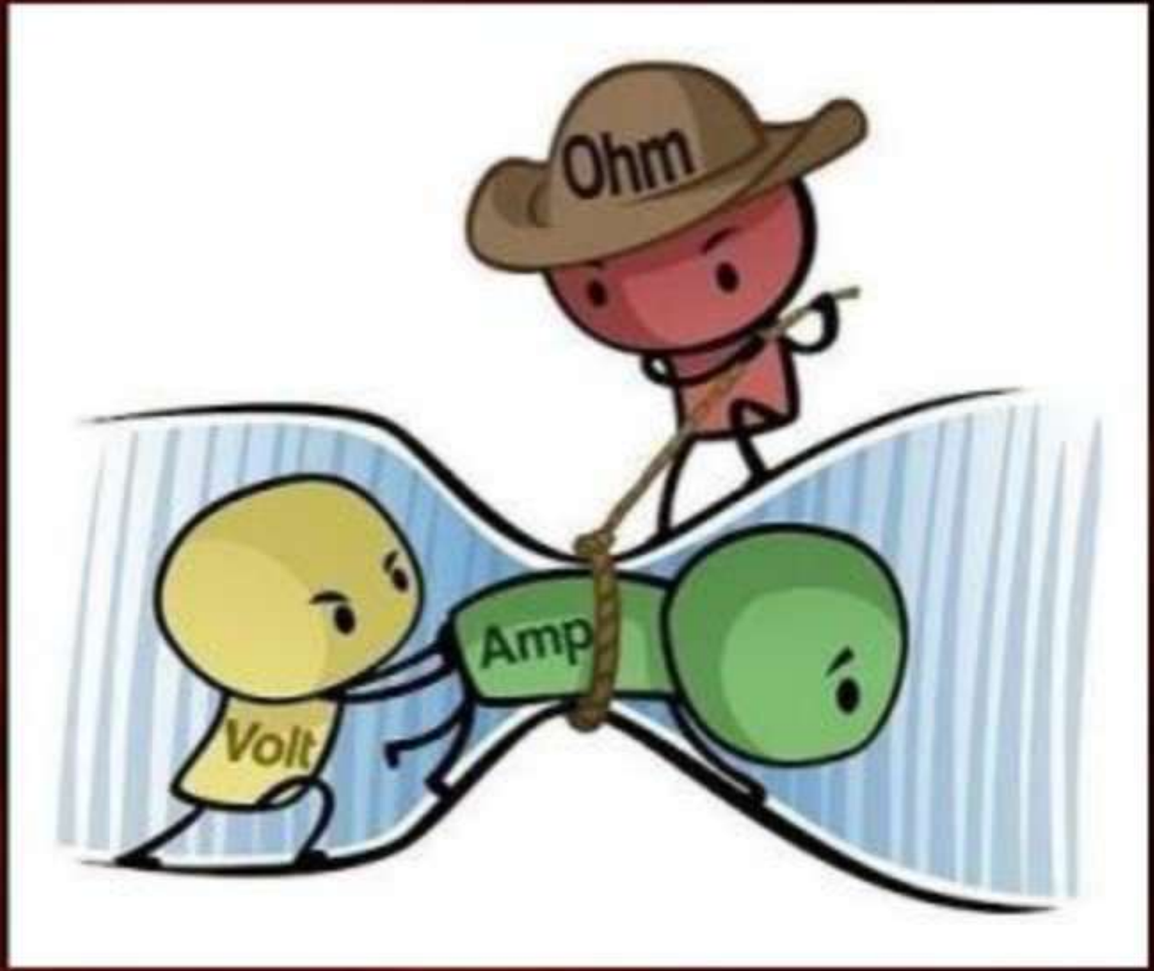
R = Resistance (constant)

RESISTANCE

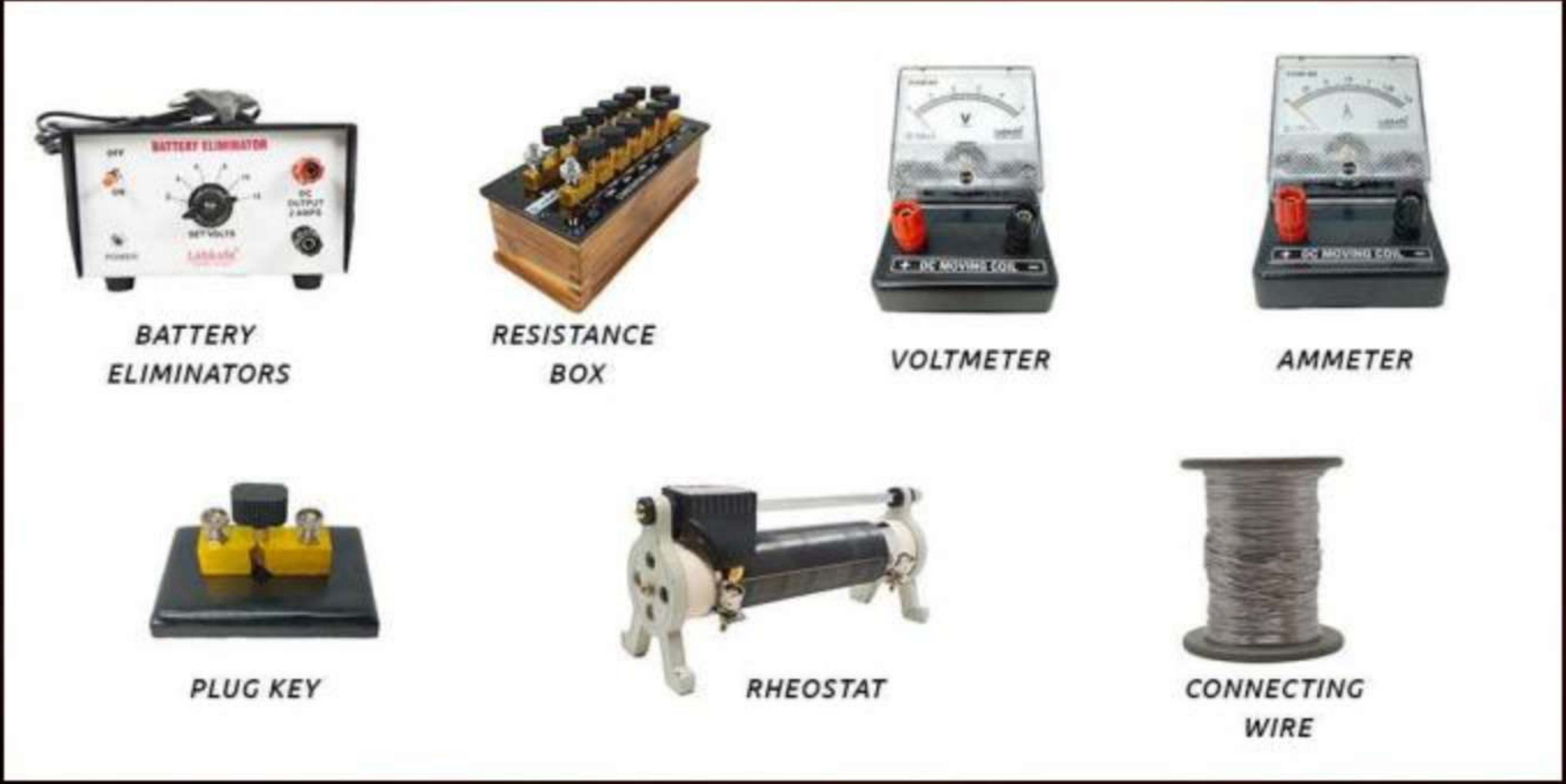
→ opposition offered by the conductor in free flow of current.

