LIGHT REFLECTION AND REFRACTION

ONE SHOT ✗

GUN-SHOT ✓

100% PAPER यहीं से आएगा !!

LIGHT REFLECTION AND REFRACTION

REFLECTION - CONCAVE & CONVEX MIRROR

CONCAVE & CONVEX LENS

REFRACTION - R.I. & SNELL 'S LAW

20+ PYQS

Reflection of Light

The bouncing back of light when it hits a polished surface like mirror.

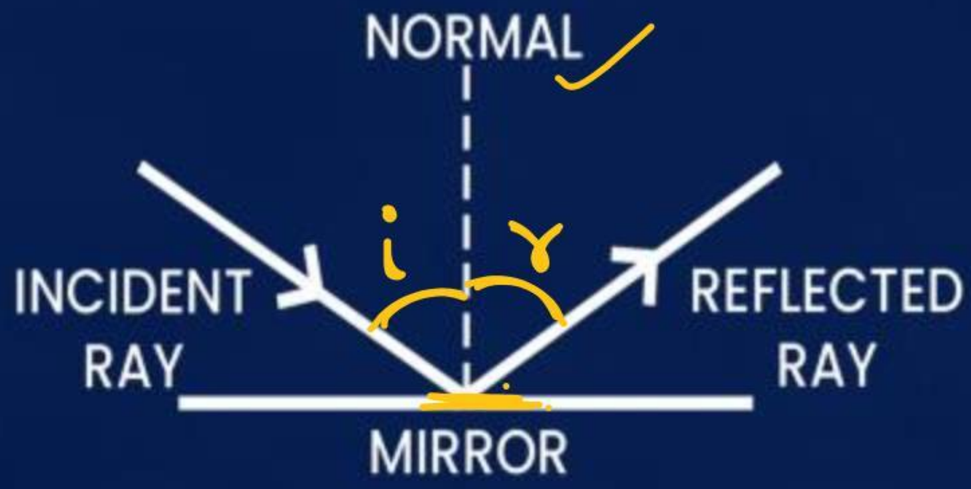
Laws of Reflection

Reflection

1. $\angle i = \angle r$

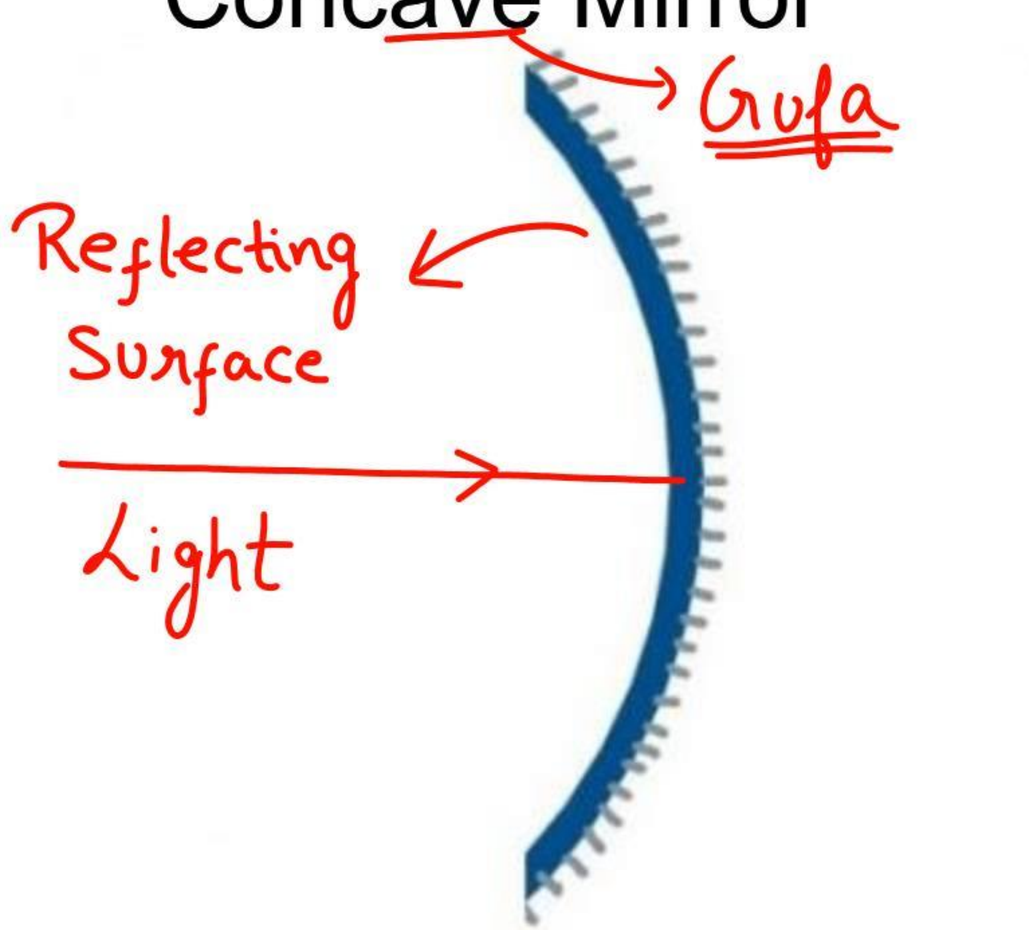
   Angle of incidence = Angle of reflection

2. The incident ray , the reflected ray & the normal , all lie in the same plane.



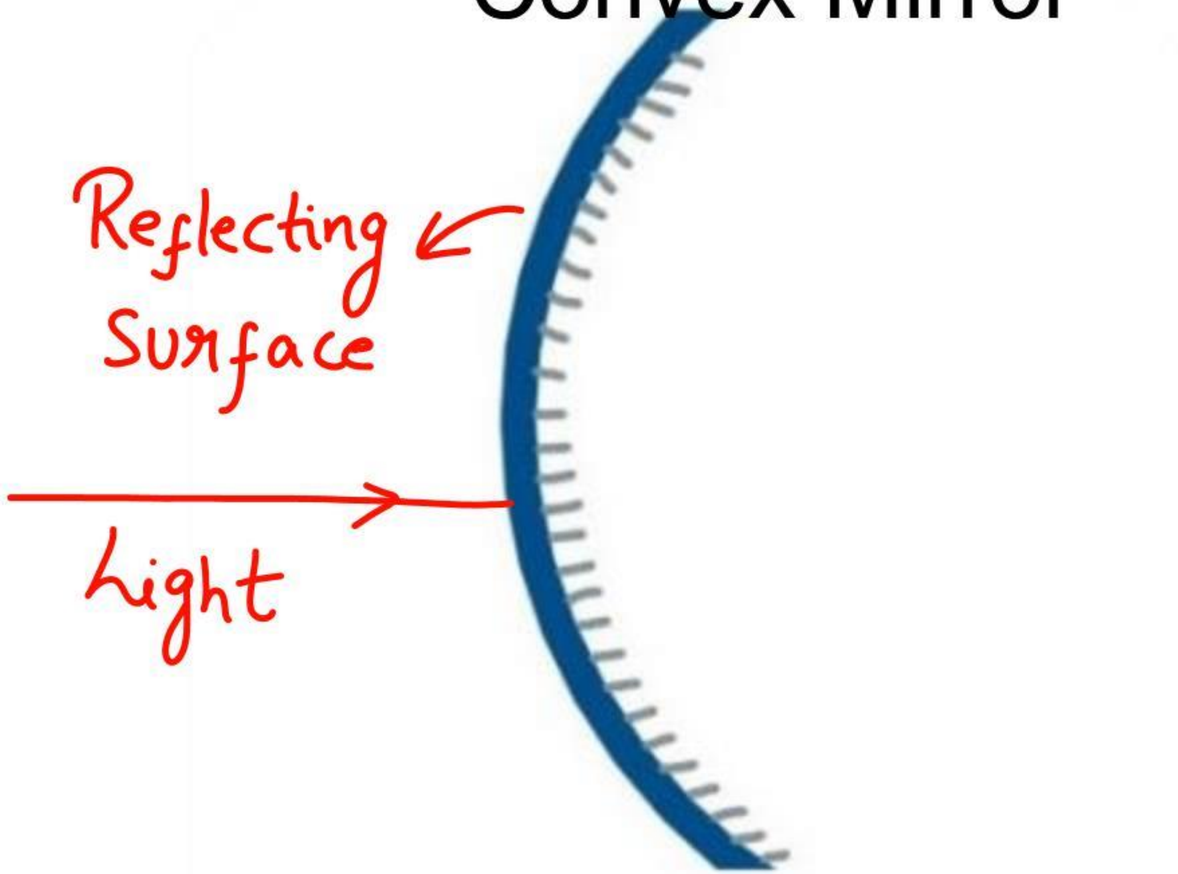
Spherical Mirrors

Concave Mirror



Concave Mirror

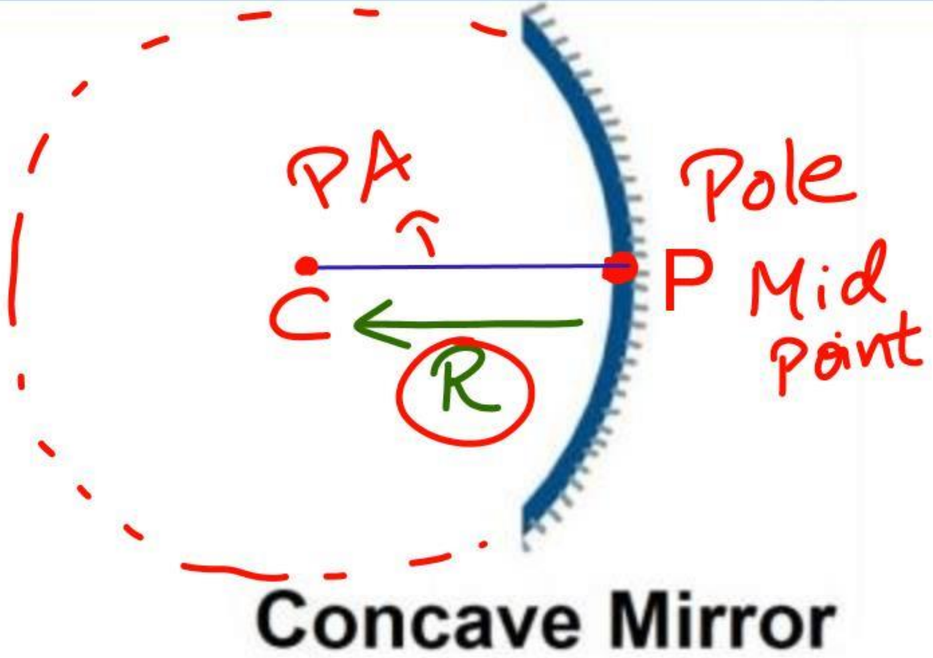
Convex Mirror



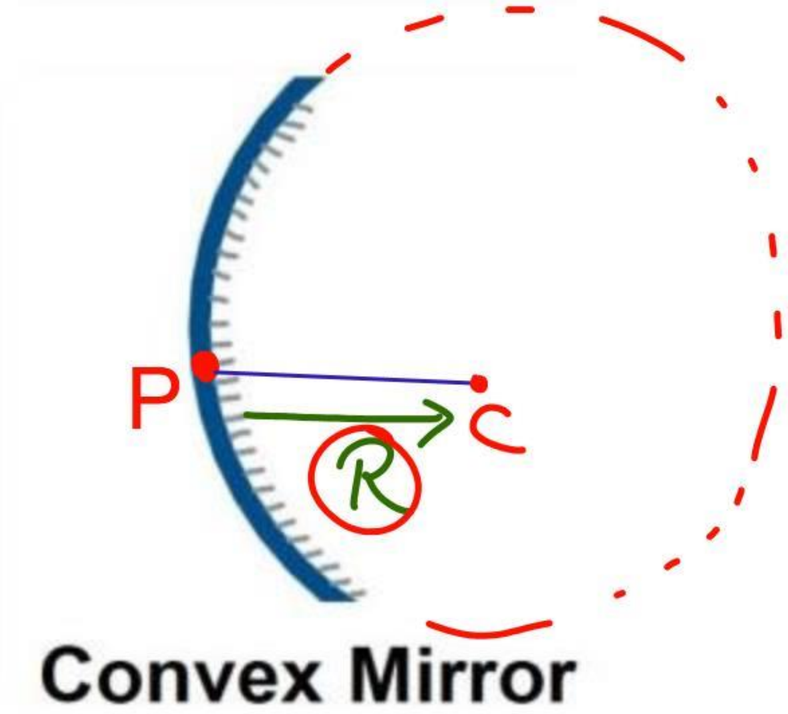
Convex Mirror

Spherical Mirrors

- Pole (P) →
- Centre of Curvature (C) →
- Principal Axis → PA
- Radius of Curvature (R) →



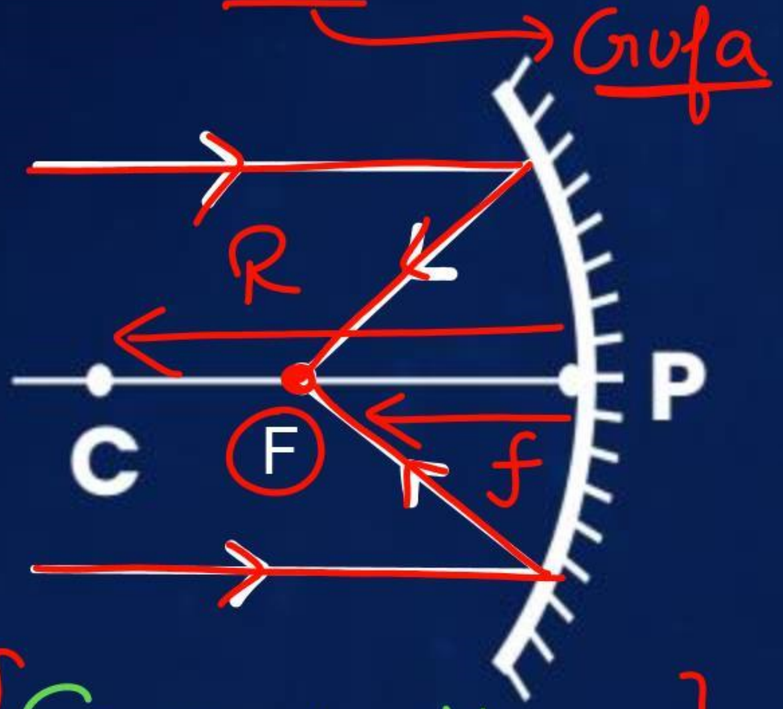
Concave Mirror



Convex Mirror

Principal Focus (F) & focal length (f)

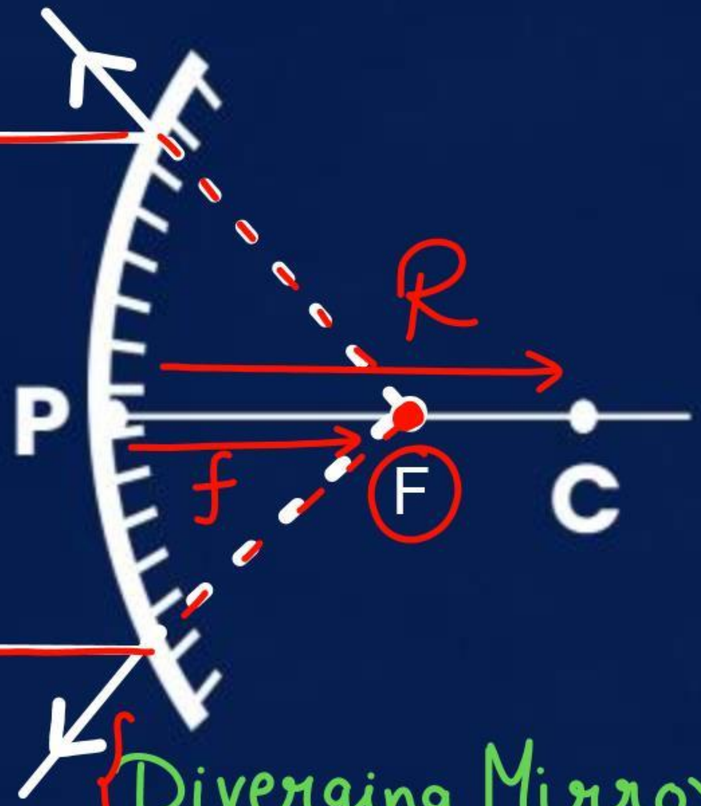
- **Concave Mirror**



{Converging Mirror}

$$R = 2f$$

- **Convex Mirror**



{Diverging Mirror}

For spherical mirrors in our syllabus $R = 2f$

Image formation & Characteristics

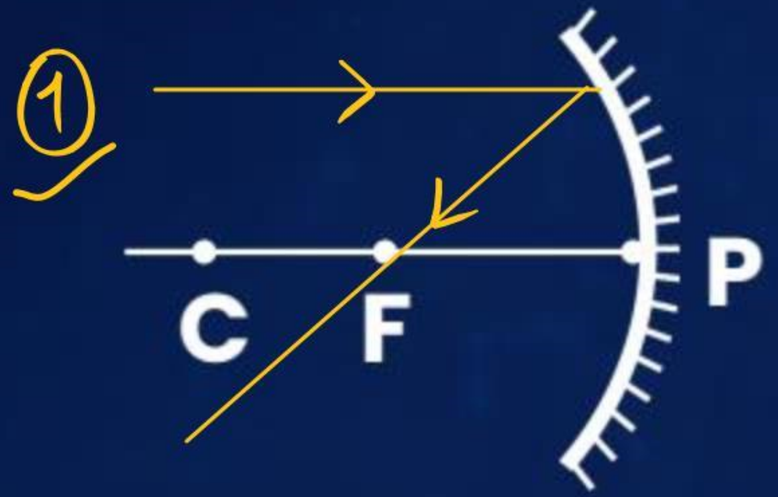
1) At least two rays of light meet ⇒ Image

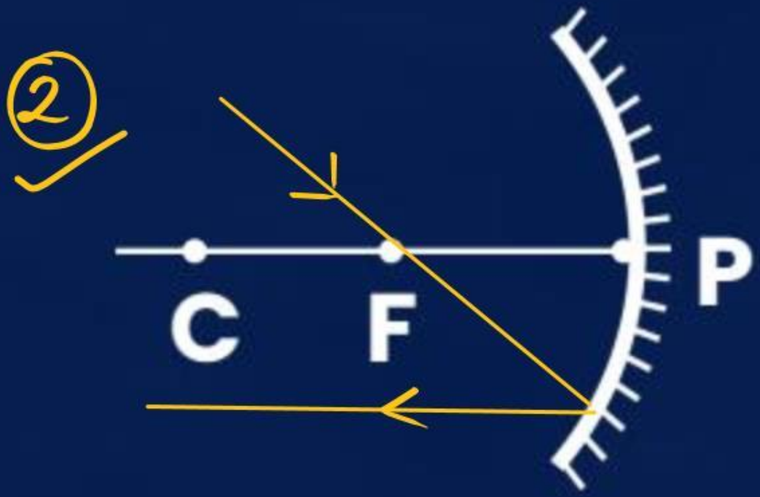
2) If rays of light actually meet ⇒ Real