→ denoted by 'R'

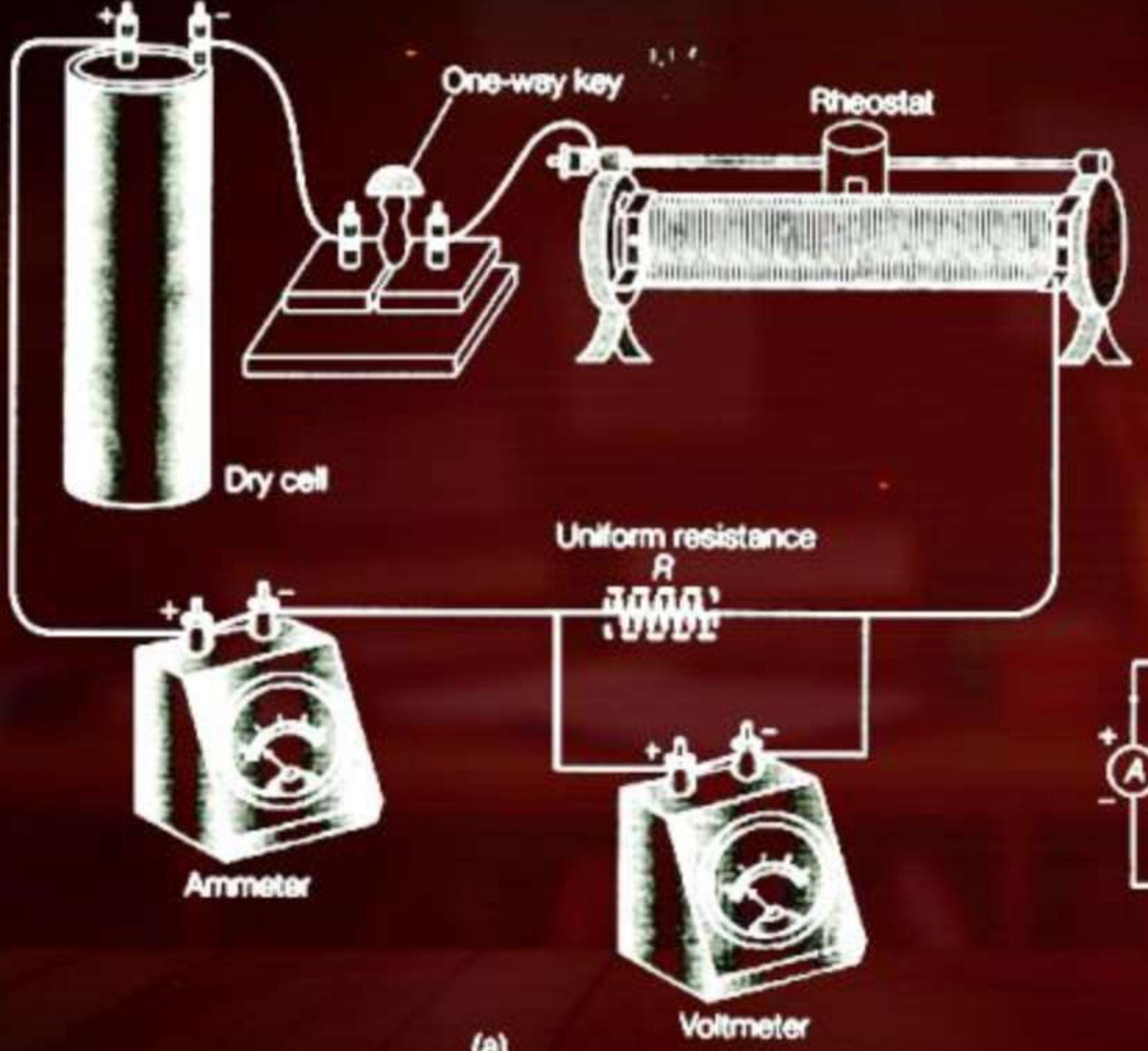
→ SI unit → ohm (Ω)



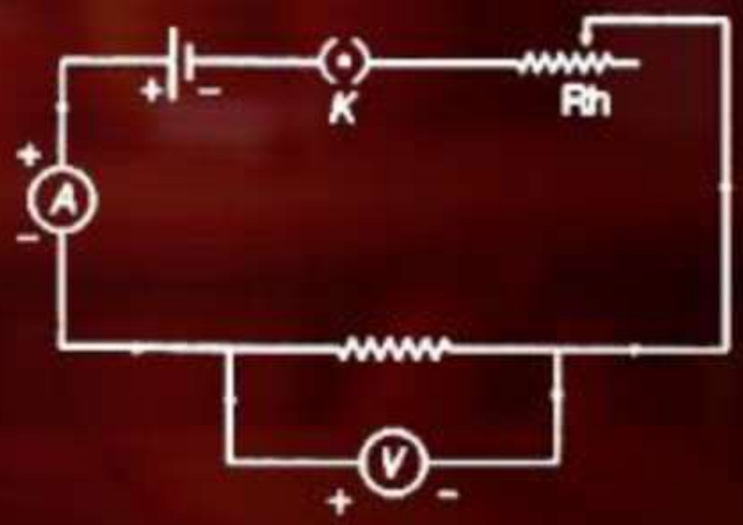
VERIFICATION OF OHM'S LAW




BATTERY ELIMINATOR
A
DC MOVING COIL
RESISTANCE BOX
V



(a)



(b)

Fig.1 (a) Arrangement diagram
(b) Circuit diagram

V-I CHARACTERISTIC CURVE/GRAPH

1 Mark

linear graph

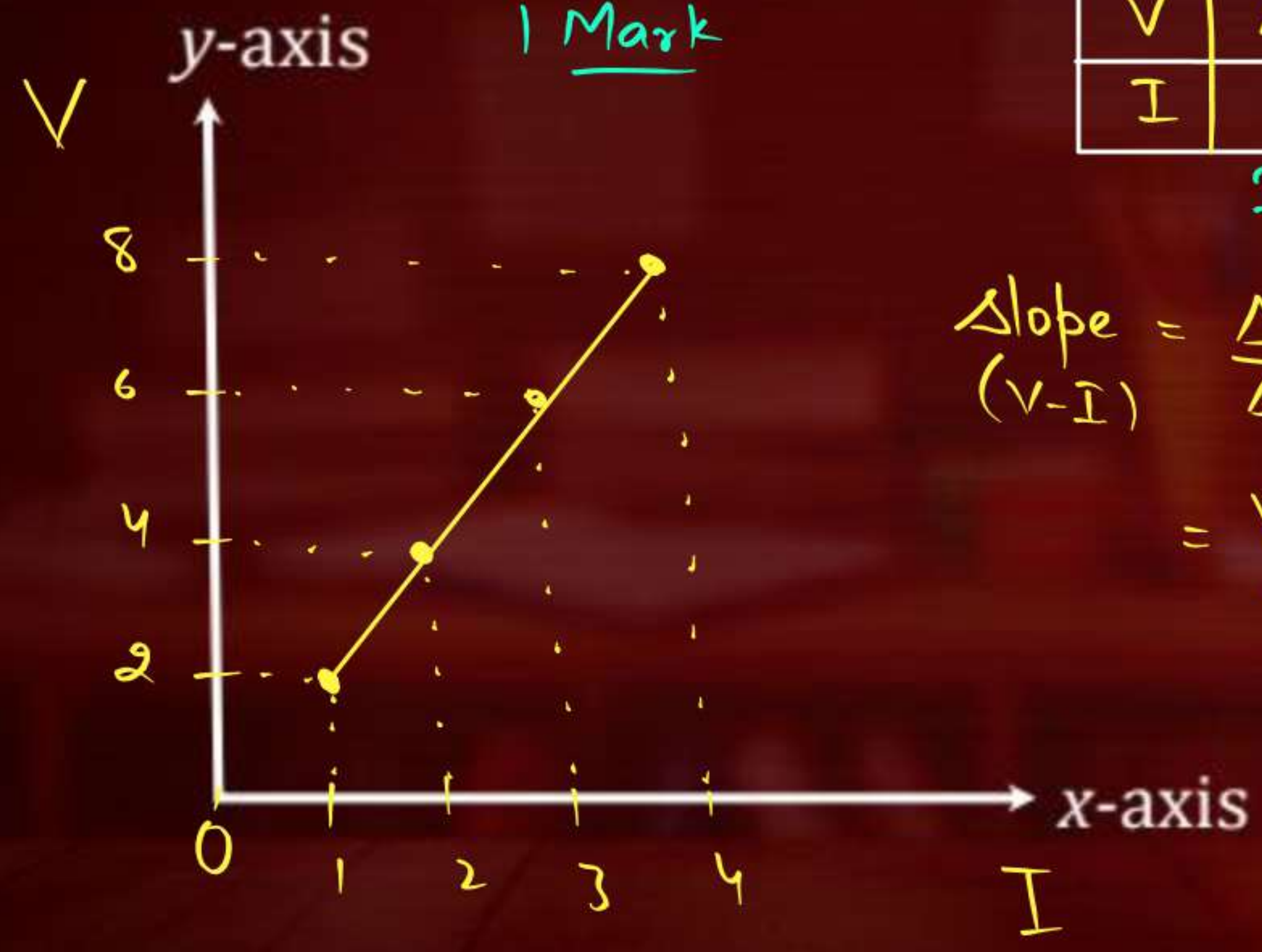
$V \propto I$

$\underline{\underline{9^{th}}}$: slope $= \dfrac{\Delta y}{\Delta x}$

$= \dfrac{y_2 - y_1}{x_2 - x_1}$

$V = IR$

Slope $\rightarrow \dfrac{V}{I} = R$
(V-I)