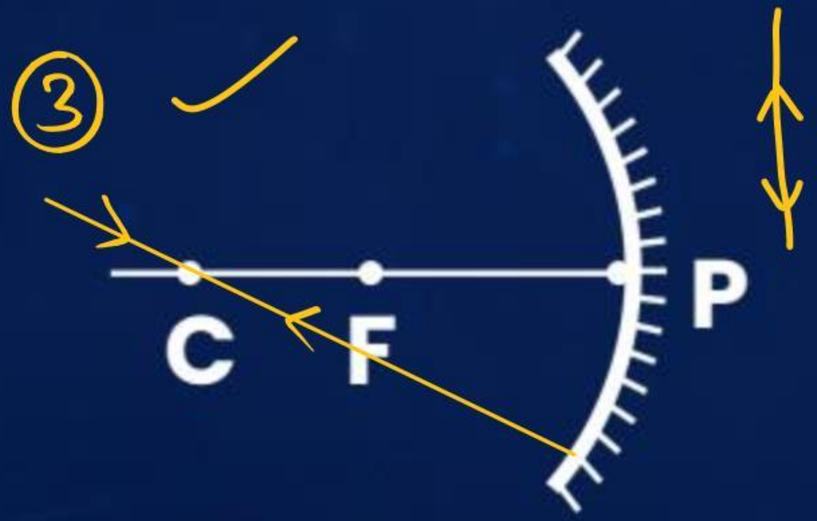
3) If rays of light appear to meet ⇒ Virtual

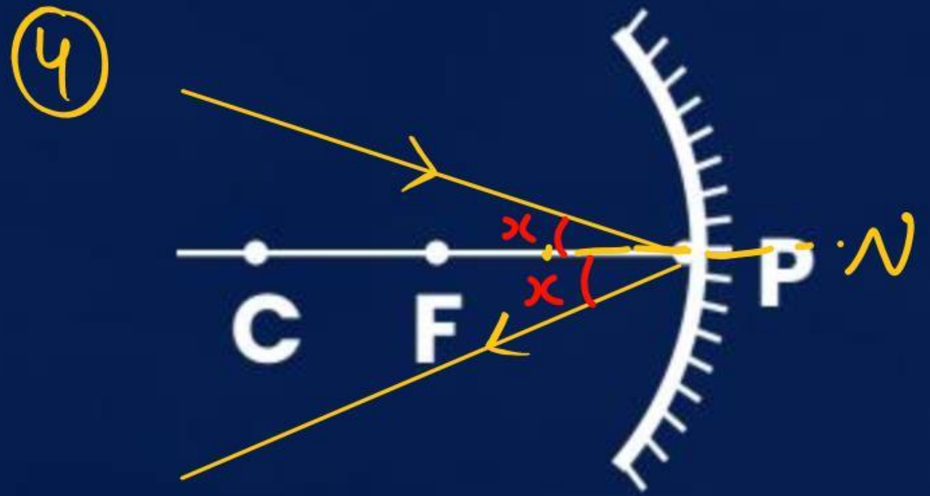
Image Formation: Concave Mirror

Rules

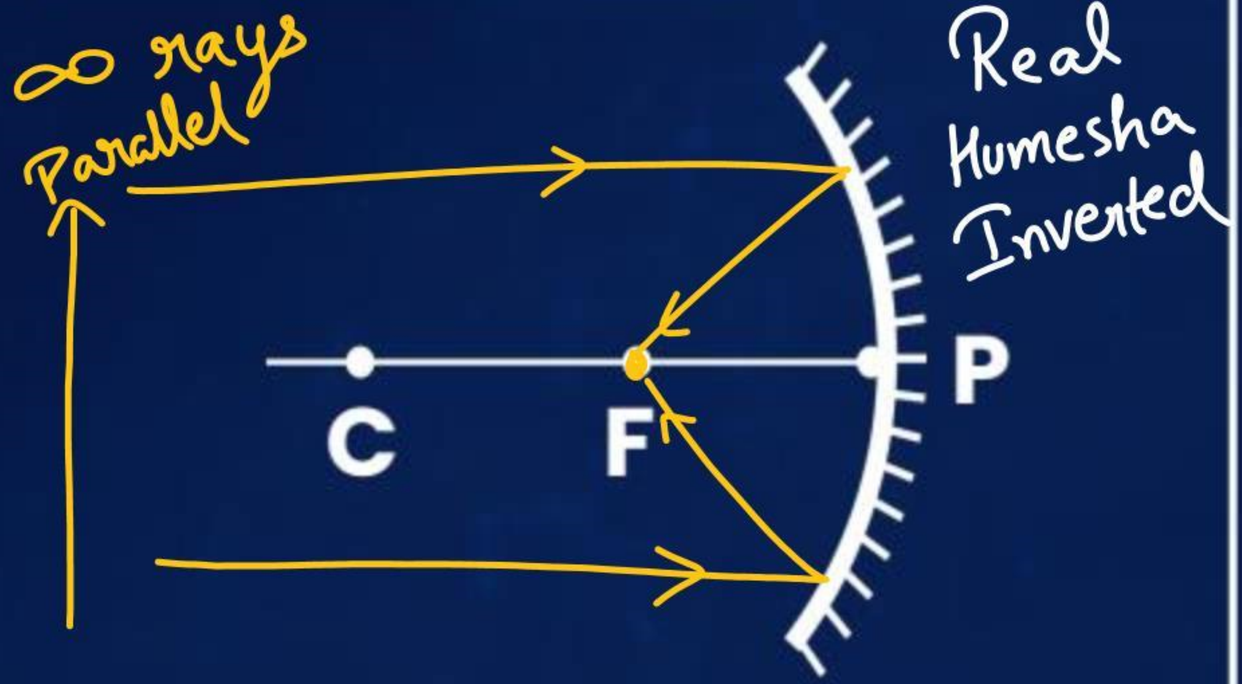








Object at ∞



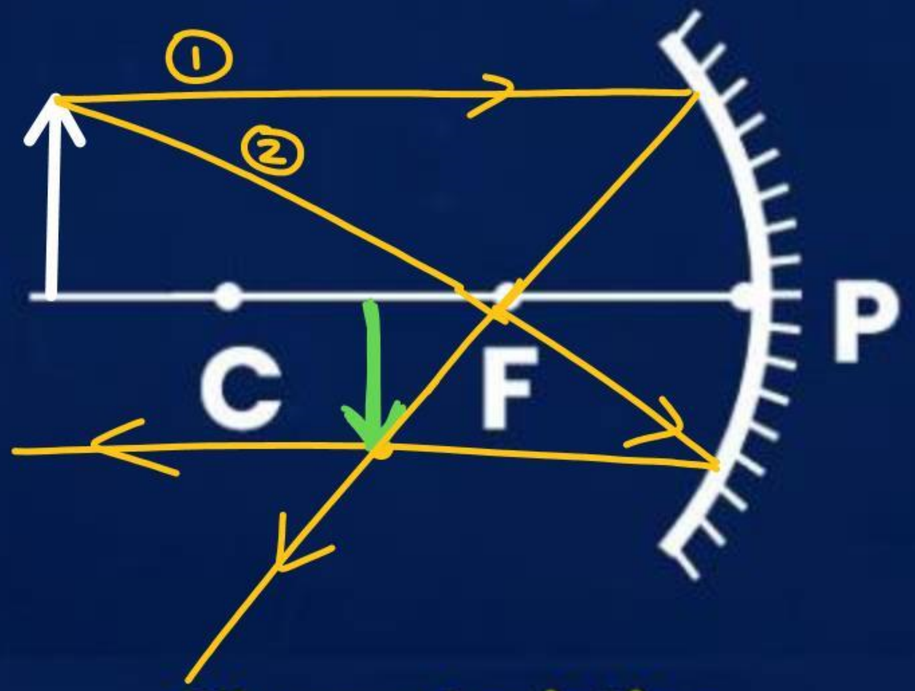
Characteristics

Image at Focus

Point size.

Real, Inverted, Highly dimnished

Object Beyond C



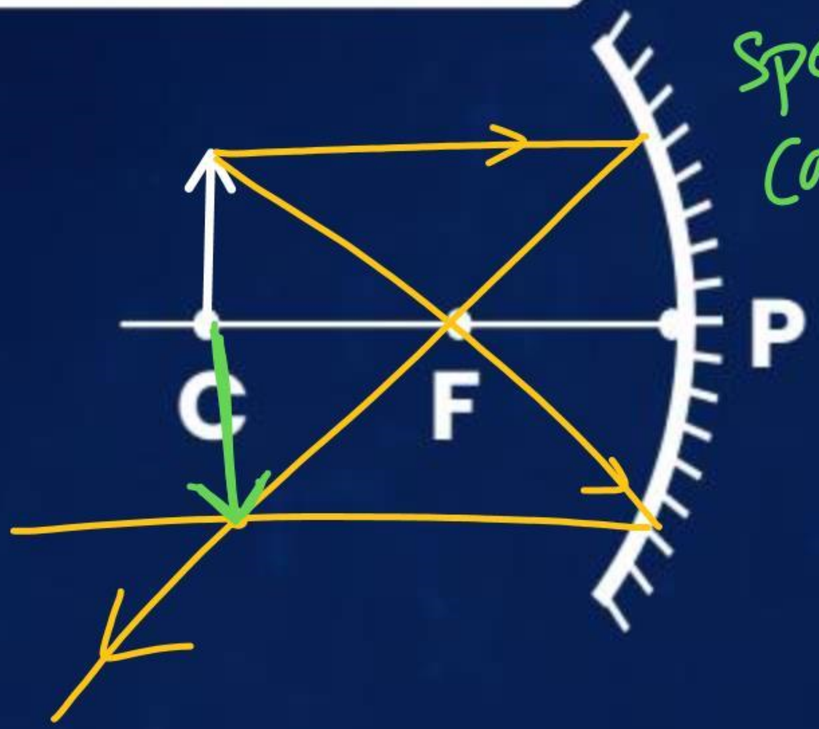
Characteristics

Image between C & F ✓✓

Real, Inverted, Dimnished

Object at C

Special Case

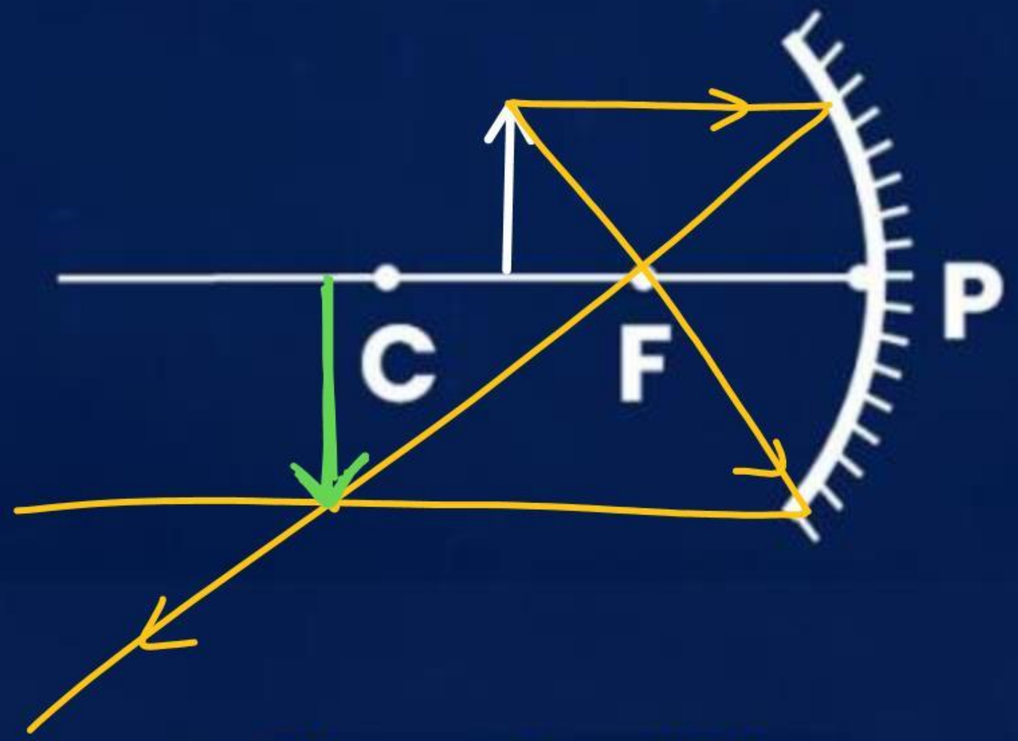


Characteristics

Image at C ✓✓

Real, Inverted, Same Size

Object between C & F

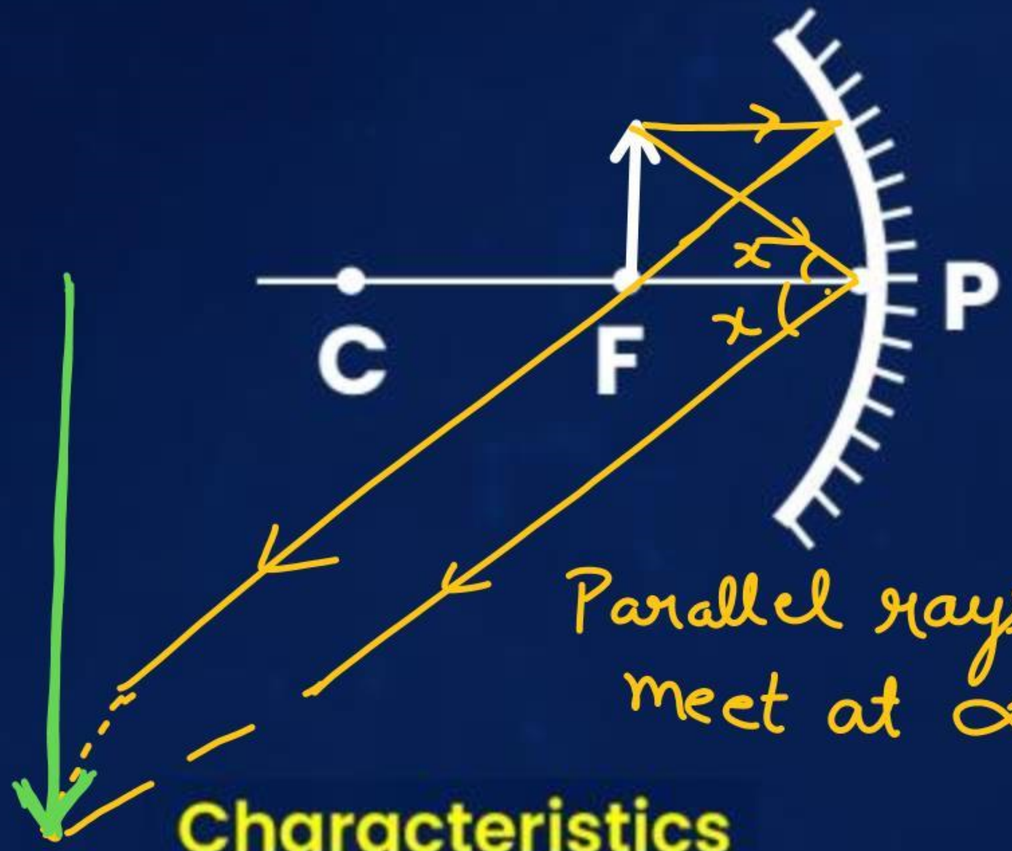


Characteristics

Image beyond C ✓✓

Real, Inverted, Magnified

Object at F



Parallel rays meet at ∞

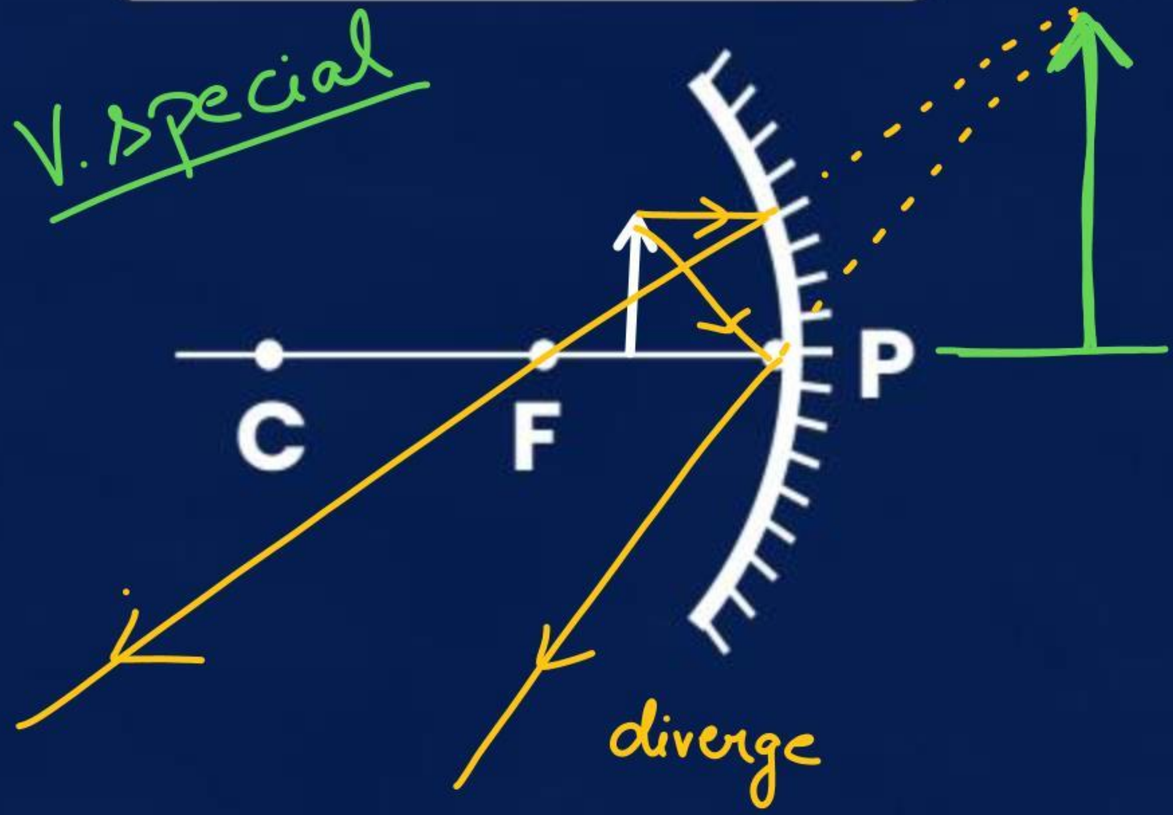
Characteristics

Image at ∞

Real, Inverted, Highly Magnified

Object Between F & P

V. Special



diverge

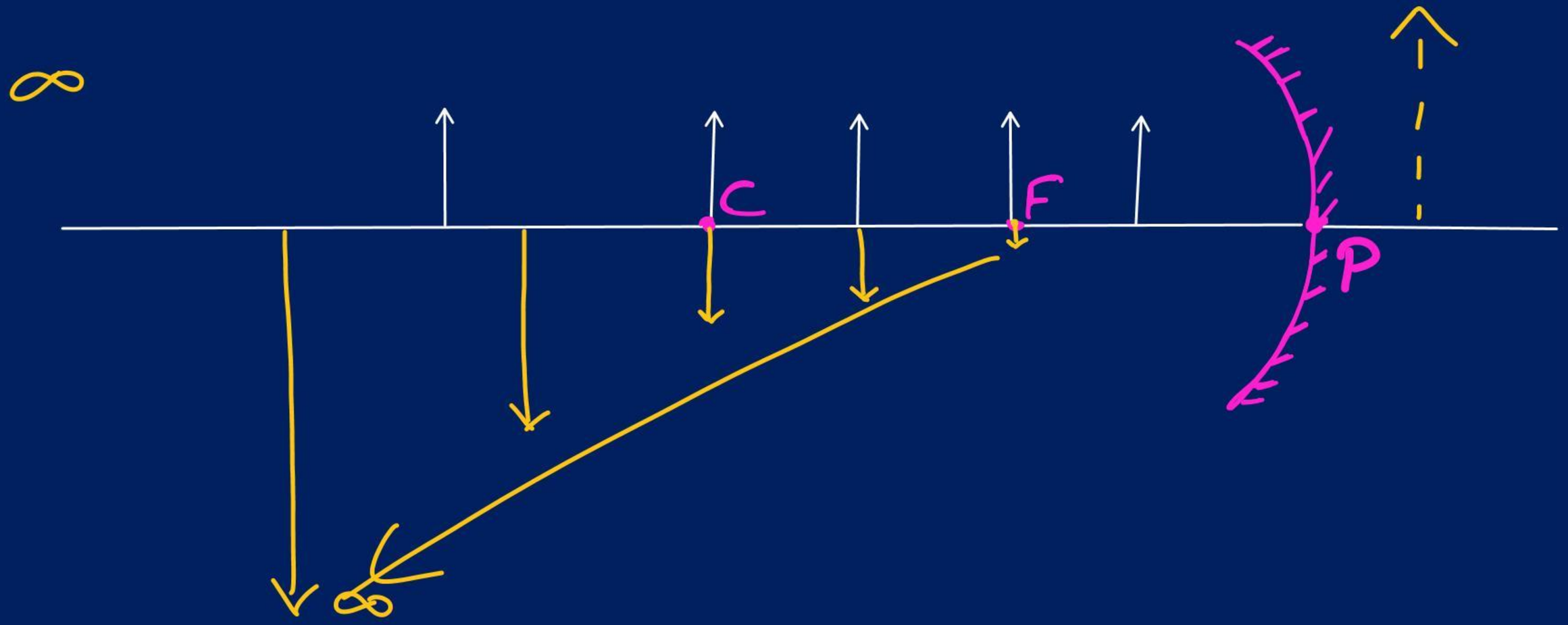
Characteristics

Image behind the mirror

Virtual, Erect, Magnified

Upright

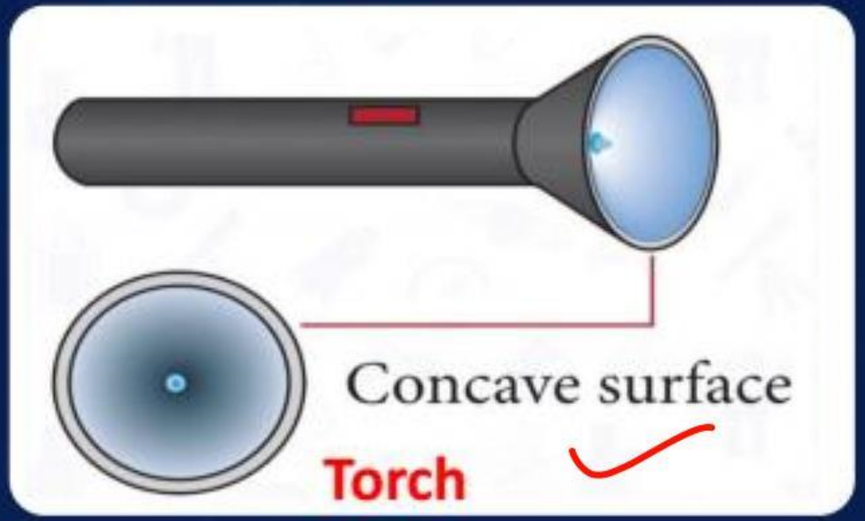
Summary for Concave Mirror

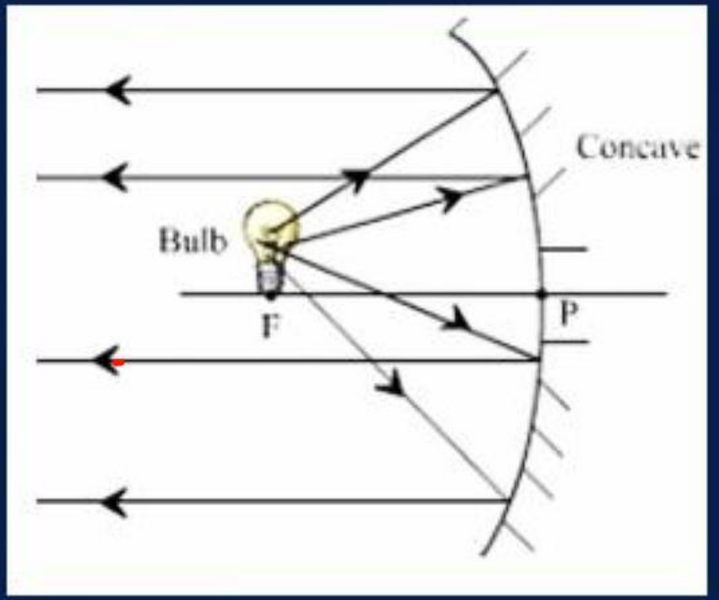


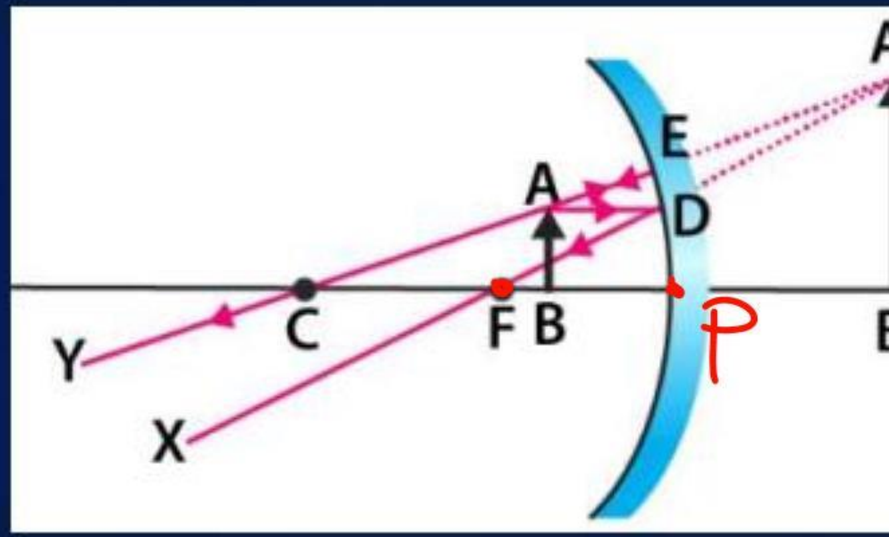
Learn

osition of the object	Position of the image	Size of the image	Nature of the image
infinity	At the focus F	Highly diminished, point-sized	Real and inverted
eyond C	Between F and C	Diminished	Real and inverted
C	At C	Same size	Real and inverted
etween C and F	Beyond C	Enlarged	Real and inverted
F	At infinity	Highly enlarged	Real and inverted
etween P and F	Behind the mirror	Enlarged	Virtual and erect

Uses of Concave Mirror







Uses of Concave Mirror

3. To Concentrate sunlight to produce heat ⟶ solar furnace

Activity 9.2

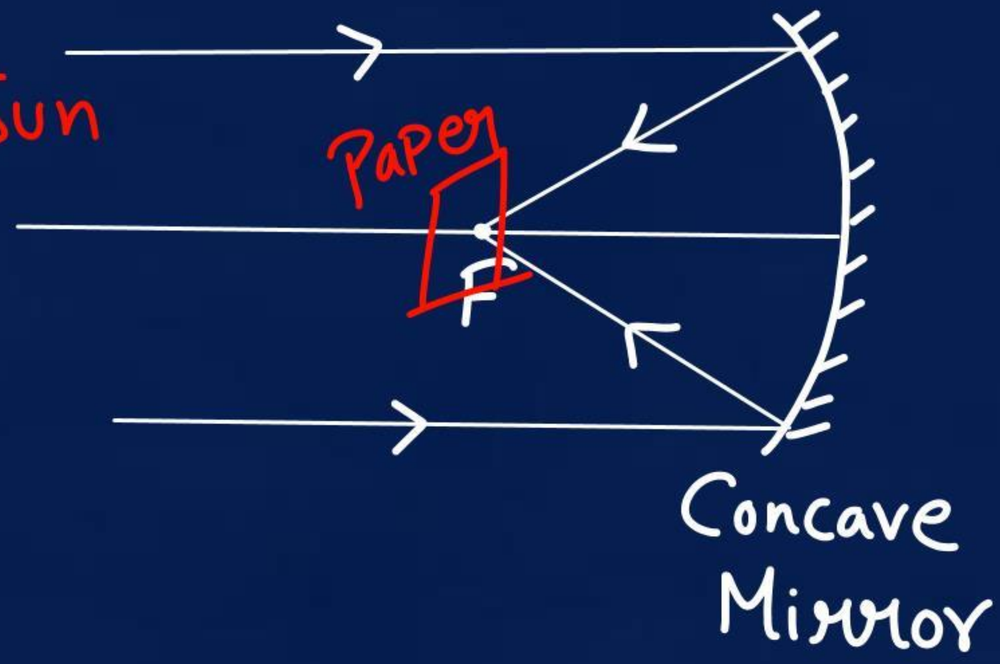
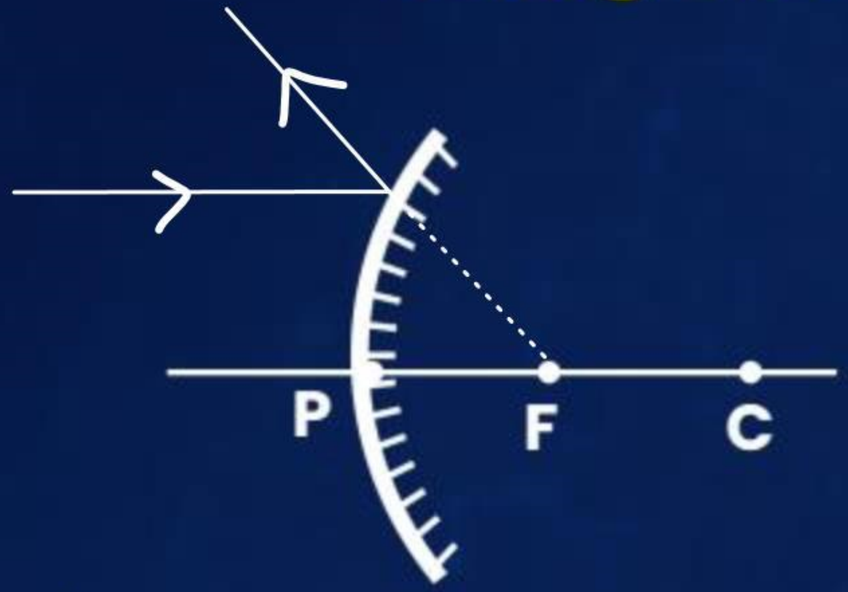
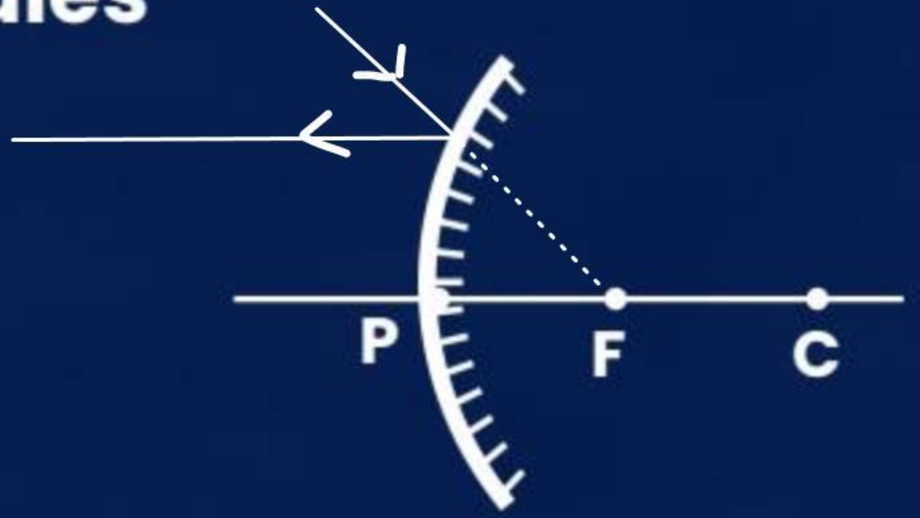
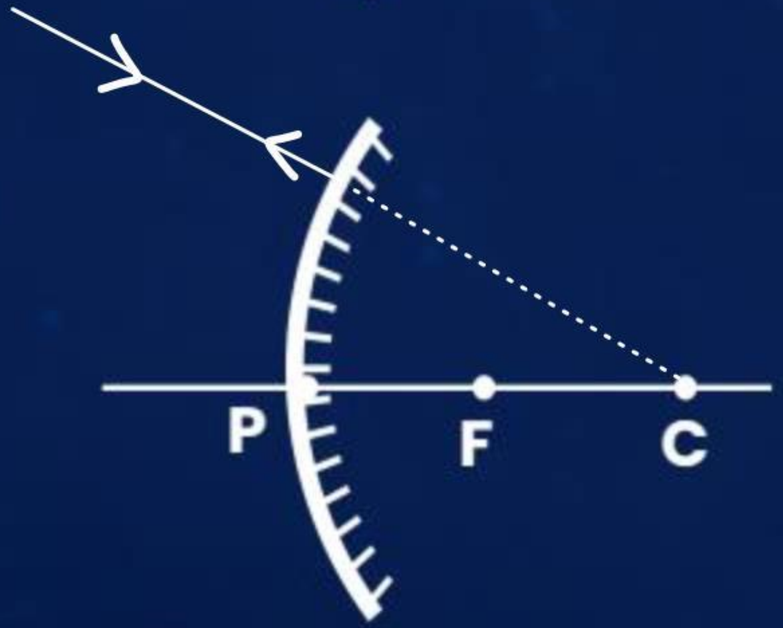


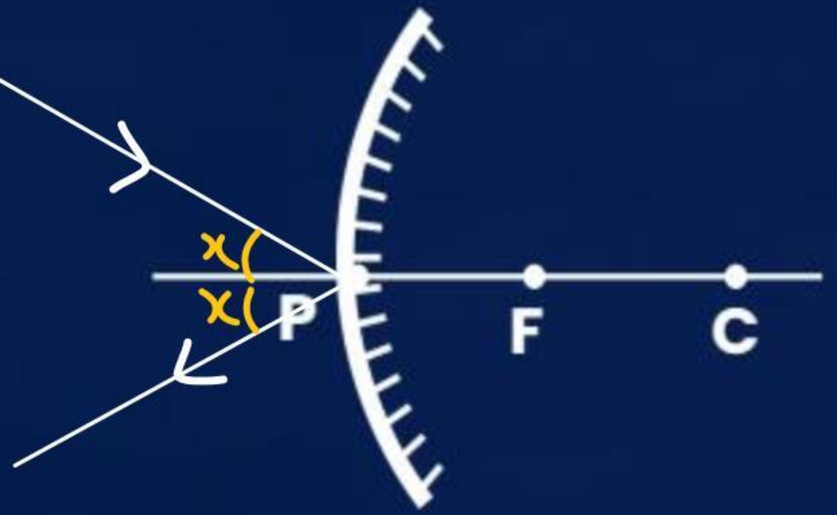
Image Formation: Convex Mirror

Rules

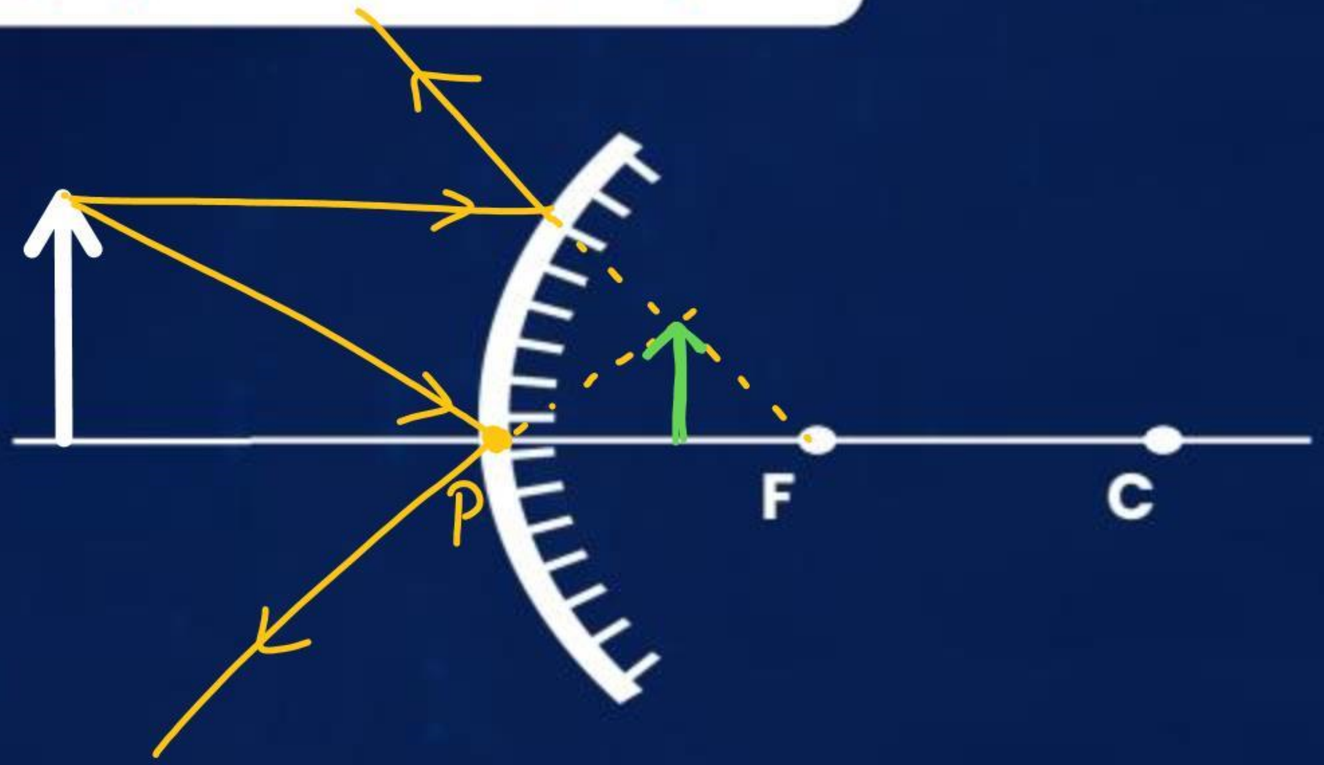








Object at finite distance (anywhere except ∞)



Characteristics

Image between F & P

Virtual, Erect, Dimnished

Upright

Use of Convex Mirror

1. **Rear-view mirrors**

① Upright / Erect Image

② Wider field of View

Summary- Convex & Concave Mirror

Concave Mirror

- Inverted
- Erect / Virtual
  Upright
  Enlarged
  { Seedhi + Badi image }

Convex Mirror

only Erect, Virtual
Dimnished

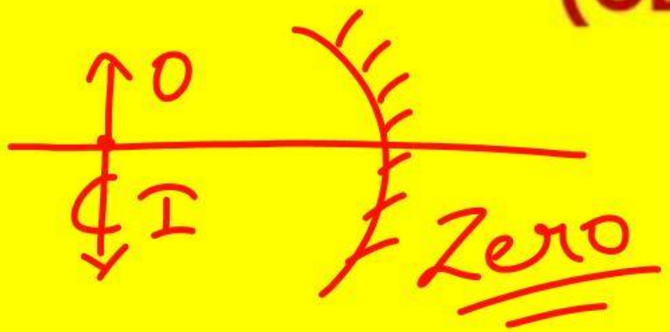
Seedhi or chotti image

Q. The image of an object placed in front of a concave mirror of focal length 15 cm is of the same size as the object. The distance between the object and its image is

(CBSE Term I 2021-22)

(a)15cm (b) 30cm

(c) 60cm (d) zero.