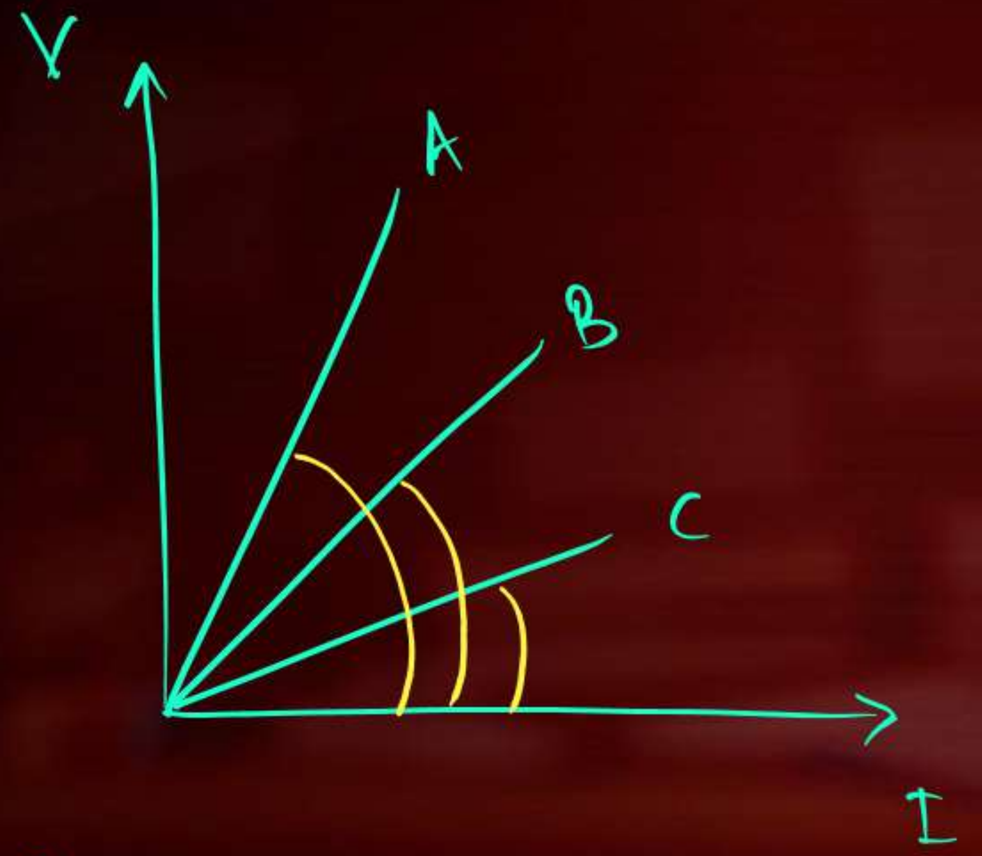
	V_1			V_2
V	2	4	6	8
I	1	2	3	4
	I_1			I_2

Slope (V-I) $= \dfrac{\Delta V}{\Delta I} = R$

$= \dfrac{V_2 - V_1}{I_2 - I_1} = \dfrac{8-2}{4-1} = \dfrac{\cancel{6}}{\cancel{3}} = 2\Omega$

1 Mark

Ex



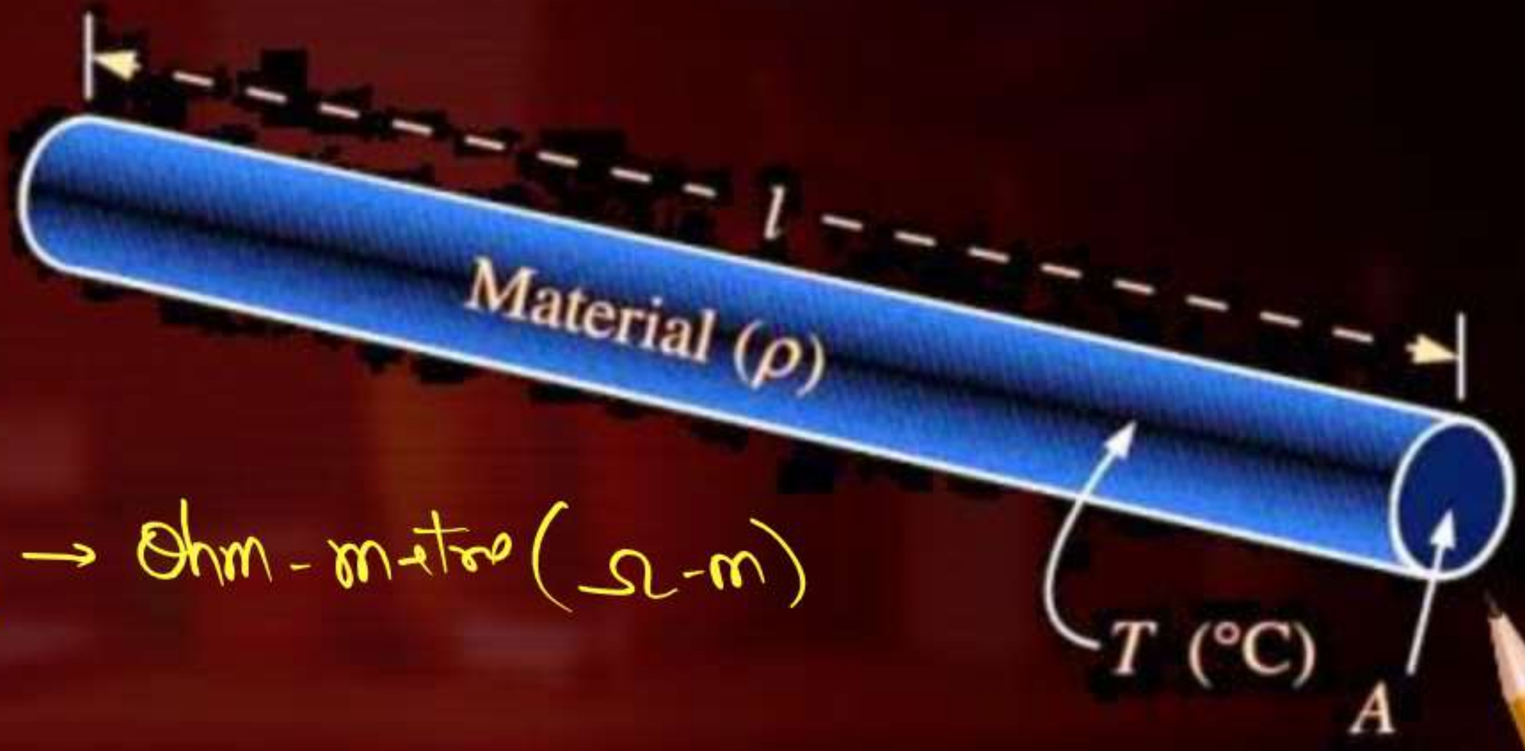
$R_A > R_B > R_C$

Ex

$R_Y > R_X$

FACTORS AFFECTING RESISTANCE

1. Length of the Wire (l) → 'm'
2. Cross-sectional Area of Wire (A) → m^2
3. Material of the Wire (ρ) → Resistivity → Ohm-metre (Ω-m)
4. Temperature



Resistance

(1) $R \propto l$

(2) $R \propto \dfrac{1}{A}$

$$R \propto \frac{l}{A}$$

$$\boxed{R = \rho \frac{l}{A}}$$

finding SI unit of 'ρ'

$$R = \rho \frac{l}{A}$$

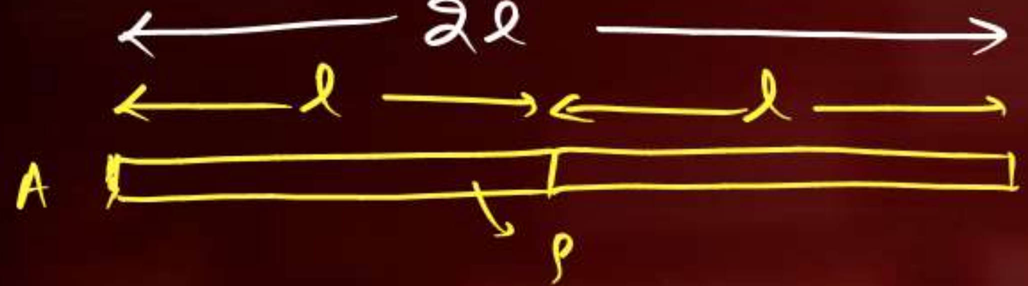
$$\Omega = \text{'}\rho\text{'} \frac{\cancel{m}}{m^{\cancel{2}}}$$

$$\Omega\text{-}m = \text{'}\rho\text{'}$$

Cases :- General :

$R = \rho \frac{l}{A}$

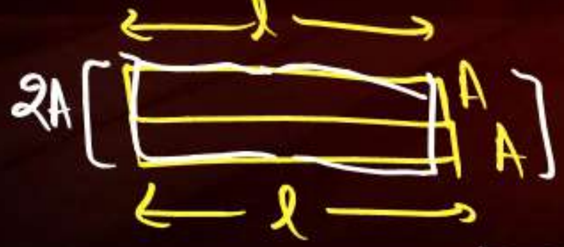
(1)



$R' = \rho \frac{2l}{A} = 2\left(\rho \frac{l}{A}\right)$

$\boxed{R' = 2R}$

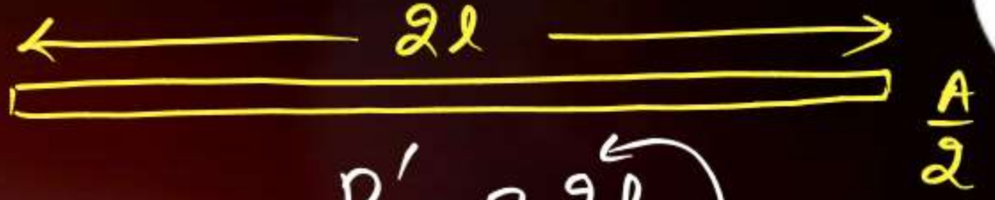
(2)



$R' = \rho \frac{l}{2A} = \frac{1}{2}\left(\rho \frac{l}{A}\right) = \frac{R}{2}$

$\boxed{R' = \frac{R}{2}}$

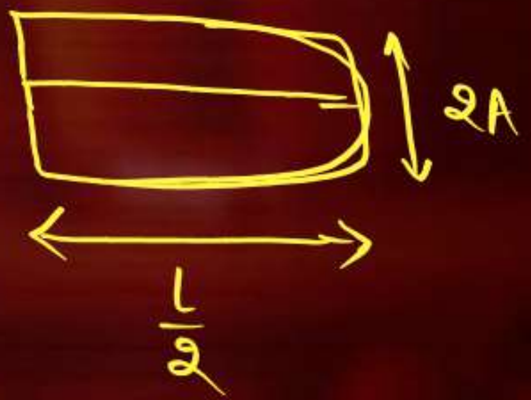
(3) Stretched to twice its length



$R' = \rho \frac{2l}{\frac{A}{2}} = 4\left(\rho \frac{l}{A}\right)$

$\boxed{R' = 4R}$

(4)



$R' = \rho \frac{L}{2(2A)}$

$= \frac{1}{4}\left(\rho \frac{L}{A}\right)$

$\boxed{R' = \frac{R}{4}}$

Ex-5

$r \longrightarrow 2r$

$A \longrightarrow 4A$

$R \longrightarrow \frac{R}{4}$

$R\downarrow \propto \frac{1}{A\uparrow}$

Ex-6

$d \longrightarrow \frac{d}{2}$

$r \longrightarrow \frac{r}{2}$

$A \longrightarrow \frac{A}{4}$

$R \longrightarrow 4R$

DIFFERENCE BETWEEN

RESISTANCE (R) → ohm	RESISTIVITY (ρ) → ohm-metre
→ Opposition offered by the conductor in the path of current flow.	→ property of a material to offer resistance in the flow of current
→ depends on length, Area of cross-section, material, temperature	→ depends on Nature of the material and temperature
$\rho \uparrow R \uparrow$	$T \uparrow \rho \uparrow$

RESISTIVITY OF ELECTRICAL SUBSTANCES

ρ
Low → Conductor
High → Insulator

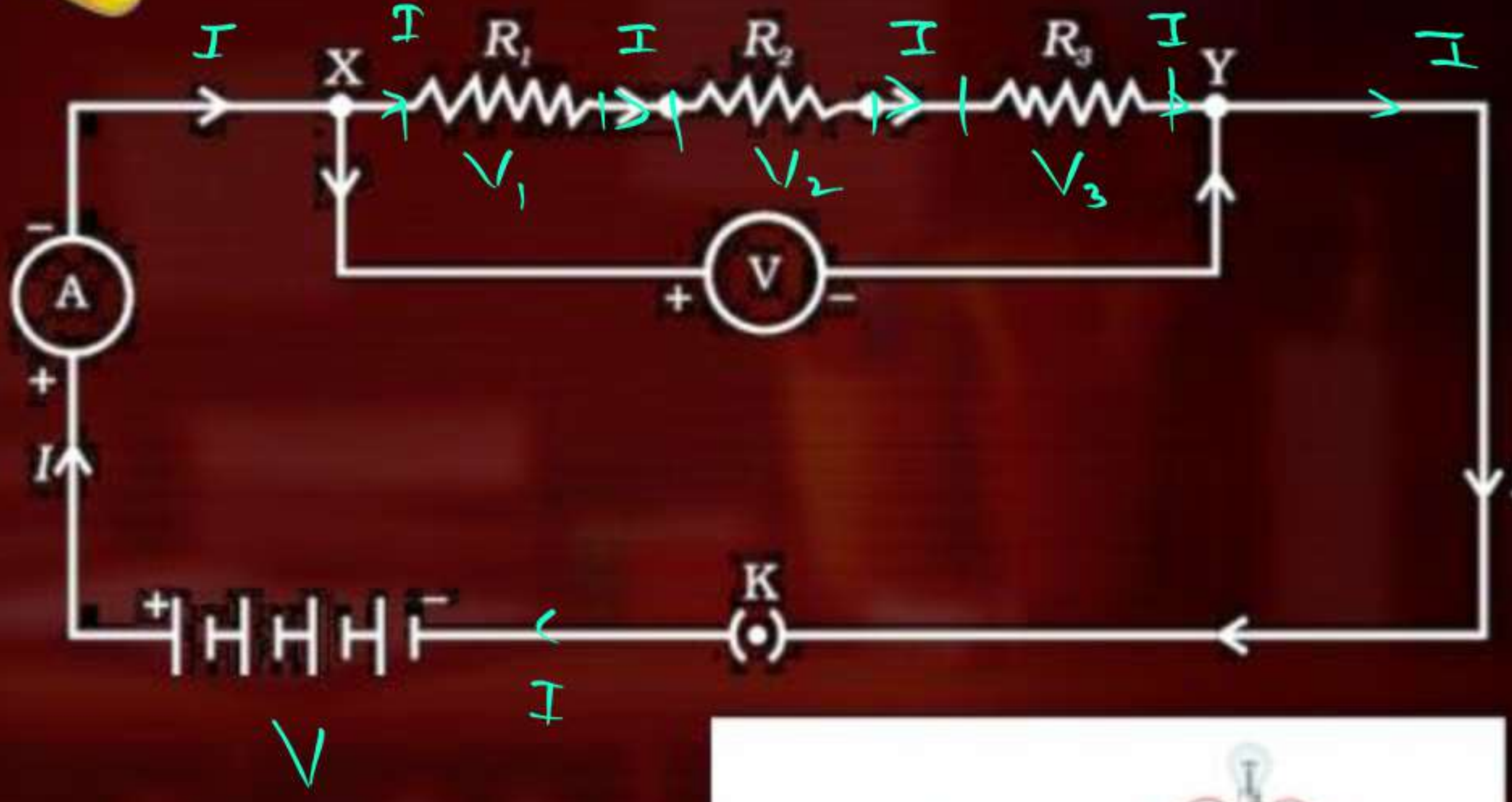
	Material	Resistivity (Ω m)
Conductors $\rho \downarrow\downarrow$	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
Alloys $\rho \to$ Med	Constantan (alloy of Cu and Ni)	49×10^{-6}
	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
Insulators $\rho \uparrow\uparrow$	Glass	$10^{10} - 10^{14}$
	Hard rubber	$10^{13} - 10^{16}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$
	Paper (dry)	10^{12}