Q. A ray of light is incident on a concave mirror, parallel to its principal axis. If this ray after reflection from the mirror passes through the principal axis from a point at a distance of 10 cm from the pole of the mirror, find the radius of curvature of the mirror.

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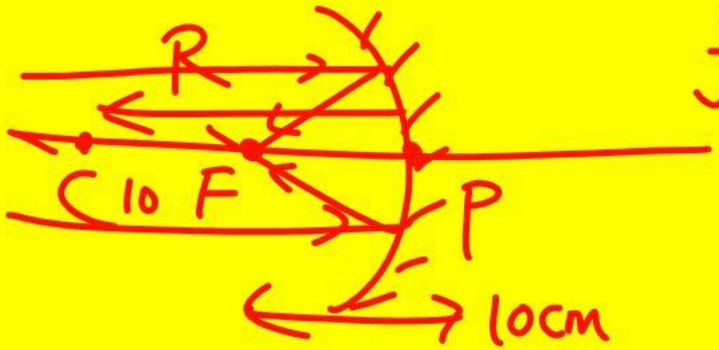


$f = 10\text{cm}$

$R = 2f$

$= 2 \times 10$

$= 20\text{cm}$

Object at ∞

Virtual {upright / Erect}

Characteristics

Image at F

Virtual, Erect, Highly Dimnished

Point size.

Learn Convex

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus F, behind the mirror	Highly diminished, point-sized	Virtual and erect
Between infinity and the pole P of the mirror	Between P and F, behind the mirror	Diminished	Virtual and erect

Q. A student wants to obtain an erect image of an object using a concave mirror of 10 cm focal length. What will be the distance of the object from mirror?

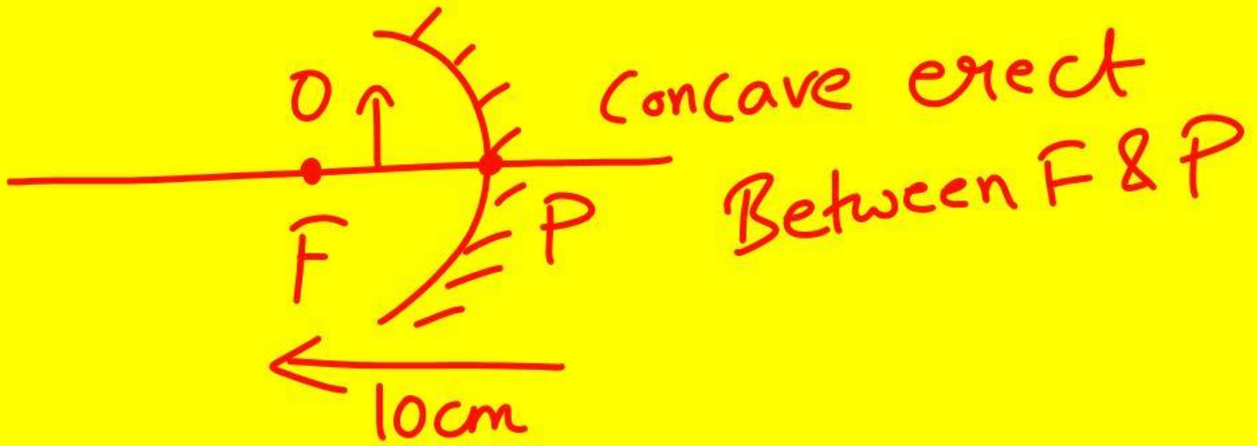
(CBSE 2023)

(a) Less than 10 cm

(b) 10cm

(c) between 10 cm and 20 cm

(d) more than 20 cm.



Q. A mirror forms a virtual, erect and diminished image of an object. Identify the type of this mirror. Draw a ray diagram to o show the image formation in this case.

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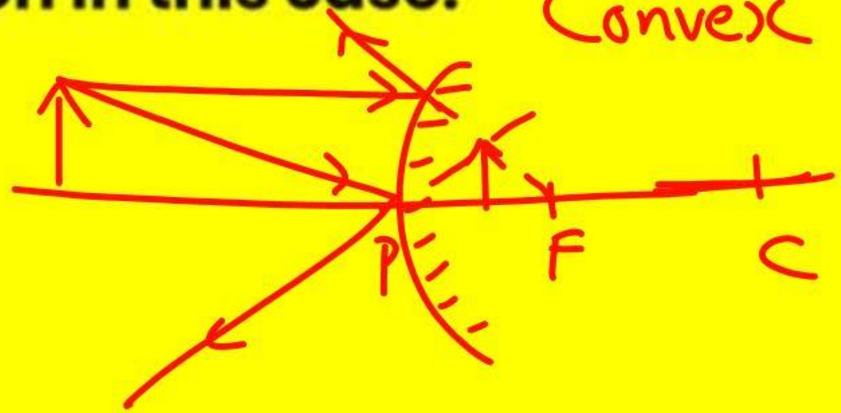
Convex Mirror



Three Concave Mirrors

Case	Mirror	Focal Length (cm)	C	Object Distance (cm)
1	A	20	40	45
2	B	15	30	30
3	C	30	60	20

→ Beyond C

→ Object between F & P

Q. a) In which one of the above cases the mirror will form a diminished image of the object ? Justify your answer. !! (A)

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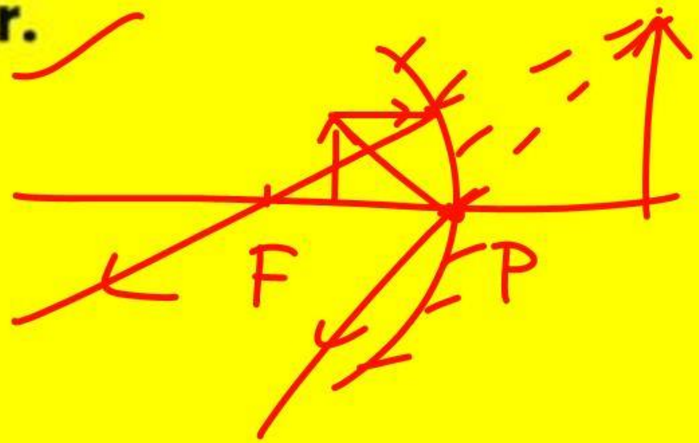
b) List two properties of the image formed in case 2.

Image C
Real, Inverted, same size

c) What is the nature and size of the image formed by mirror C? Draw ray diagram to justify your answer.

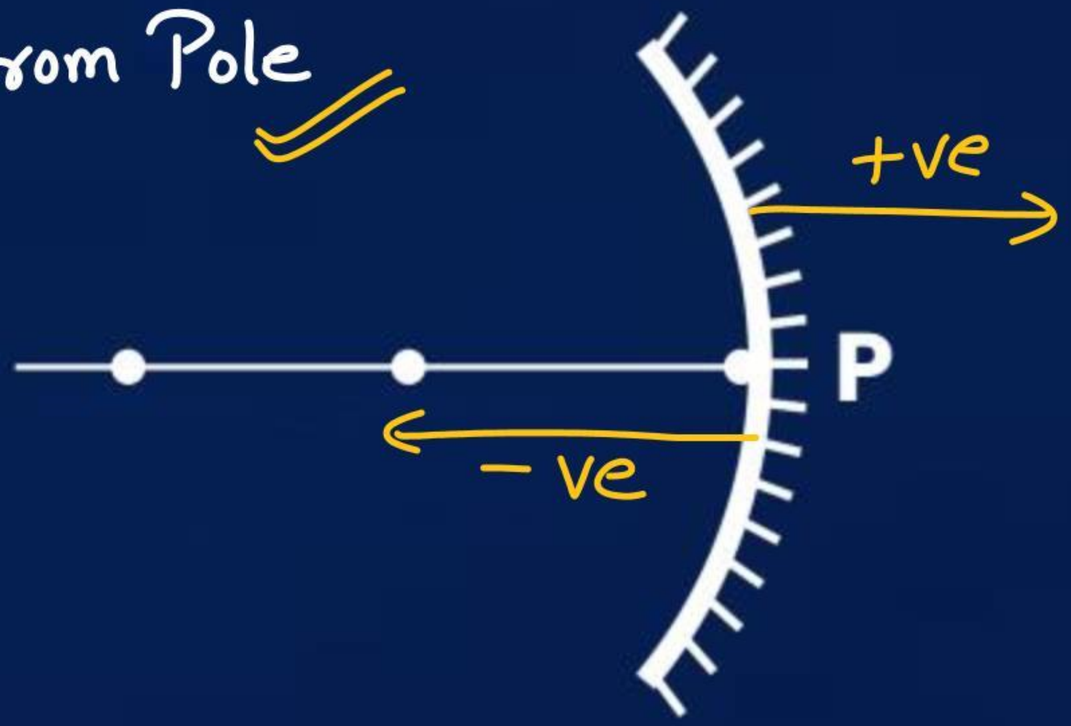


Sign Convention

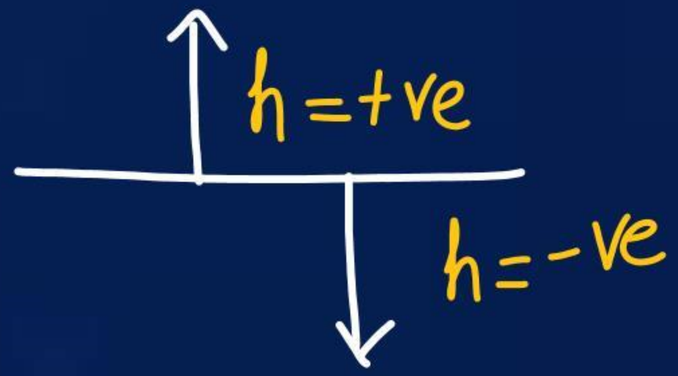
1) All distances are measured from Pole

2) +x axis
+ve

−x axis
−ve



3)



Mirror Formula

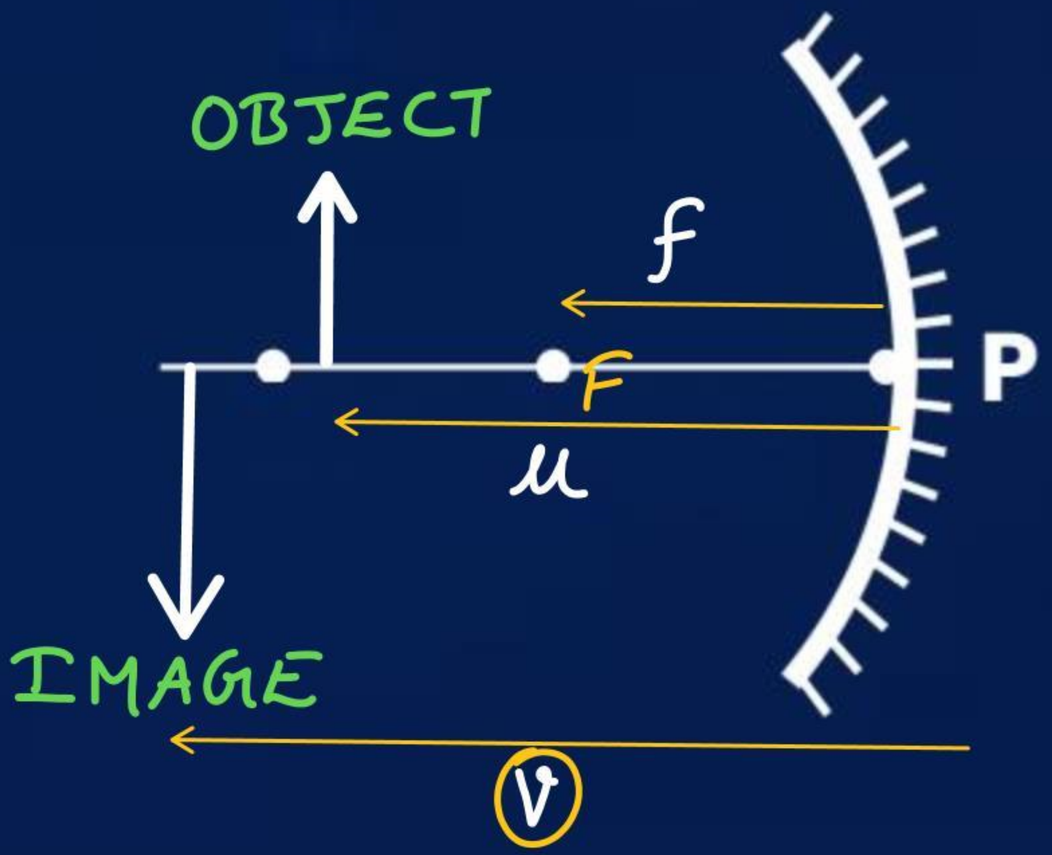
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

- u = object distance
- v = Image distance

Note:→ $u \rightarrow$ -ve Always

$f \rightarrow$ +ve Convex

Convex → +



Q. An object is placed at 3 cm from convex mirror of focal length 6 cm. Find image distance from mirror.

A) 3 cm

~~B) 2 cm~~

C) 6 cm

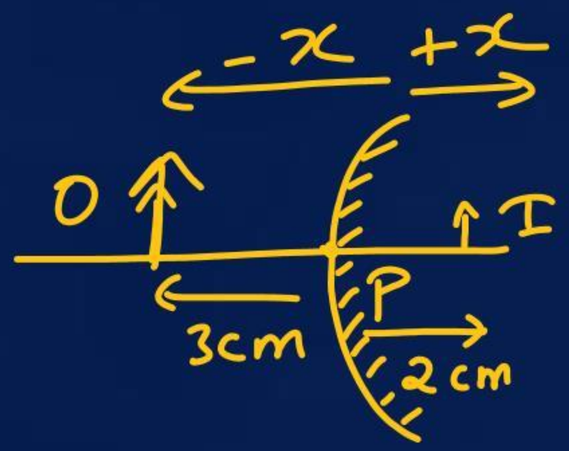
D) 1 cm

Convex $\rightarrow +$

$f = +6\text{cm}$

$u = -3\text{cm}$

$V = ?$



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

$$\frac{1}{6} = \frac{1}{V} - \frac{1}{3}$$

$$\frac{1}{6} + \frac{1}{3} = \frac{1}{V} \longrightarrow \frac{1}{V} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$$

$$V = +2\text{cm}$$

Q. An object is placed at a distance of 10 cm from the pole of a convex mirror of focal length 15 cm. Find the position of the image.

(CBSE 2024)

Convex → +

$f = +15\,cm$

$u = -10\,cm$

$v = ?$

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

Q/HW =

H.W.

Comment

Q. An object is placed at a distance of 18 cm from the pole of a concave mirror of focal length 12 cm. Find the position) of the image formed in this case.

(CBSE 2024)

Concave

$f = -12\text{cm}$

$u = -18\text{cm}$

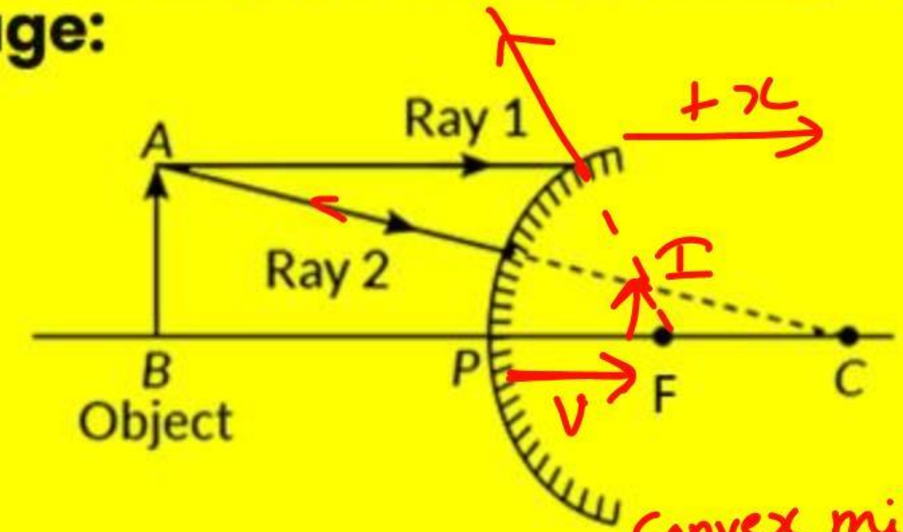
$v = ?$

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

02 H.W.

Comment

Q. (a) Complete the following ray diagram to show the formation of image:



① P & F
② Virtual Erect diminish

(b)Mention the nature, position and size of the image formed in this case.

(c)State the sign of the image distance in this case using the Cartesian sign convention. +ve

(CBSE 2023)

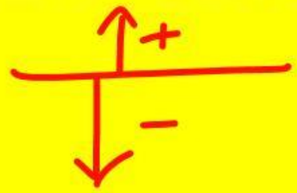
Magnification (m)

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

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

Q. A student has focused the image of an object of height 3 cm on a white screen using a concave mirror of focal length 12 cm. If the distance of the object from the mirror is 18 cm, find the values of the following :

$v = ?$ $\quad v = -36\,cm$



(i) distance of the image from the mirror.

(CBSE 2023)

$h_i = -6\,cm$

(ii) height of the image.