SERIES CIRCUIT

i = Same

V = divide

Derivation



$$V = V_1 + V_2 + V_3$$

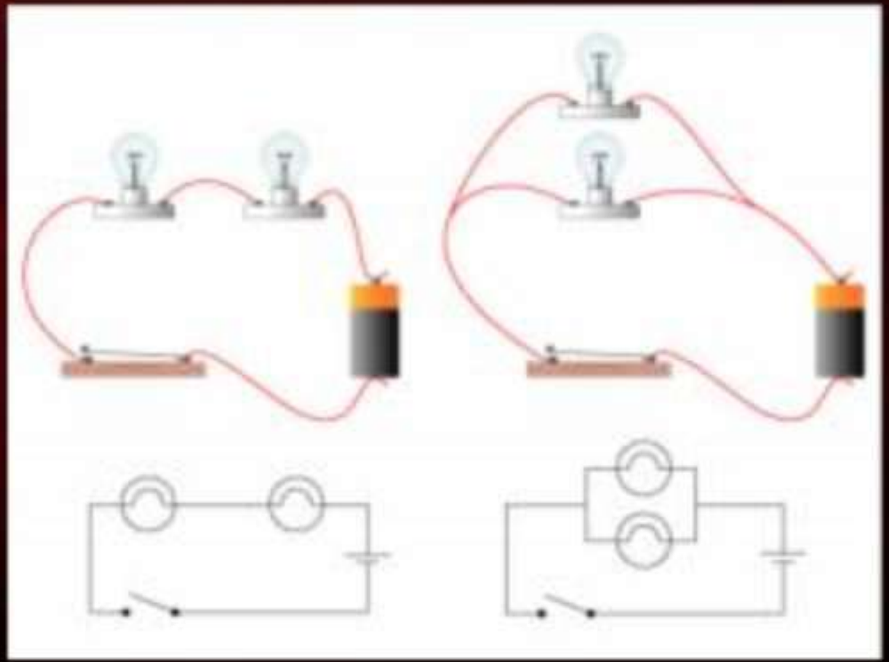
$$(V = IR)$$

$$IR_t = IR_1 + IR_2 + IR_3$$

$$\cancel{I}R_t = \cancel{I}(R_1 + R_2 + R_3)$$

Series

$$\boxed{R_t = R_1 + R_2 + R_3}$$



PARALLEL CIRCUIT

$i \rightarrow$ divide

$V \rightarrow$ Same

Derivation :-

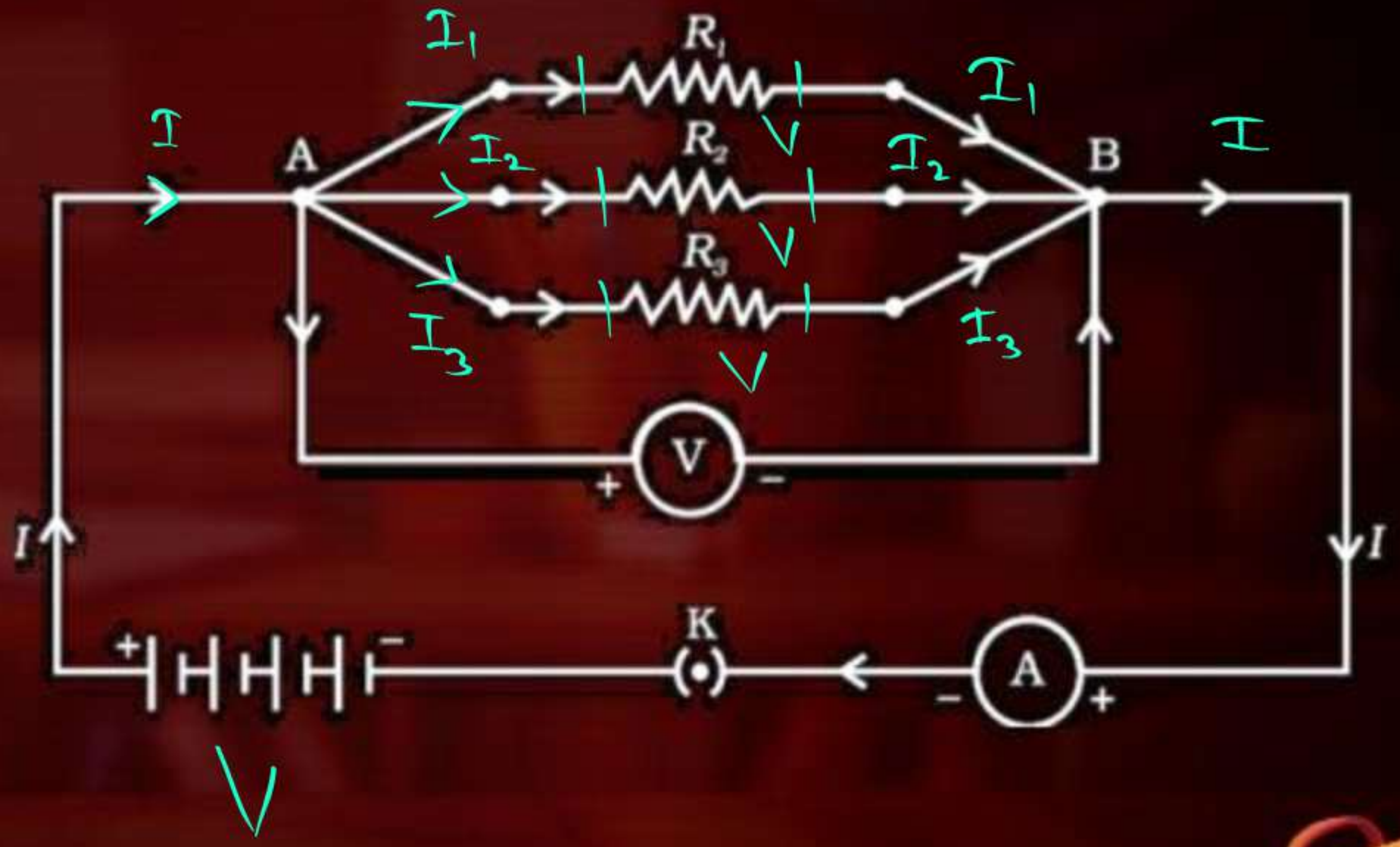
$$I = I_1 + I_2 + I_3$$

$$\left(V = IR, \quad I = \frac{V}{R} \right)$$

$$\frac{V}{R_t} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{\cancel{V}}{R_t} = \cancel{V}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)$$

Parallel $\leftarrow$ $\boxed{\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$



Shortcut

\# 

.... $R_{Max} = 20\,\Omega$

\# 

R_{Min}

$$\frac{1}{R_t} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} + \frac{1}{9}$$

$$\frac{1}{R_t} = \frac{9+6+3+2}{18} = \frac{\cancel{20}^{\,10}}{\cancel{18}_{\,9}}$$

$$R_t = \frac{9}{10} = 0.9\,\Omega$$

\# Series

Bade Waale se Bhi Bada

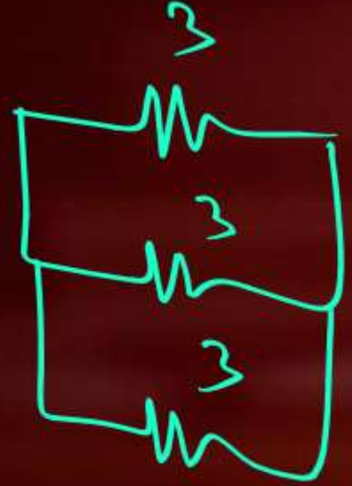
\# Parallel

Chote Wale se Bhi Chota

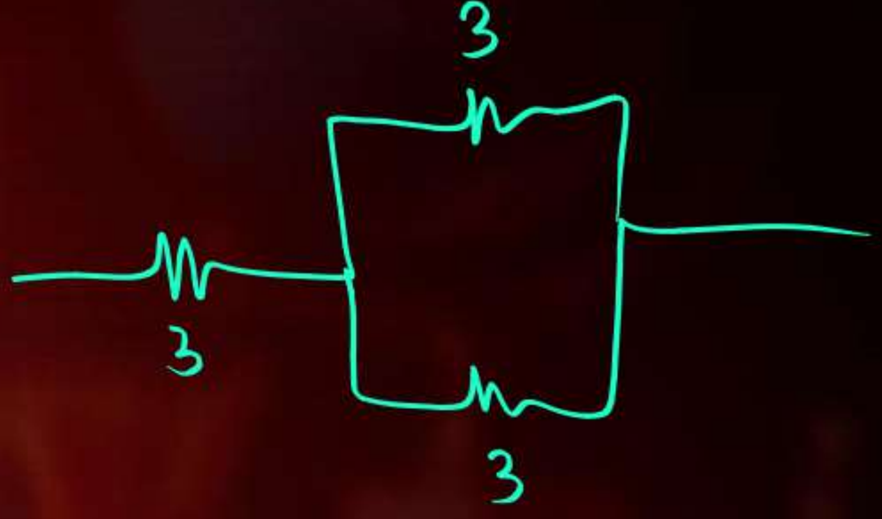
Jugaad

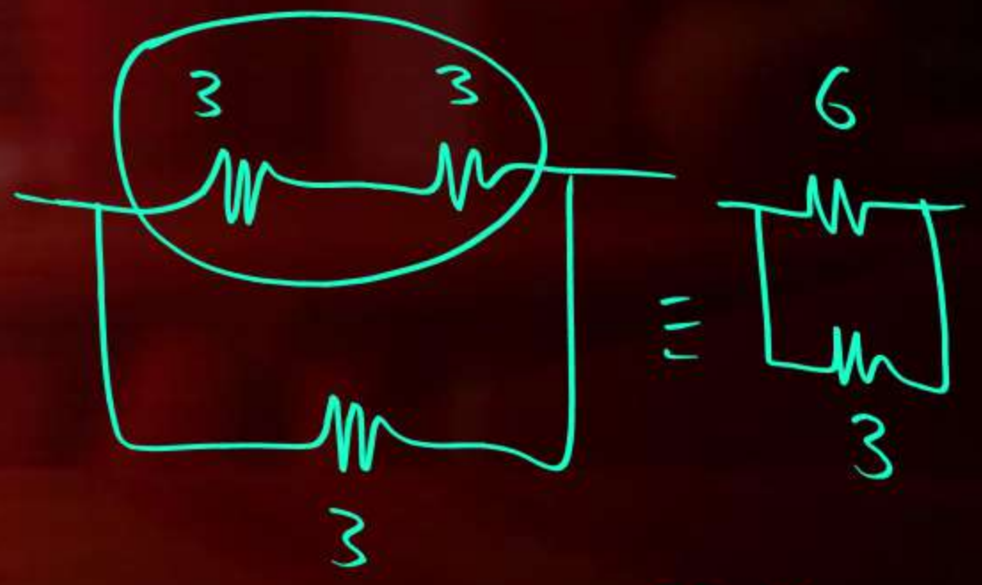
a) 4.5Ω   b) 2Ω $3 + \frac{3}{2} = 4.5\,\Omega$