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

$$-\frac{1}{12} = \frac{1}{v} - \frac{1}{18}$$

$$\frac{1}{v} = \frac{1}{18} - \frac{1}{12} = \frac{2-3}{36} = -\frac{1}{36}$$

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

$$-2 = \frac{h_i}{3}$$

$$\boxed{h_i = -6\,cm}$$

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

$$= -\frac{(+36)}{-18}$$

$$m = -2$$

Object

$h_o = 3\,cm$

Concave

$f = -12\,cm$

$u = -18\,cm$

Magnification (m) & Nature of Image

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

$h_i = m \times h_o$

$m = 2$

$h_i = 2 \times h_o$

$m = 3$

$h_i = 3 \times h_o$

$m = -4$

$h_i = -4 \times h_o$

m Value > 1

Magnified

$m = \frac{1}{2} (0.5)$

$h_i = \frac{1}{2} h_o$

m Value < 1

Diminished

$m = -\frac{1}{3} (-0.3)$

$h_i = -\frac{1}{3} h_o$

$m = -2$

$h_i = -2 h_o$

$O \uparrow$ $\downarrow I$ Inverted

$m = +3$

$h_i = +3 h_o$

$O \uparrow$ $\uparrow I$ Erect

Find the type of Mirror

① $m = -2$

$h_i = -2 \times h_o$

Inverted

Concave mirror

② $m = +\frac{1}{2}$

$h_i = +\frac{1}{2} h_o$

Convex mirror

③ $m = -\frac{1}{2}$

Inverted
Concave

Q. "The linear magnification produced by a spherical mirror is +3." Based on this statement answer the following questions :

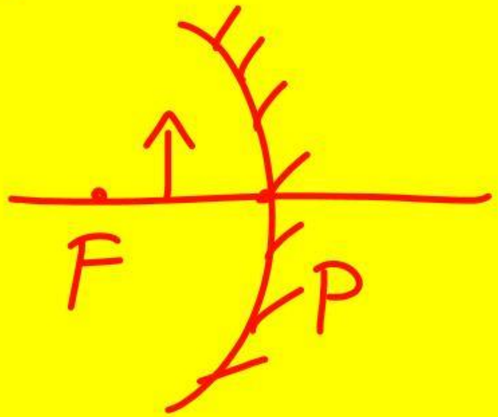
(a) What is the type of mirror? Concave mirror

$m = +3$

$h_i = +3\, h_o$

(b) Where is the object located?

(c) List two properties of the image formed (other than the size/magnification). Virtual, erect, behind the mirror



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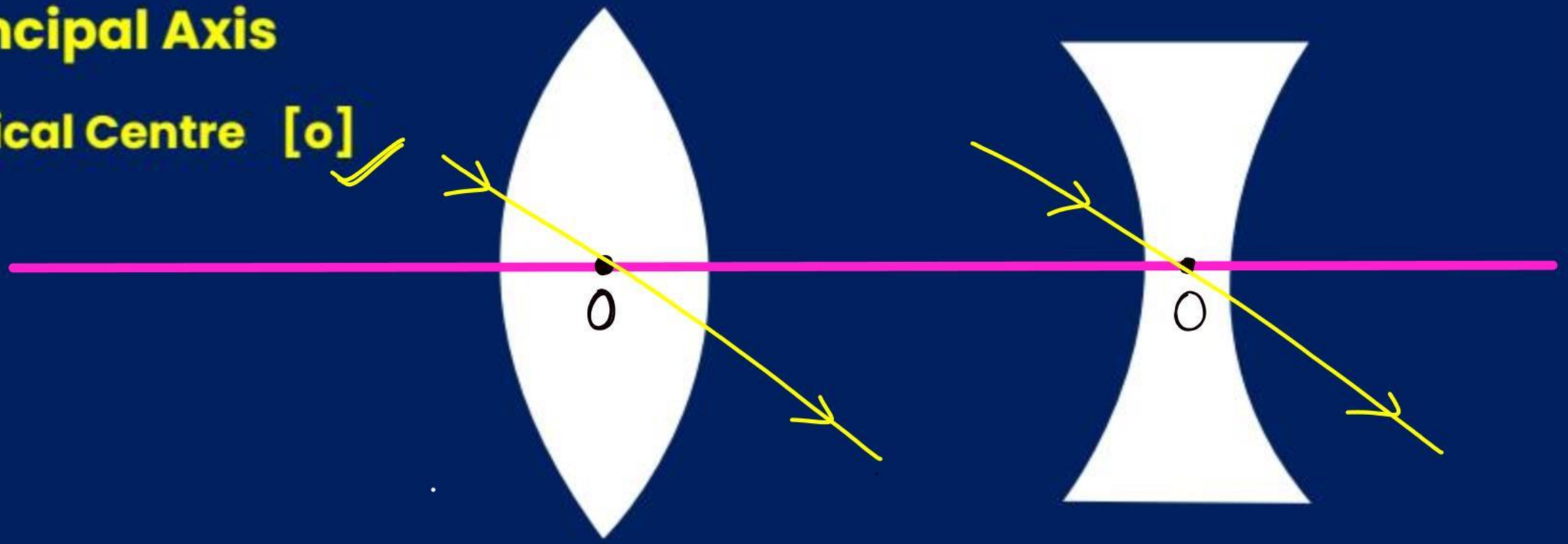
Erect Magnified

Spherical Lenses

- **Principal Axis**
- **Optical Centre [o]**



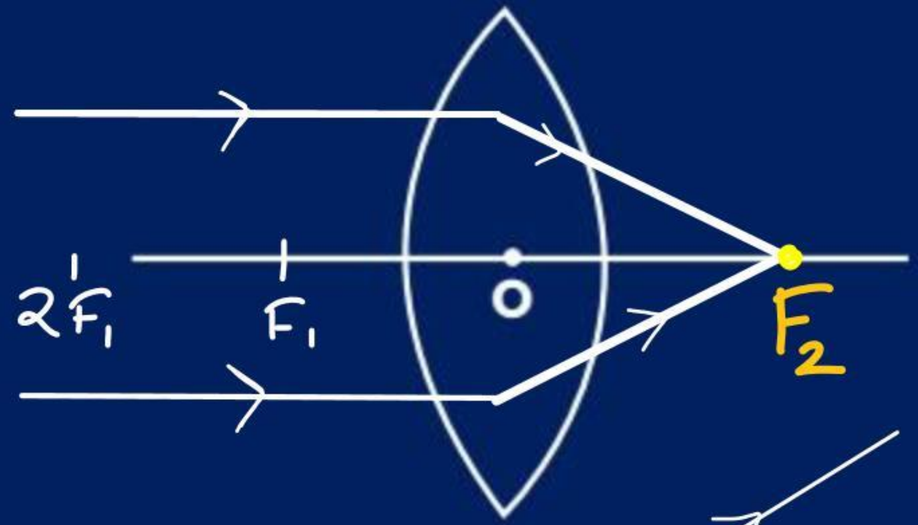
Convex Lens
Thick in middle

Concave Lens
Thin in middle

Principal Focus (F) & Focal Length (f)

1) Convex Lens

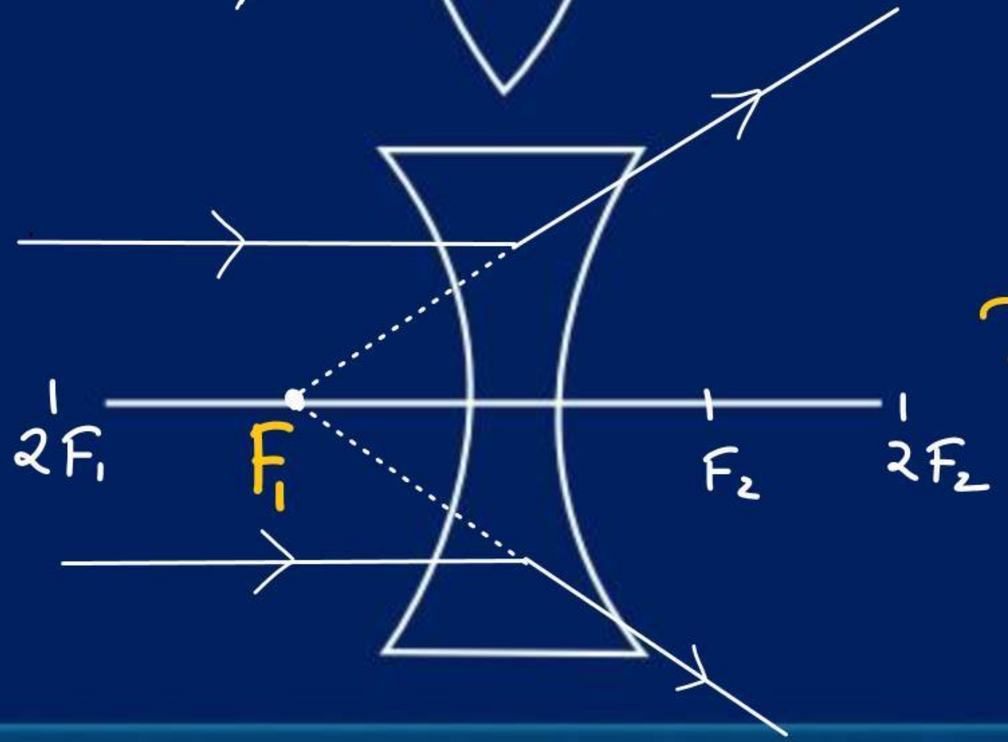
Note: They have two F → F_1 & F_2 due to two Curved Surfaces.



Converging Lens

1) ~~Convex~~ Lens

Concave

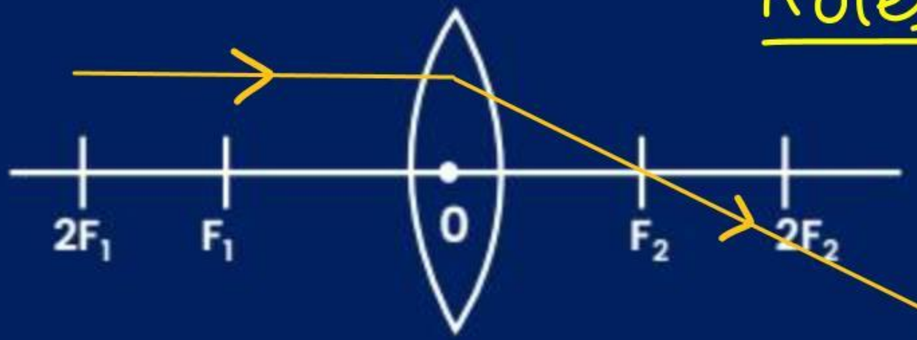


Diverging Lens

Image Formation → Convex Lens

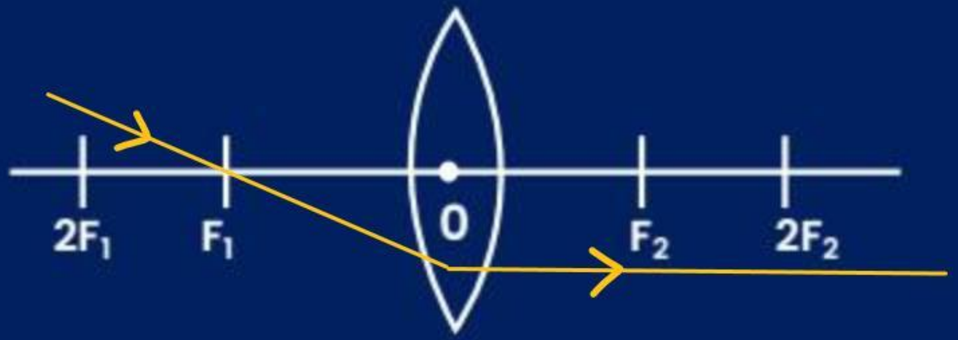
Rules

1.



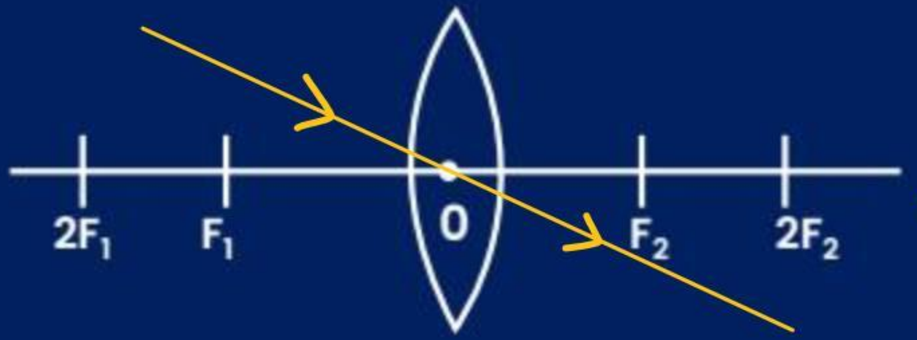
✓

2.



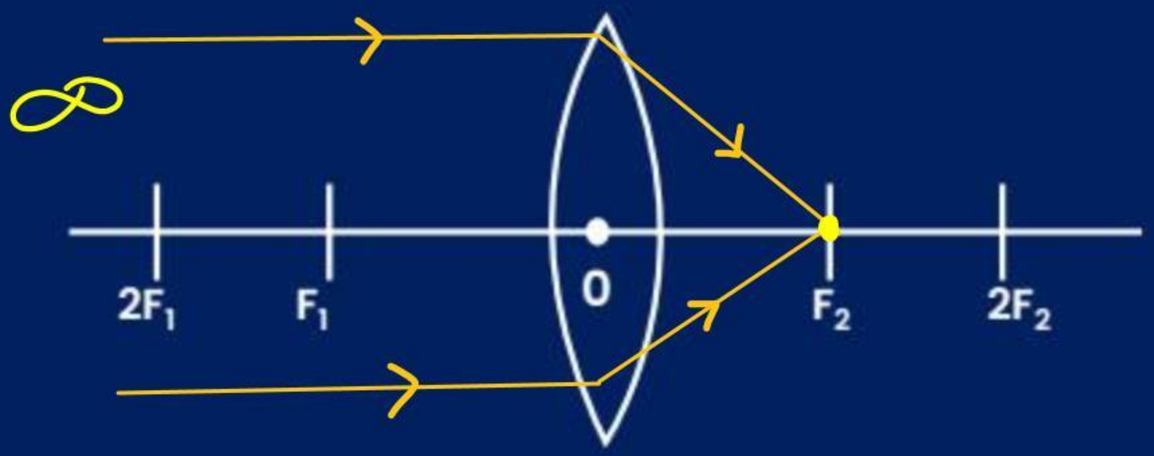
✗

3.



✓

Object at ∞

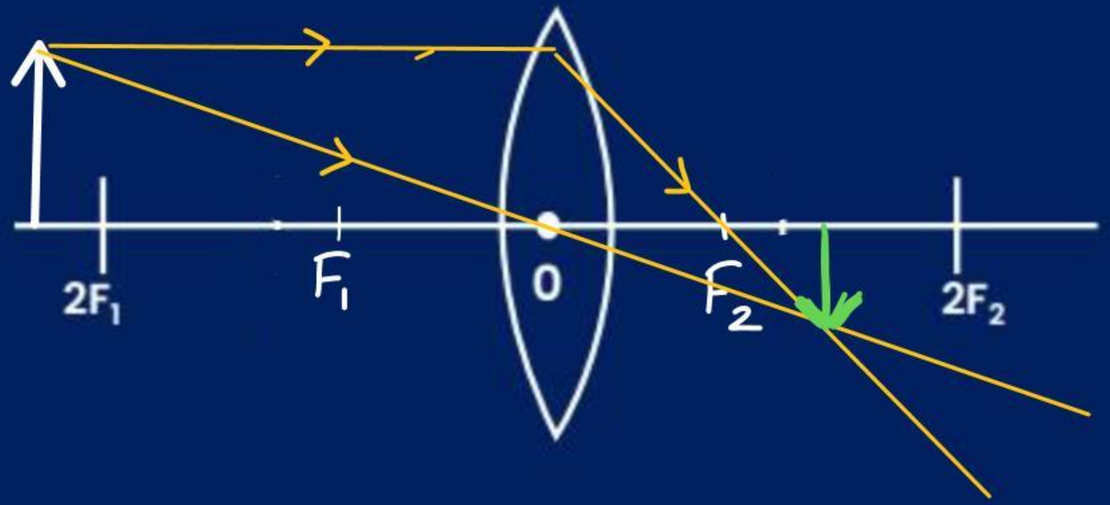


Characteristics of Image

Image at F_2 ✓

Real, Inverted, Highly Dimnished → Point size

Object Beyond $2F_1$ ✓

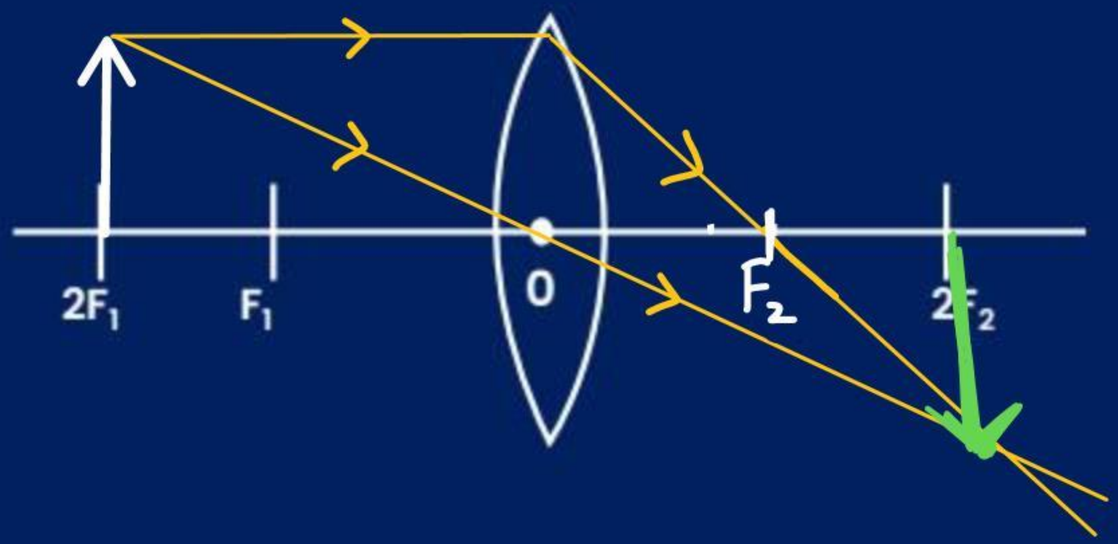


Characteristics of Image

✓ Image between F_2 & $2F_2$

Real, Inverted, Dimnished

Object at $2F_1$

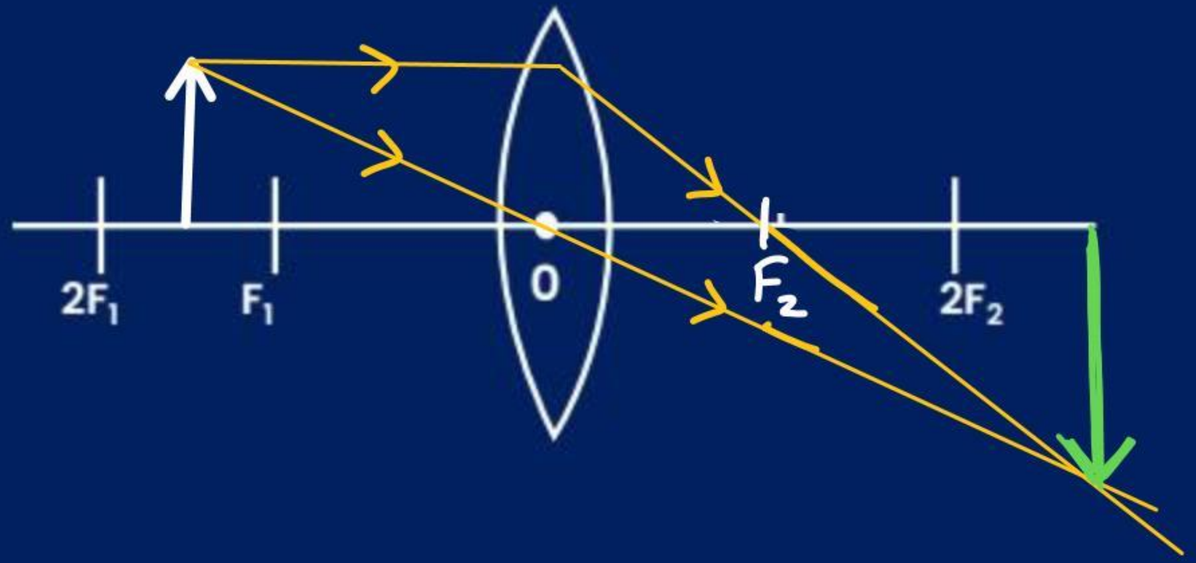


Characteristics of Image

Image at $2F_2$

Real, Inverted, Same Size

Object Between $2F_1$ & F_1

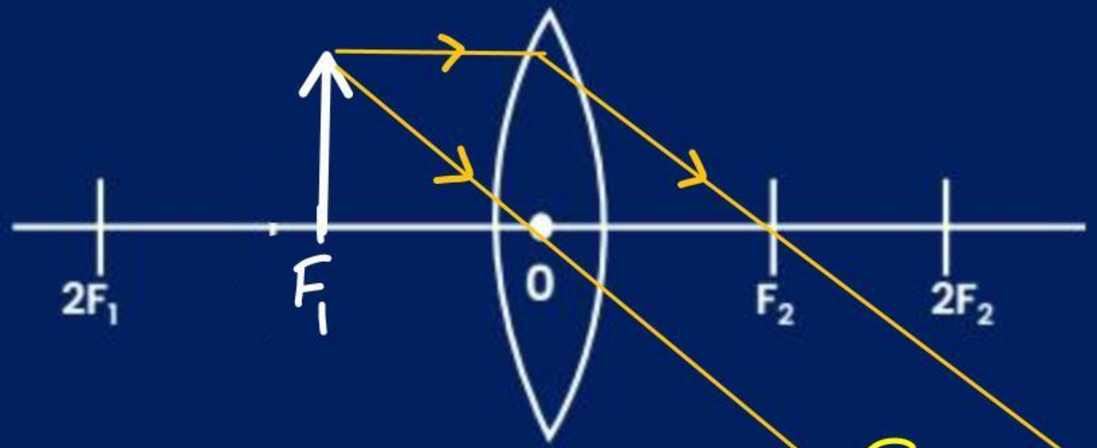


Characteristics of Image

Image Beyond $2F_2$

Real, Inverted, Magnified

Object at F_1



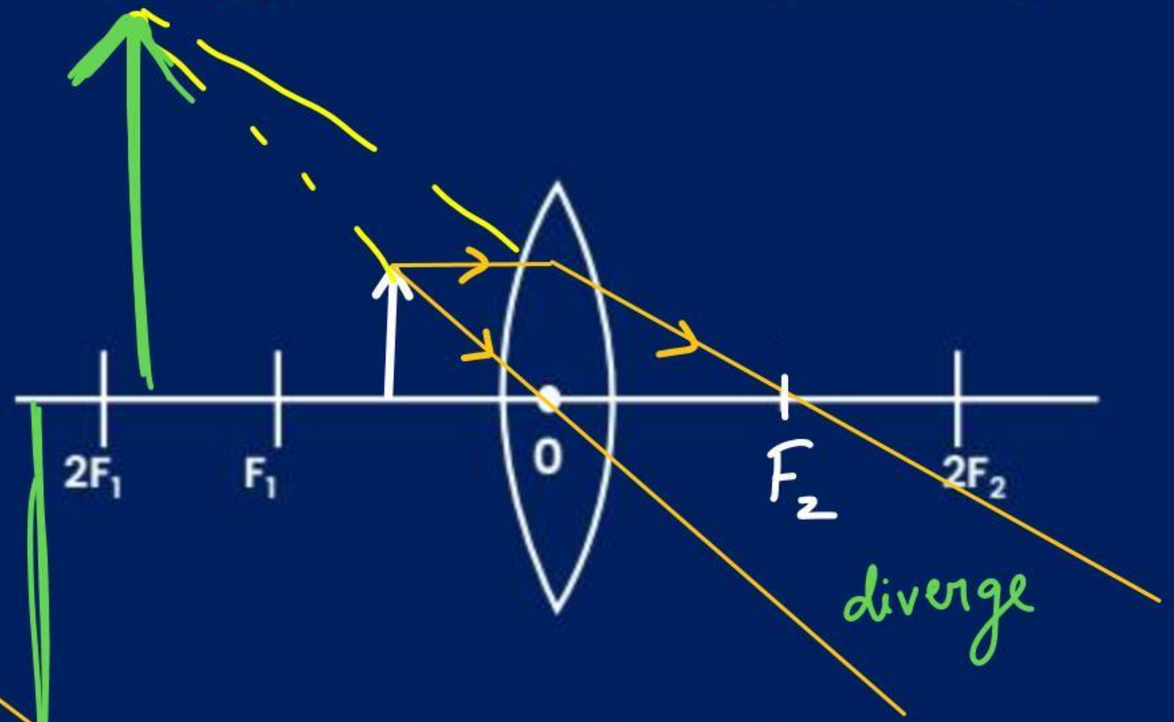
Parallel

Characteristics of Image

Image at ∞ ✓

Real, Inverted, Highly Magnified

Object Between F_1 & O

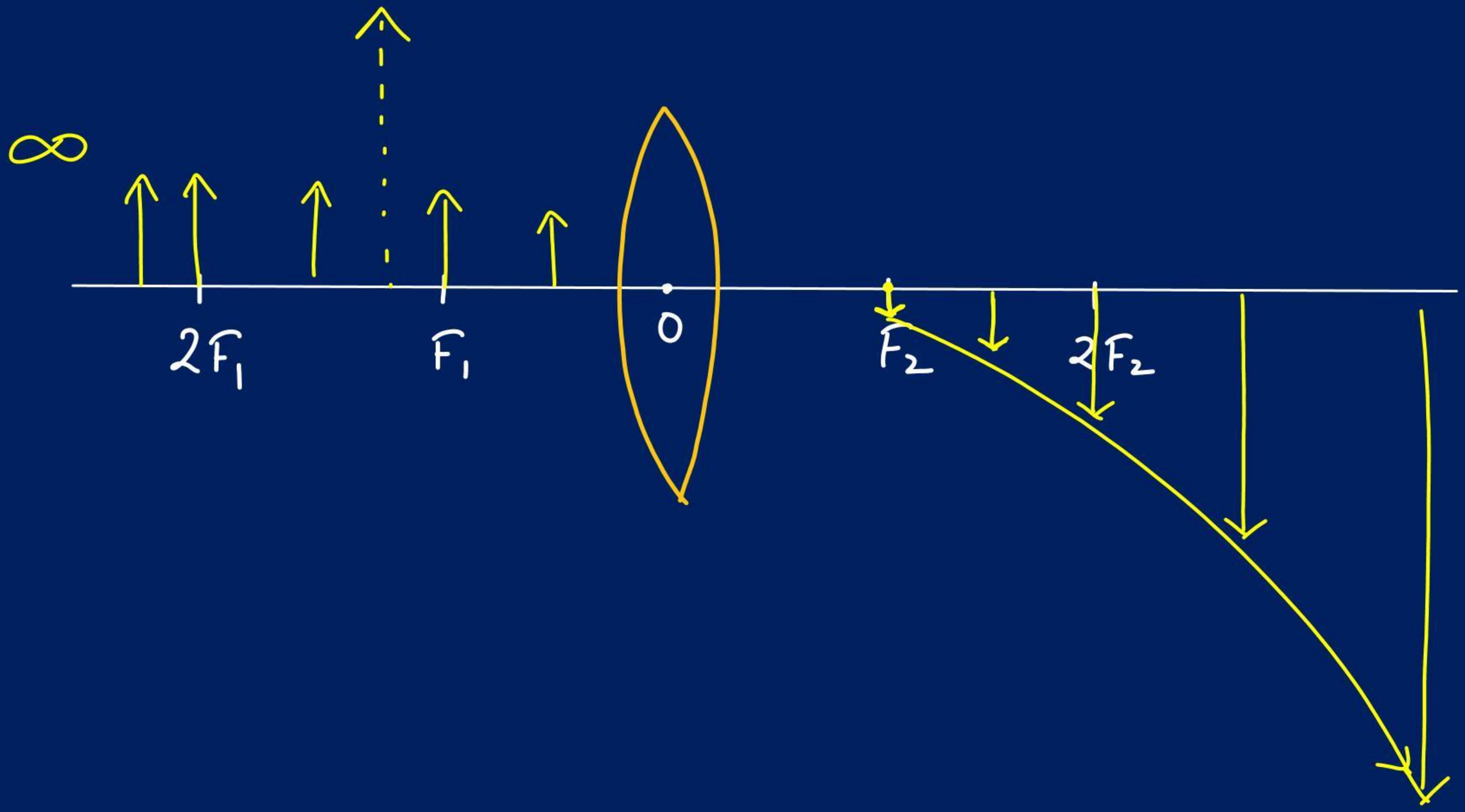


diverge

Characteristics of Image

Image on same side of object

Virtual, Erect, Magnified


∞
2F1
F1
O
F2
2F2

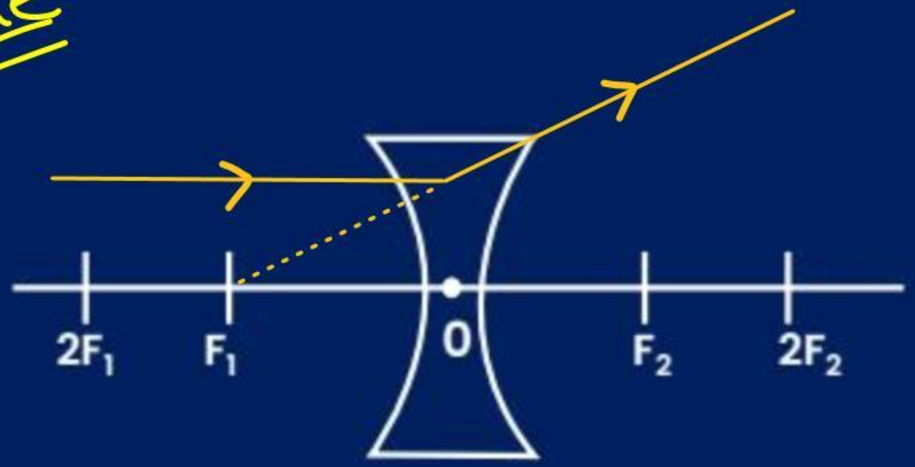
Learn

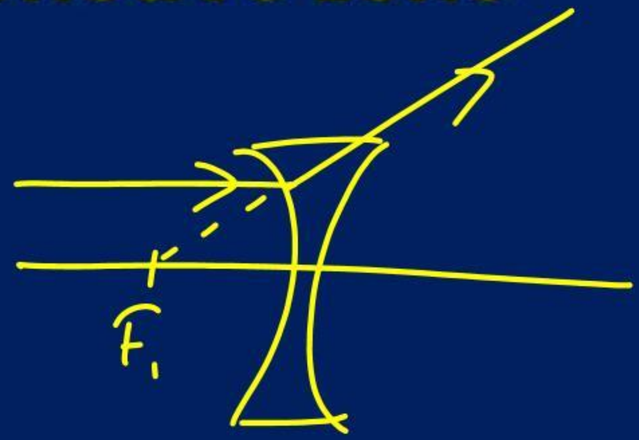
Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

Image Formation → Concave Lens

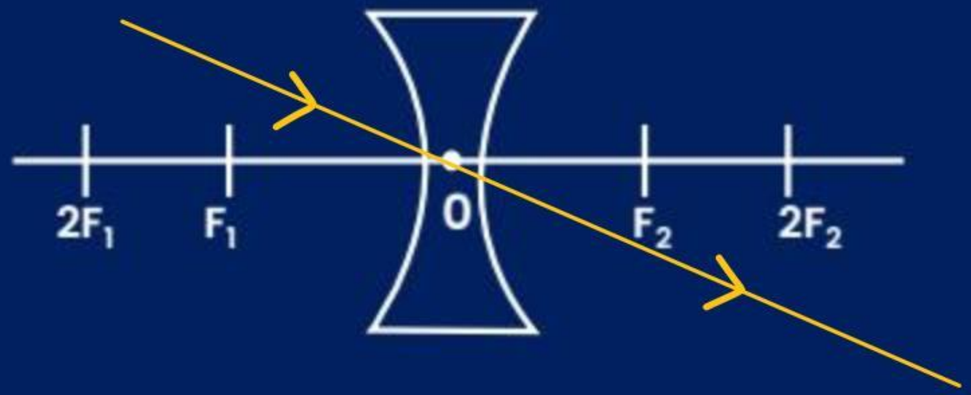
Rule

1.

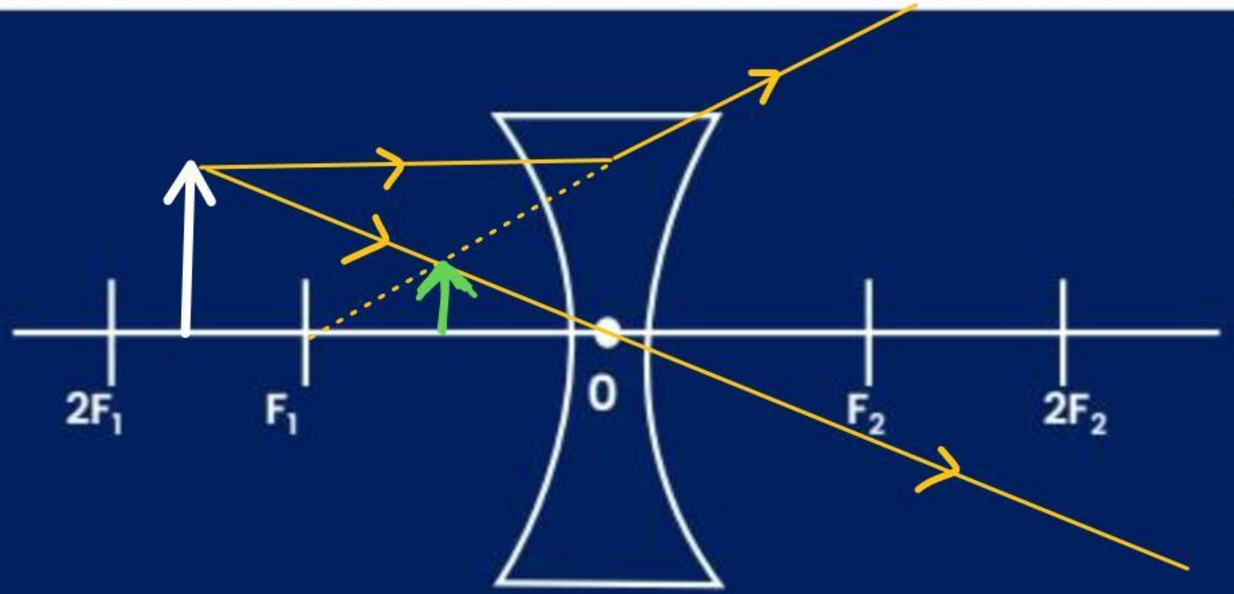




2.



Object at finite distance (anywhere except ∞)