≡ 9Ω



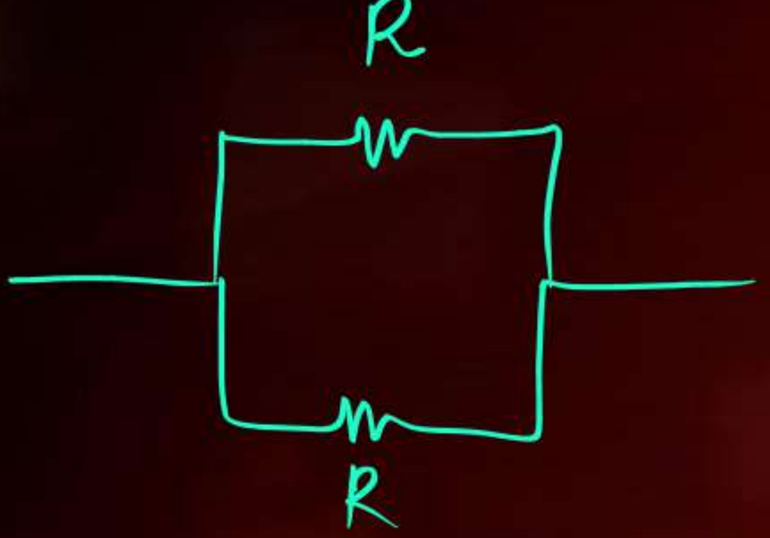
≡ 1Ω



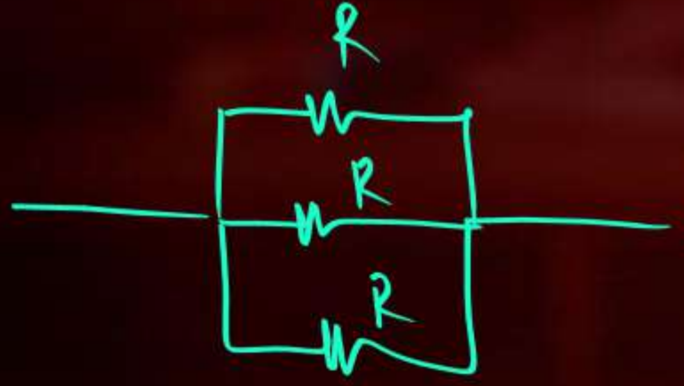


≡ 2Ω

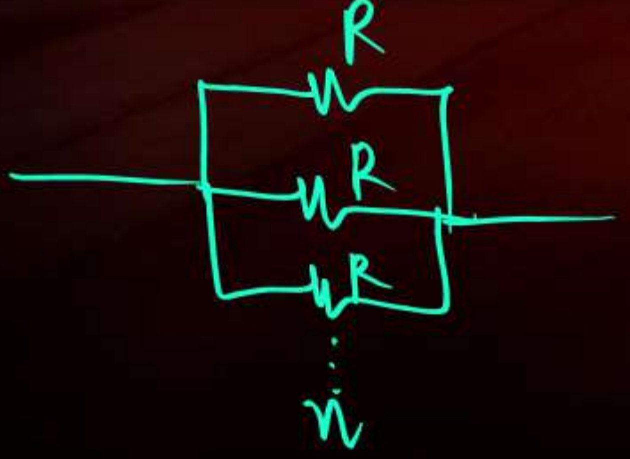
Jugaad



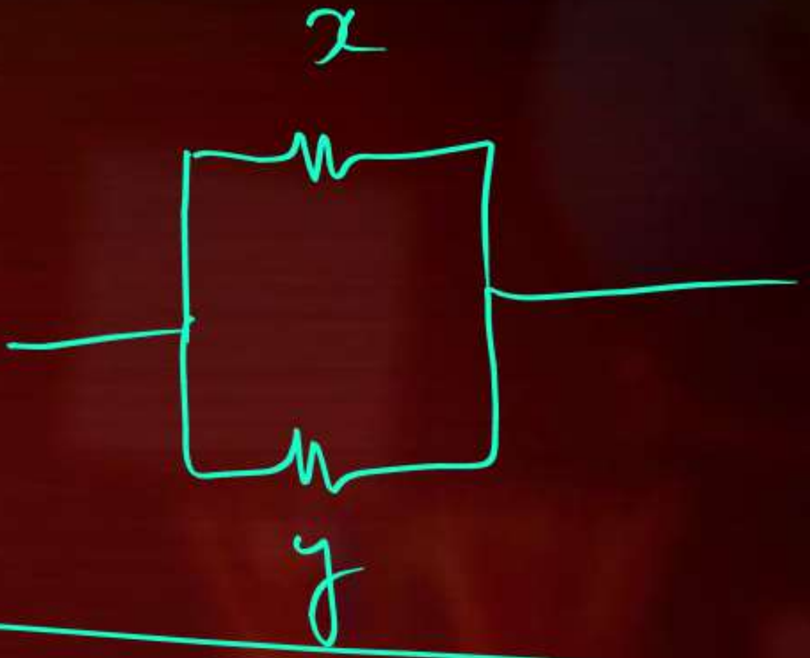
$\equiv \frac{R}{2}$



$\equiv \frac{R}{3}$

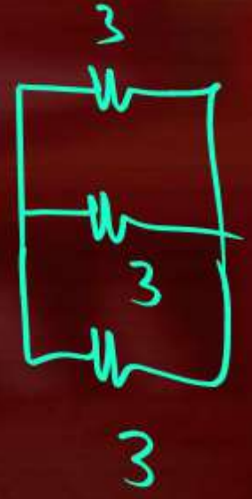


$\equiv \frac{R}{n}$



$\equiv \frac{xy}{x+y}$

Practice



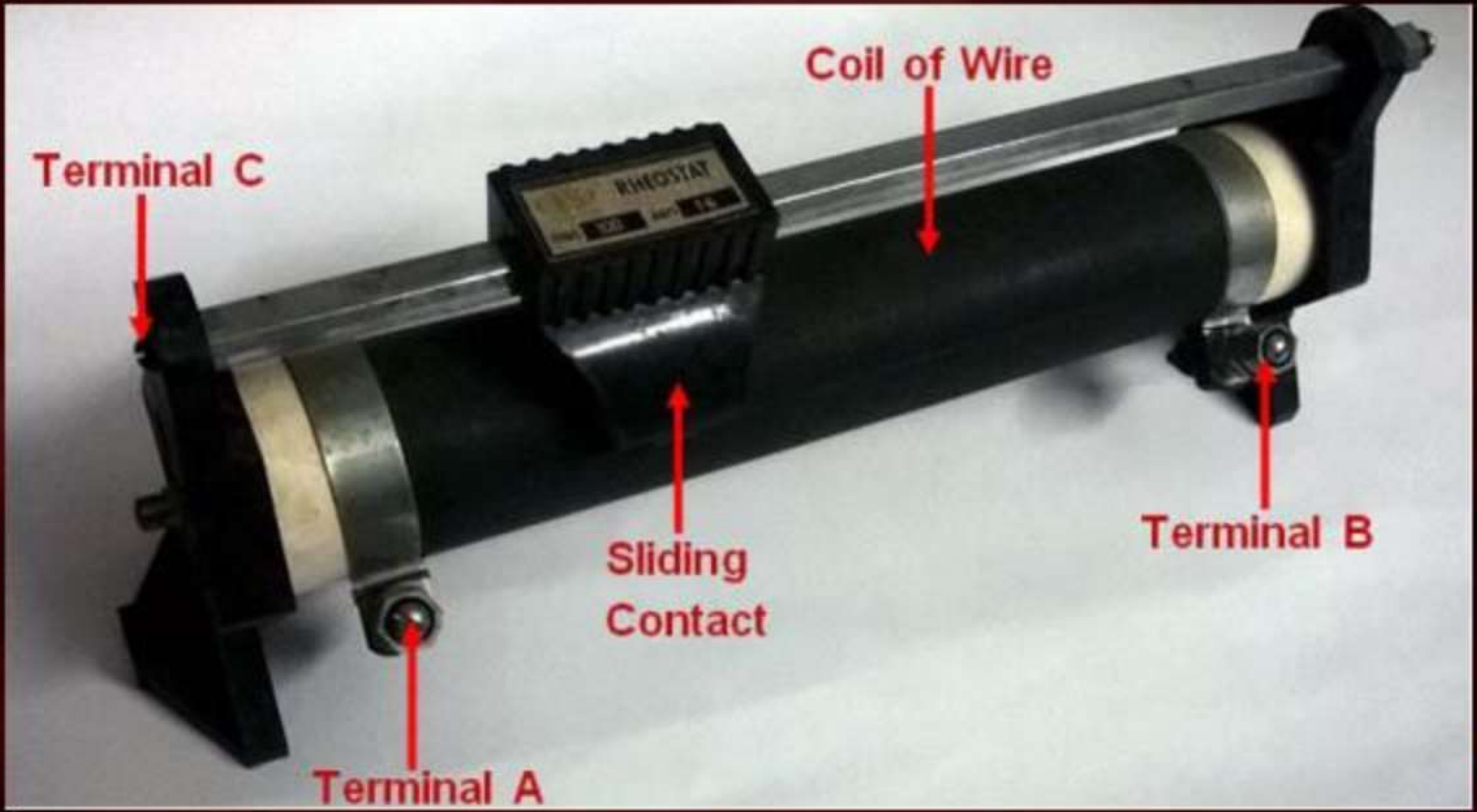
$\equiv \frac{R}{3} = \frac{\cancel{3}}{\cancel{3}}$

$= 1\Omega$

$\equiv \frac{6\times 3}{6+3} = \frac{\cancel{18}^{2}}{\cancel{9}}$

$= 2\Omega$

WORKING OF RHEOSTAT



THREE EFFECTS OF CURRENT

1. **Chemical Effects of Current :** When Electric current is passed through the conducting solution, it causes chemical reactions to occur on cathode and anode. Example electroplating, Hydrolysis, Formation of Sodium Hydroxide (NaOH) (Class VIII and Class XII Electrochemistry)

2. **Magnetic Effects of Current :** When electric current is passed through a conductor, magnetic field is produced in the area around the conductor (Class X, Chapter 13)

3. **Heating Effects of Current :** When current is passed through a conductor, due to repetitive collisions between moving charges and atoms, heat energy and power is dissipated. (Class X, Chapter 12)

JOULE'S LAW OF HEATING

$H \propto i^2$
$\propto R$
$\propto t$

It states that, "Heat produced in a conductor is directly proportional to the square the amount of Current flowing(I), Resistance(R) of the conductor, Time Period (T) of the flow of current".

$\boxed{H = i^2 R t}$ ✓

* **Proof of Joule's Law:-**

$V = \frac{W}{Q}$

$W = QV$

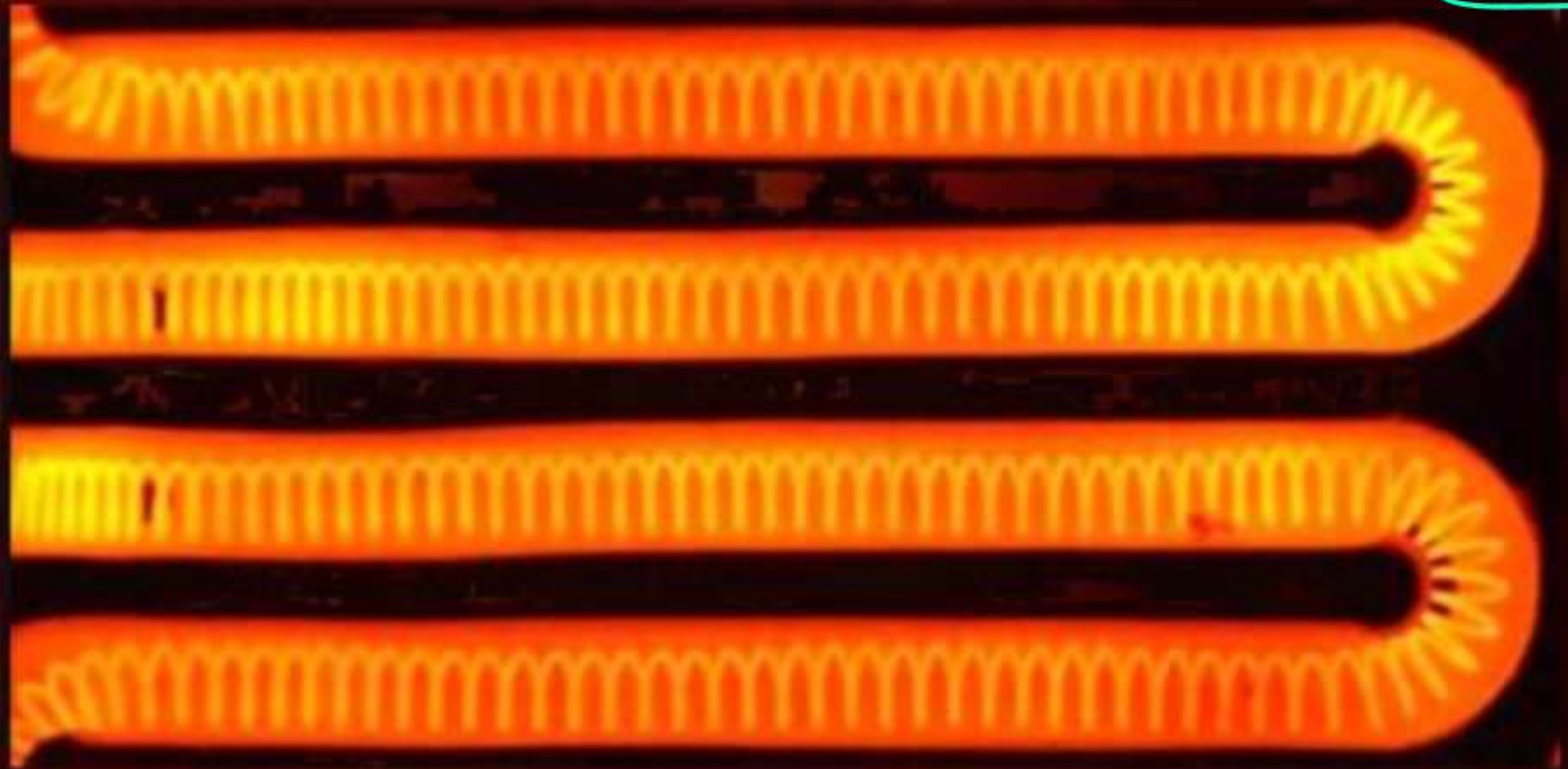
$W = It\,IR$

$\boxed{E = I^2 R t}$

$I = \frac{Q}{t}$

$(V = IR,\ Q = It)$

$\boxed{H = I^2 R t}$



QUESTION

An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Given :-

$R = 20\,\Omega$

$i = 5\,A$

$t = 30\,s$

$H = ?$

$H = i^2 R t$

$= 5^2 \times 20 \times 30$

$= 25 \times 20 \times 30 = 15000\,J$

QUESTION

100 J of heat are produced each second in a 4 Ω resistance. Find the potential difference across the resistor.

PRACTICAL APPLICATIONS OF HEATING EFFECTS

1. Electric Bulb:

→ Tungsten (filament)

↓

Pure Metal (M.P. - 3380°C)

↓

Glow ← heat retention

→ Argon (Noble gas)

2. Electric Fuse: → Sn-Pb Alloy ✓

Cu-Ni Alloy ✓

i → [o—o] → i

→ fuse wire → M.P. low

↓

When current exceeds a certain value

↑

Melts and breaks the ckt

3. Heating Element: → Nichrome Alloy

Alloys ρ↑ R↑ H↑ ✓

QUESTION

Which ~~element~~ substance is used to make:

(A) Filament of the bulb ⟶ Tungsten

(B) Connecting Wires ⟶ Copper / Aluminium

(C) Heating Element ⟶ Nichrome Alloy

(D) Fuse Wire ⟶ Sn-Pb Alloy

QUESTION

Why does the cord of the electric heater does not glow but coil does ?

ELECTRICAL POWER

*** Derivation**

$$P = \frac{W}{t}$$

$$V = \frac{W}{Q} \rightarrow W = QV$$

$$P = \frac{QV}{t}$$

(1) General formula ← * $\boxed{P = VI}$

9th $\boxed{P = \frac{W}{t} = \frac{E}{t}}$ → use $E = P \times t$

$$P = VI$$

$V = IR$ → $P = IRI$

$$\boxed{P = I^2R}$$

(2) Series

$I = \frac{V}{R}$ → $P = V\frac{V}{R}$

$$\boxed{P = \frac{V^2}{R}}$$

(3) Parallel

Electrical Energy

$$P = \frac{\mathcal{E}}{t}$$

$$\boxed{\mathcal{E} = P \times t}$$

$$\mathcal{E} = VIt \quad \text{— (1)}$$

$$\mathcal{E} = I^2Rt \quad \text{— (2)}$$

$$\mathcal{E} = \frac{V^2}{R}t \quad \text{— (3)}$$

Joule's Law

$$P = VI$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

QUESTION

Which has more resistance a 100 W bulb or a 60 W bulb?

$\times$ 100 W $\rightarrow R\downarrow$

$\checkmark$ 60 W $\rightarrow R\uparrow$

$P = \frac{V^2}{R}$ $V^2 \rightarrow$ Const.

$P\downarrow \propto \frac{1}{R\uparrow}$

$P = 100\,W$

$R = 484\,\Omega$

$V = 220\,V$

$R = ?$

$$\boxed{P = \frac{V^2}{R}}$$

$$100 = \frac{220 \times 220}{R}$$

$$R = \frac{22\cancel{0} \times 22\cancel{0}}{1\cancel{00}} = 484\,\Omega$$

$P = 60\,W$

$R = 806.6\,\Omega$

$V = 220\,V$

$R = ?$

$$P = \frac{V^2}{R}$$

$$60 = \frac{220 \times 220}{R}$$

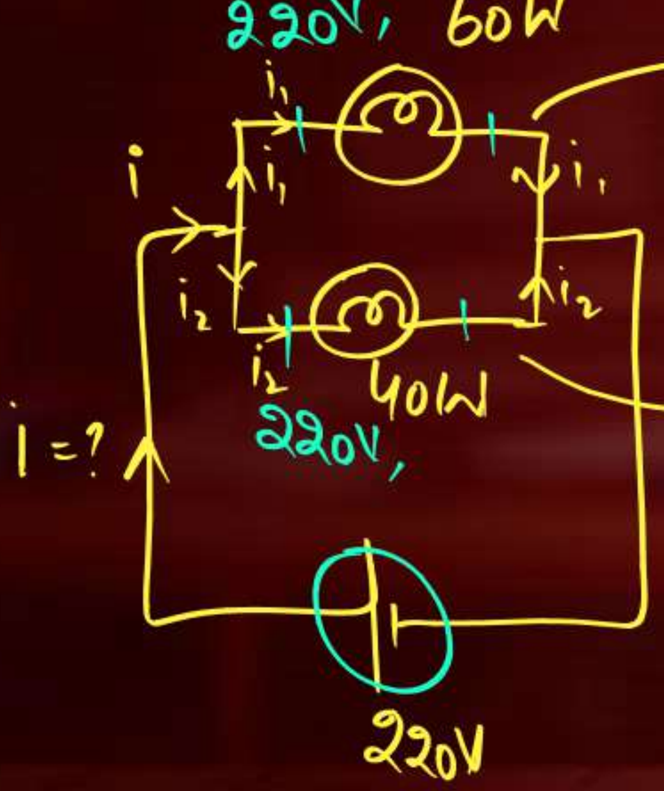
$$R = \frac{220 \times 22\cancel{0}}{6\cancel{0}} = \frac{\cancel{4840}}{\cancel{6}\,3}$$

$\cancel{2420}$

$806.6\,\Omega$

QUESTION

A 60 W and a 40 W bulb is connected (in parallel) across a battery of 220 V, find the amount of current flowing in the circuit.



$$P = V i_1$$

$$60 = 220 \times i_1 \longrightarrow i_1 = \frac{60}{220}\,A$$

$$P = V i_2$$

$$40 = 220 \times i_2 \longrightarrow i_2 = \frac{40}{220}\,A$$

$$i = i_1 + i_2$$

$$= \frac{60}{220} + \frac{40}{220} = \frac{\overset{5}{\cancel{100}}}{\underset{11}{\cancel{220}}} = \frac{5}{11}\,A$$

QUESTION

A bulb having power rating as 60 W, 220 V is connected across 110 V, how much power will be expended by the bulb?

$P = \frac{V^2}{R}$

$60 = \frac{220 \times 220}{R}$

$R = \frac{220 \times 220}{60}\ \Omega$

$P = Vi$

$60 = 220 \times i$

$i = \frac{60}{220}\ A$

$\frac{i}{2} = \frac{30}{220}\ A$

$P = Vi$

$P' = 110 \times \frac{30}{220}$

$P' = 15W$

$P' = \frac{V^2}{R} = \frac{(110)^2}{\frac{220 \times 220}{60}}$

$= \frac{110 \times 110 \times 60}{220 \times 220} = 15\,W$

COMMERCIAL UNIT OF ENERGY

Energy $= P \times t$

- SI unit → Joule
- CGS unit → ergs
- Practical unit (Heat) → Calorie
- Commercial Unit (Trade) → Kilowatt hour (KWh)

$$\underbrace{\text{Kilowatt}}_{P} \times \underbrace{\text{hour}}_{t}$$

$$\boxed{1\ \text{kWh} = 3.6 \times 10^{6}\ \text{J}}$$

QUESTION

An electric refrigerator rated 400 W operates 8 hour/day. What is the cost of the energy to operate it for 30 days at Rs 3.00 per kWh?

$P = 400\,W = \frac{4\cancel{00}}{10\cancel{00}}\,kW = 0.4\,kW$

$t = 8h \times 30 = 240h$ ✓

$\boxed{E = P \times t}$

$= \frac{0.4 \times 24\cancel{0}}{1\cancel{0}}$

$E = 96\,kWh$

$1\,kWh \longrightarrow ₹3$

$96\,kWh \longrightarrow 96 \times 3$

$= ₹288$


THANK
YOU