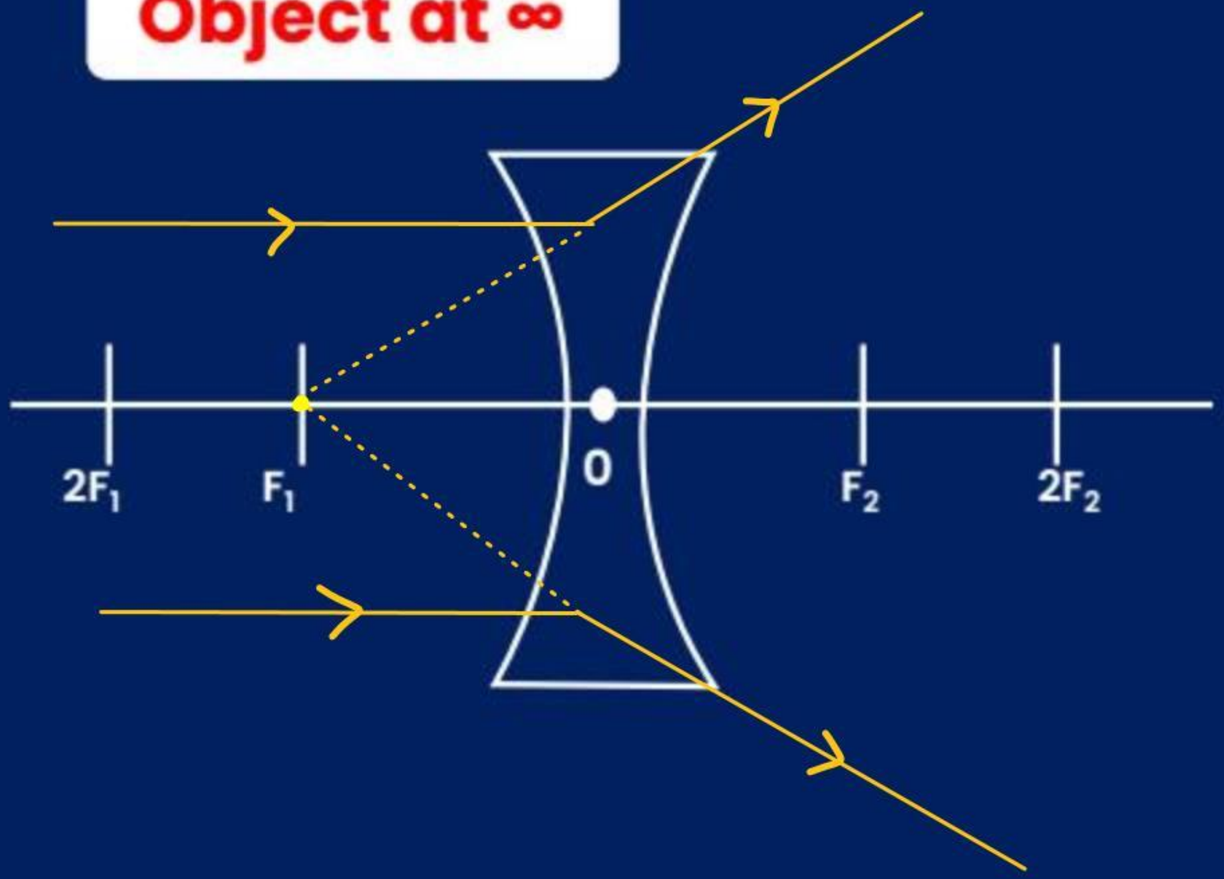


Characteristics of Image

Image between F_1 & O

Virtual, Erect, Diminished

Object at ∞



Characteristics of Image

Image at F_1

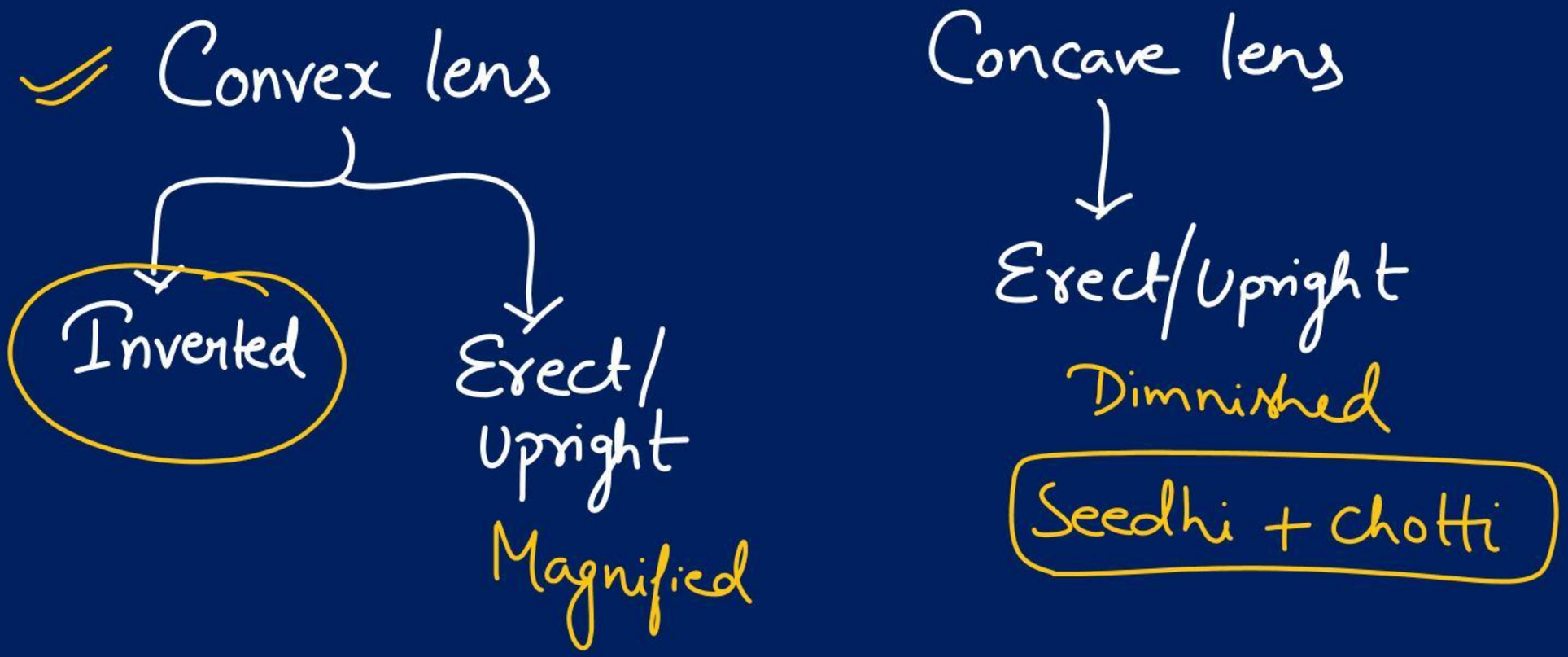
Virtual, Erect, Highly Diminished

↓

Point size

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect

Summary Of Convex & Concave Lens



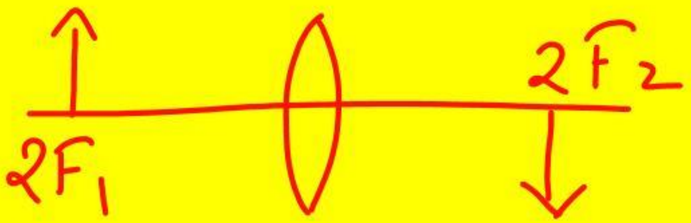
Q. At what distance from a convex lens should an object be placed to get an image of the same size as that of the object on a screen?

(a) Beyond twice the focal length of the lens.

(b) At the principal focus of the lens.

(c) At twice the focal length of the lens

(d) Between the optical centre of the lens and its principal focus.



(CBSE 2024)

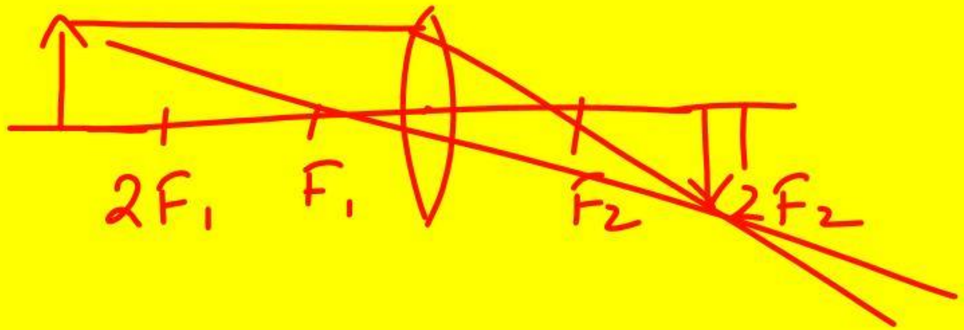
Q. When an object is placed beyond 2F of a convex lens, the nature of the image formed is

(a) real, inverted and diminished

(b) real, erect and magnified

(c) virtual, erect and magnified

(d) real, inverted and magnified.



(CBSE 2023)

Sign Convention , Lens Formula & Magnification

1) Here all distances are measured from O [optical Centre]

2) Rest all same rule for sign.

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

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

- $u \rightarrow$ -ve
- Convex $\rightarrow$ +ve
- f = +ve

Same Rule

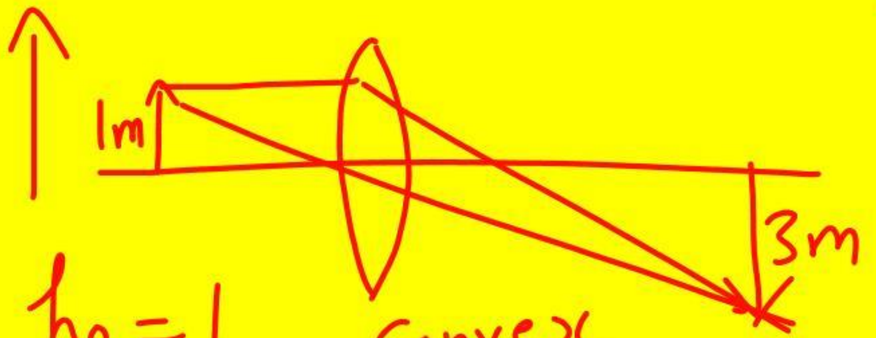
Q. The image of a candle flame formed by a lens is obtained on a screen placed on the other side of the lens. According to new cartesian sign convention, if the image is three times the size of the flame, then the lens is

(a) concave and magnification is +3

(b) concave and magnification is -3

(c) convex and magnification is -3

(d) convex and magnification is +3.



(CBSE Term I 2021-22)

$$m = \frac{h_i}{h_o} = \frac{-3}{1}$$

$$= -3$$

$$h_i = (-3) h_o$$

Q. An object of height 10 cm is placed 25 cm away from the optical centre of a converging lens of focal length 15 cm. Calculate the image-distance and height of the image formed. 15cm

(CBSE 2023)

$h_o = 10\text{cm}$

Convex lens

$+$

$f = +15\text{cm}$

$u = -25\text{cm}$

$V = ?$

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

$$\frac{1}{15} = \frac{1}{v} - \frac{1}{-25}$$

$$\frac{1}{15} = \frac{1}{v} + \frac{1}{25}$$

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{25} = \frac{5-3}{75} = \frac{2}{75}$$

$$v = \frac{75}{2}\text{ cm}$$

$$m = \frac{v}{u} = \frac{\frac{75}{2}}{-25} = \frac{-3}{2}$$

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

$$\frac{-3}{2} = \frac{h_i}{10}$$

$$h_i = -15\text{cm}$$

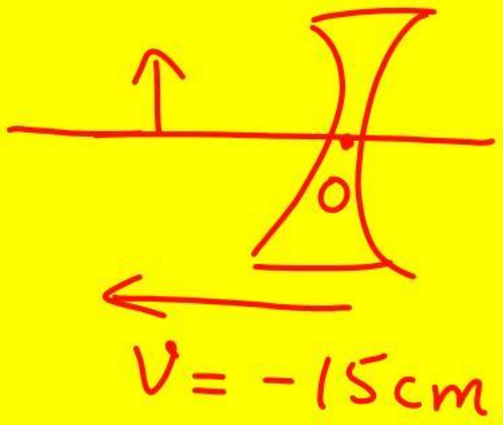
Q. The focal length of a concave lens is 20 cm. At what distance from the lens should a 5 cm tall object be placed so that its image is formed at a distance of 15 cm from the lens? Also o calculate the size of the image formed.

$f = -20\,cm$

$h_o = 5\,cm$

$v = -15\,cm$

$u = ?$



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

(CBSE 2024)

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

H.W. Comment

Power of a Lens

Ability Of A Lens To Converge Or Diverge Rays Of Light.

Convex lens
+ve
$f \rightarrow +ve$
$P \rightarrow +ve$

It Is Defined As Reciprocal Of Focal Length.

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

P → Diaptore (D)

f → always in metre

$\frac{cm}{100}$

Power of Combination

$$P = P_1 + P_2 + \dots$$

$$P = \frac{1}{f_1} + \frac{1}{f_2} + \dots$$

P → D

f_1 f_2 → in metres

Q. An object is kept at a distance of 1m from a lens of power +2D:

(i) Identify the type of lens. Convex

(ii) Calculate its focal length and distance of the image formed.

$P = +2\,D$

$\frac{1}{f\,(\text{in metres})} = +2$

$f = \frac{1}{2} = 0.5\,\text{metre}$

(CBSE 2023)

$u = -1m$

$v = ?$

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

Comment

Q. The power of a combination of two lenses in contact is +1.0 D. If the focal length of one of the lenses of the combination is +20.0 cm, the focal length of the other lens would be

(CBSE Term I 2021-22)

(a) -120.0cm

(b) +80.0 cm

(c) -25.0cm

(d) -20.0cm

$$P = P_1 + P_2$$

$$1 = \frac{1}{f_1} + \frac{1}{f_2}$$

f_1 f_2 → in metre

$$f_2 = \frac{1}{4} \times 100$$

$$= -25\,cm$$

$$1 = \frac{1}{\frac{20}{100}} + \frac{1}{f_2}$$

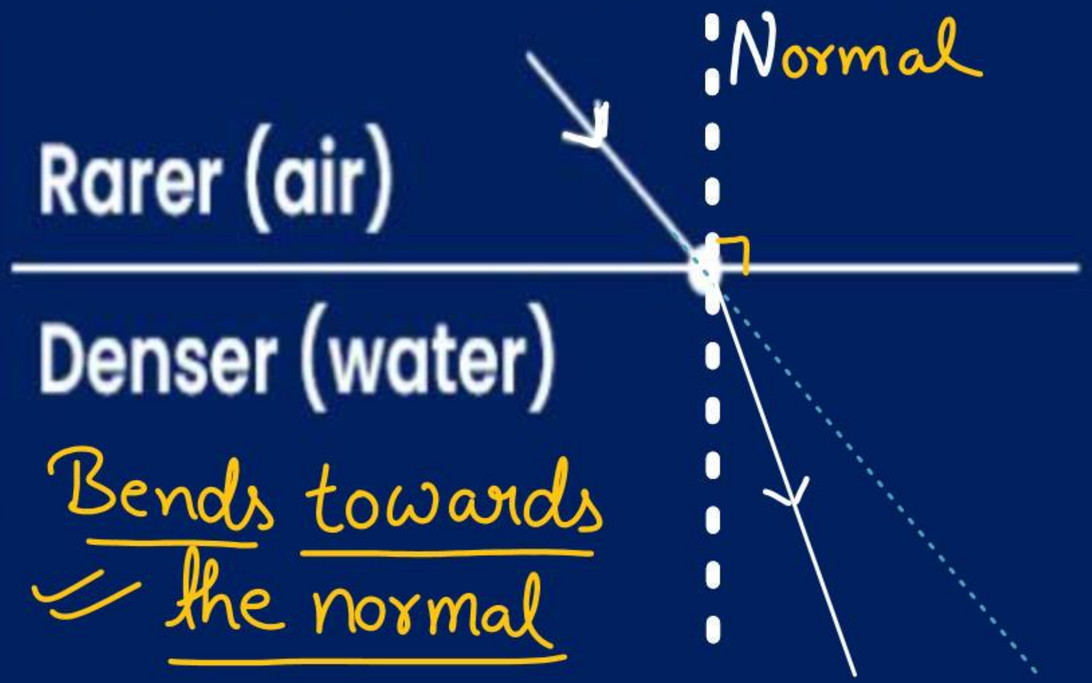
$$1 = \frac{100}{20} + \frac{1}{f_2}$$

$$\frac{1}{f_2} = 1 - 5 = -4$$

$$f_2 = \frac{-1}{4}\,m$$

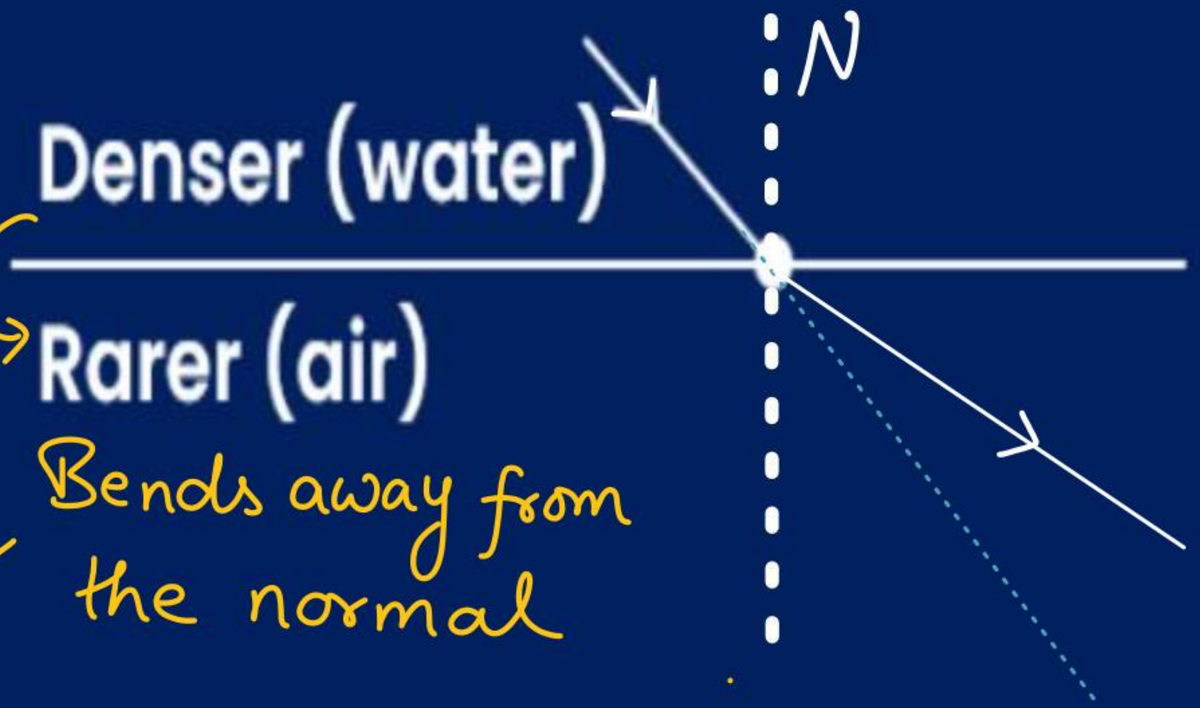
Refraction of light

Rarer to Denser Medium



Bends towards the normal

Denser to Rarer Medium



Bends away from the normal

Denser → Jisme speed of light कम हो!

No change in medium

No Bending

Refractive Index (R.I.)

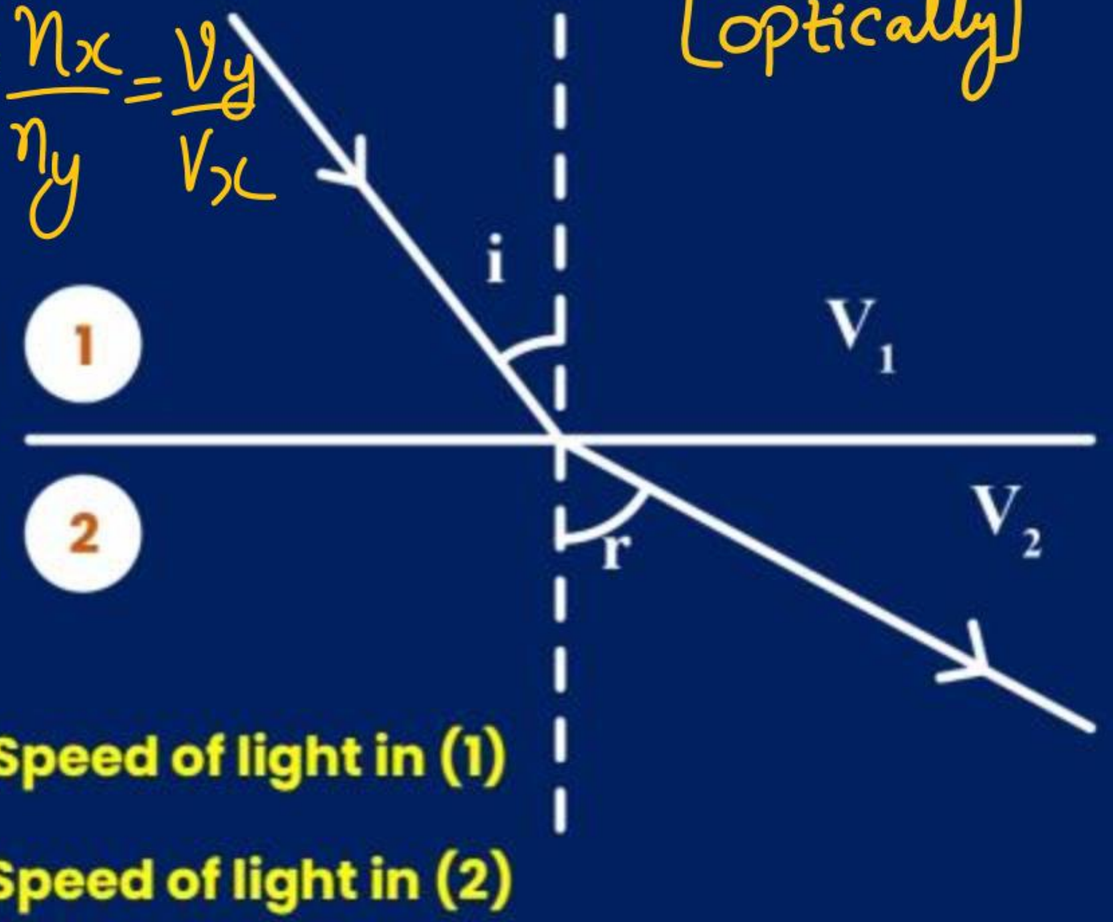
$(\eta) \Rightarrow$ Kitna Dense ?? [optically]

R.I. of 2 (g) w.r.t. 1 (ω)

$$\eta_{12} = \frac{\eta_2}{\eta_1} = \frac{V_1}{V_2}$$

$$\eta_{\omega g} = \frac{\eta_g}{\eta_\omega} = \frac{V_\omega}{V_g}$$

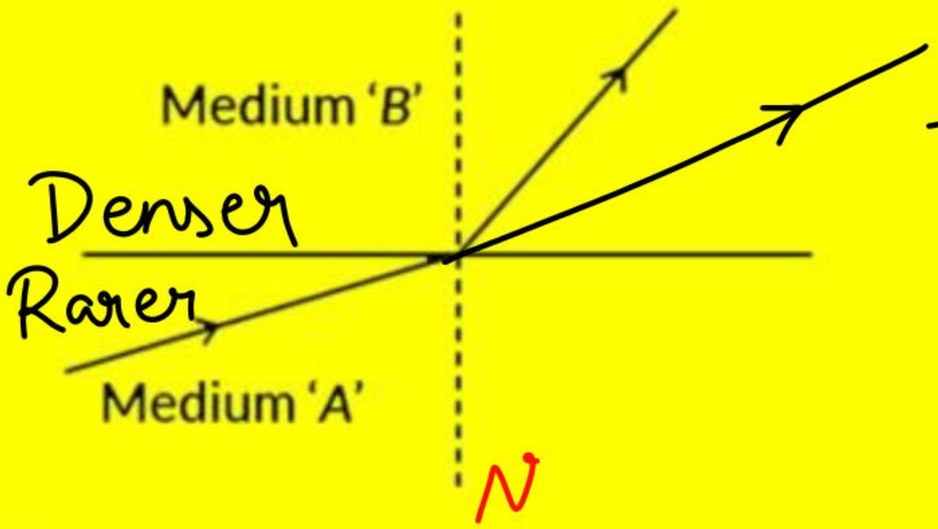
$$\eta_{yx} = \frac{\eta_x}{\eta_y} = \frac{V_y}{V_x}$$



V_1 = Speed of light in (1)

V_2 = Speed of light in (2)

Q. A light ray enters from medium A to medium B as shown in the figure.



Towards the normal

$$\eta_{AB} = \frac{\eta_B}{\eta_A} = \frac{v_a}{v_b}$$

(a) Which one of the two media is denser w.r.t. other medium ? Justify your answer.

(b) If the speed of light in medium A is v_a and in medium B is v_b what is the refractive index of B with respect to A.

(CBSE 2023)

Absolute Refractive Index (R.I.) Refractive Index

When 1st medium is Air, 2nd medium is any medium.

R.I. of glass w.r.t air

$$\eta_{ag} = \frac{\eta_g}{\eta_a} = \frac{V_a}{V_g}$$

$\eta_a \approx 1$

$V_a = C$

$$\eta_g = \frac{V_a}{V_g}$$

$$\boxed{\eta_g = \frac{C}{V_g}}$$

R.I. of water w.r.t air

$$\eta_{aw} = \frac{\eta_w}{\eta_a} = \frac{V_a}{V_w}$$

$\eta_a \approx 1$

$V_a \to C$

$$\boxed{\eta_w = \frac{C}{V_w}}$$

Ab RI medium X

$$\boxed{\eta_x = \frac{C}{V_x}}$$

Ab. R.I. of Gudiya.

$$\eta_{AG} = \frac{\eta_G}{\eta_A} = \frac{v_A}{v_G}$$

$$\eta_A \approx 1$$

$$v_A \to c$$

$$\boxed{\eta_G = \frac{c}{v_G}}$$

$$\boxed{\eta_\gamma = \frac{c}{v_\gamma}}$$

Concept building

R.I. of glass is 1.5

R.I. of water is 1.33

- Which is more dense? glass
- In which light travels faster → water
- Find relation between V_g & V_w.

$$n_{wg} = \frac{n_g}{n_w} = \frac{V_w}{V_g}$$

(a) Define the term absolute refractive index of a medium.

R.I. of medium w.r.t air $\eta = \frac{c}{v}$ **(CBSE 2023)**

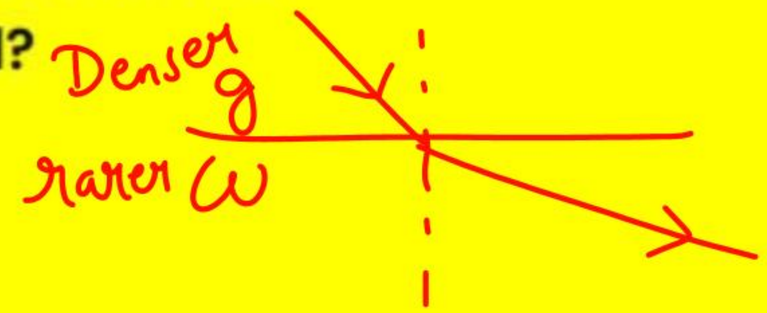
(b) Absolute refractive indices of water and glass are $\frac{4}{3}$ and $\frac{3}{2}$ respectively

rarer dense

$\eta_w = \frac{4}{3} = 1.33$ $\eta_g = \frac{3}{2} = 1.5$

(i) In which one of the two media is the speed of light more? → water

(ii) If a ray of light enters obliquely from glass to water, will it bend towards the normal or away from the normal?



(c) The absolute refractive indices of water and glass are $\frac{4}{3}$ and $\frac{3}{2}$ respectively. If the speed of light in glass is 2×10^8 m/s, find the speed of light in (i) water and (ii) vacuum.

$n_w = \frac{4}{3}$ $n_g = \frac{3}{2}$

$n_{wg} = \frac{n_g}{n_w} = \frac{v_w}{v_g}$ (CBSE 2023)

$v_g =$ ✓ $v_w =$??

H.W.
Comment

Ab R.I.

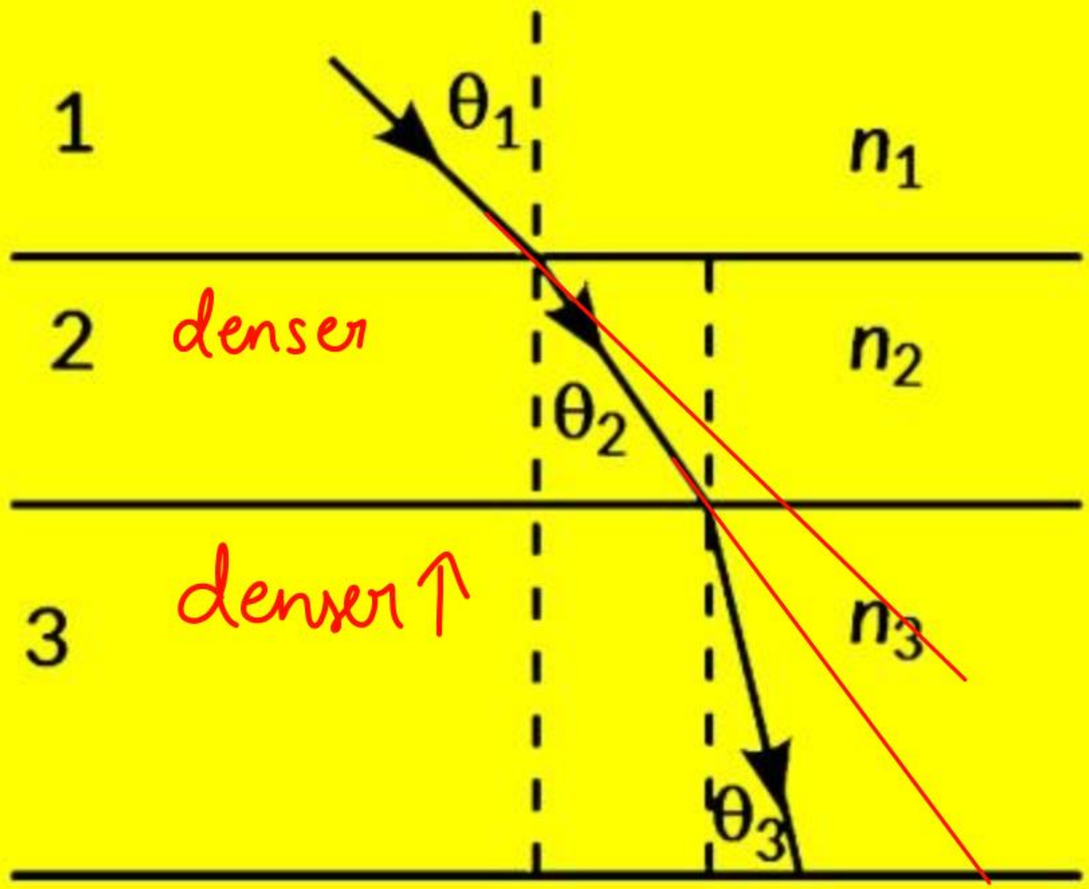
✓ $n_g = \frac{c}{v_g}$ ✓ ?

Q. In the diagram shown above n_1, n_2 and n_3 are refractive indices of the media 1, 2 and 3 respectively. Which one of the following is true in this case?

(CBSE Term I 2021-22)

Dense $\eta \uparrow$

$n_3 > n_2 > n_1$



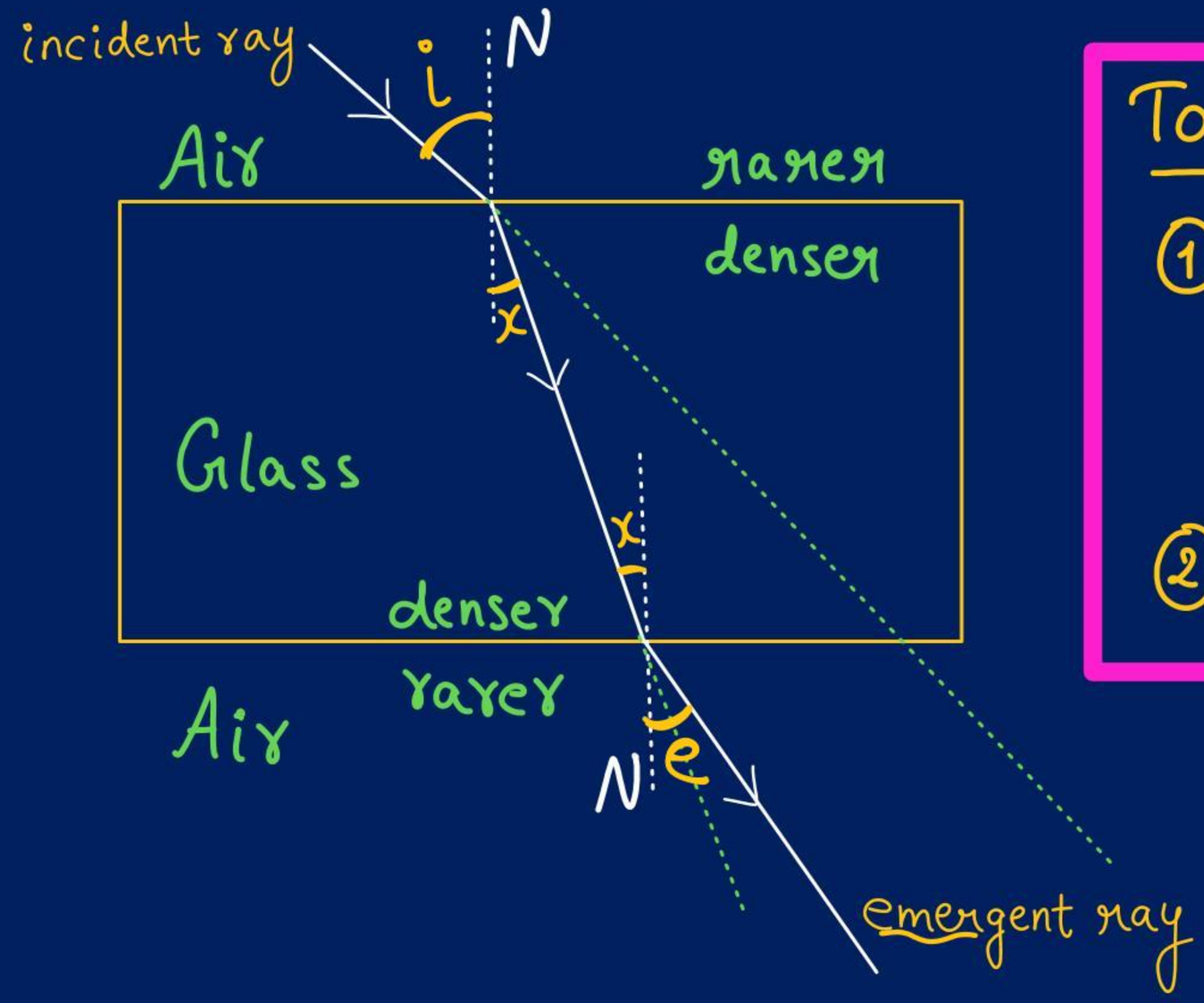
(a) $n_1 = n_2$

(b) $n_1 > n_2$

(c) $n_1 > n_3$

(d) $n_3 > n_1$

Refraction Through A Glass Slab



To remember

1. emergent ray is parallel to incident ray
2. $\angle e = \angle i$

Laws of Refraction:

① • The incident ray, Normal & the refracted ray lies on the same plane

② • The ratio of sine of Angle of incidence to the sine of angle of refraction remains constant for a given pair of media.

Snell's Law

$$\frac{\sin i_1}{\sin \gamma_1} = \frac{\sin i_2}{\sin \gamma_2}$$

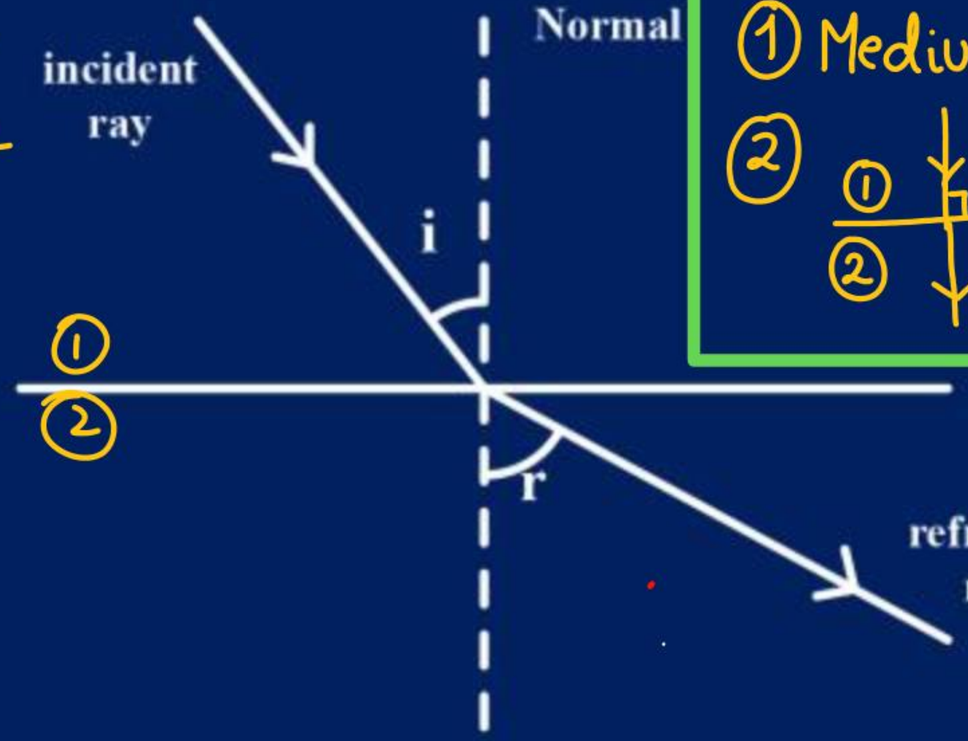
$$\frac{\sin i}{\sin \gamma} = \text{Constant}$$

i_1 γ_1

i_2 γ_2

$i \rightarrow$ Change

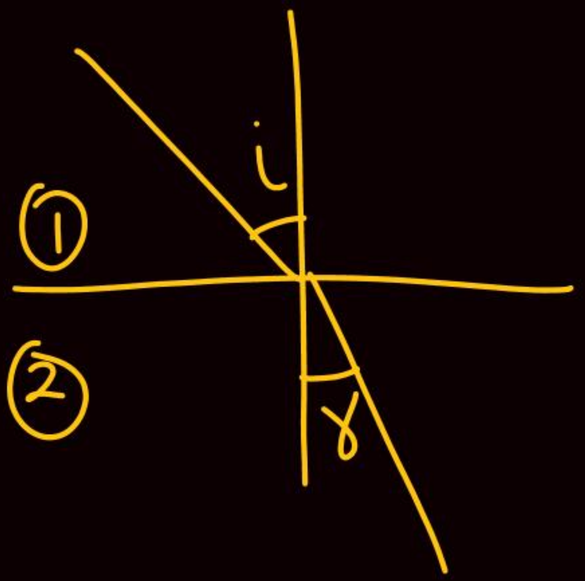
$\gamma \rightarrow$ Change



No Bending

① Medium Same

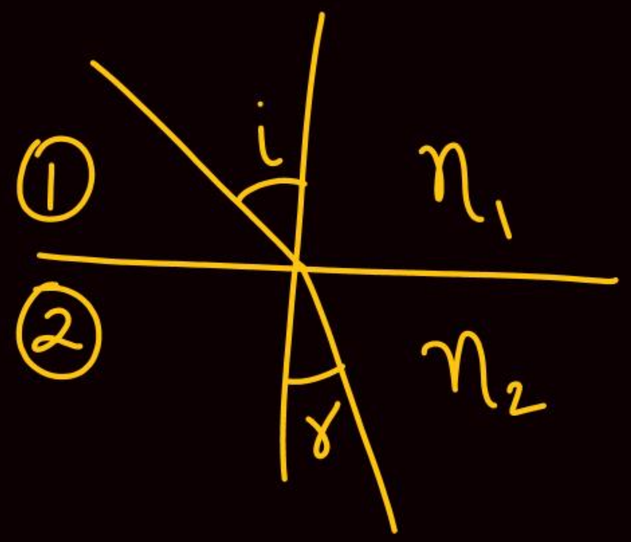
②



$$\frac{\sin i}{\sin \gamma} = \text{Constant} = {}_1\eta_2$$

$i, \gamma \rightarrow$ change ✓

$$\frac{\sin i}{\sin \gamma} = {}_1\eta_2$$



$$\eta_1 \sin i = \eta_2 \sin \gamma$$

$$\frac{\sin i}{\sin \gamma} = \frac{\eta_2}{\eta_1} = \eta_{12}$$