ALAKH SIR ke FARREY

LIGHT REFLECTION AND REFRACTION

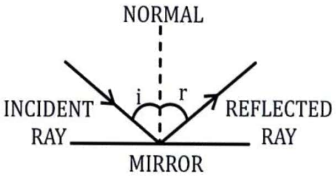
REFLECTION OF LIGHT

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

Laws of Reflection :-

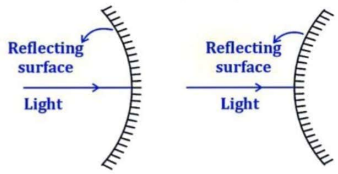
(i) $\angle i = \angle r$
Angle of incidence = Angle of Reflection

(ii) The incident ray, reflected ray, and the normal, all lie in the same plane.

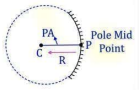


Spherical Mirrors :-

concave mirror **convex mirror**



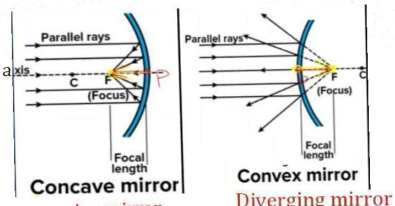
Pole :- Centre is reflecting surface of spherical mirror.
Centre of Curvature - Centre of the sphere of which the mirror is part of



Principal Axis - line joining P and C
Radius of Curvature - Distance PC

✲ Principal Axis is normal to mirror at Pole.

Principle Focus (F) and Focal length (f) :-

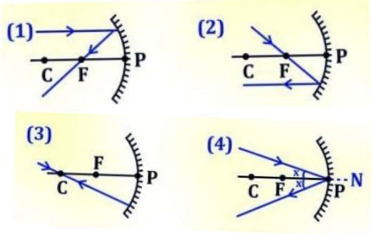


In our syllabus
R = 2f

Image formation and characteristics

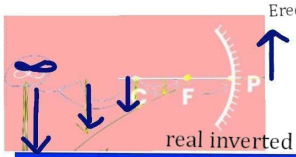
- if rays of light actually meet → Real
- if rays of light appear to meet → Virtual

image formation - Concave mirror



Position of object	Figure	Position of image	Nature of image
1. At infinity		At the principal focus or in the focal plane	Real, inverted, extremely diminished in size
2. Beyond the centre of curvature		Between the principal focus and centre of curvature	Real, inverted and diminished
3. At the centre of curvature		At the centre of curvature	Real, inverted and equal to object
4. Between focus and centre of curvature		Beyond centre of curvature	Real, inverted and bigger than object.
5. At the principal focus		At infinity	Extremely magnified
6. Between the pole and principal focus		Behind the mirror	Virtual, erect and magnified

Erect, virtual magnified

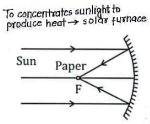


object	Image
1) ∞	F
2) ∞ c	FC
3) C	C
4) CF	C∞
5) F	∞
6) FP	

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

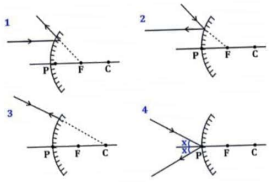
Uses of Concave Mirror

To concentrates sunlight to produce heat → solar furnace

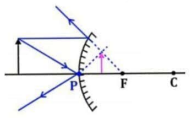


Concave Mirror

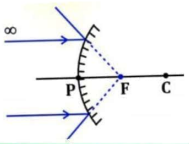
Image Formation : convex Mirror



Object at finite distance :-
(anywhere except ∞)
Characteristics
Image between F and P, virtual, erect, Diminished upright



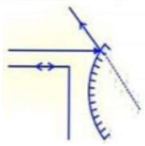
object at ∞ :-
Characteristics
Image at F
Virtual, Erect, Highly Diminished point size



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

Use of Convex Mirror :-

- Rear-View mirrors -
  - Upright / Erect image
  - wider field of view



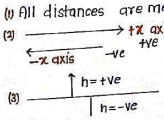
summary - convex and Concave Mirror :-

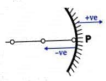
✲ Concave Mirror
- Inverted
- Erect / Virtual upright, Enlarged
(Seedhi + Badi Image)

✲ Convex Mirror
- only Erect, Virtual Diminished
(seedhi or chotti image)

Sign Convention

(1) All distances are measured from pole.



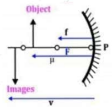


Mirror formula

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

u = object distance
v = Image distance

Note: u → -ve Always
f → +ve convex
convex → +



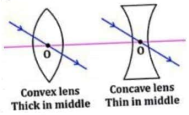
Magnification (m)

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

hi = mho

Spherical lenses :-

- Principal axis
- Optical Centre [O]

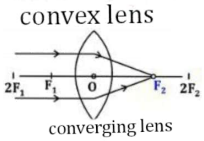


Convex lens
Thick in middle

Concave lens
Thin in middle

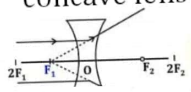
Principle Focus (F) and Focal length (f)

convex lens



converging lens

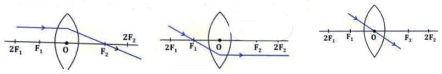
concave lens



diverging lens

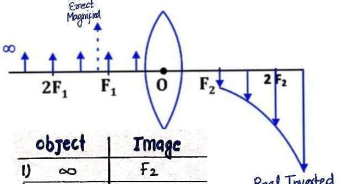
Note: They have two F F1 and F2 due to two curved surfaces

image formation → convex lens



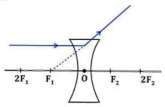
Ray diagram	Position of object	Position of image	Nature of image
	At infinity	At F	Real, inverted and highly diminished
	Between infinity and 2F	Between F and 2F	Real, inverted and diminished
	At 2F	At 2F	Real, inverted and same sized

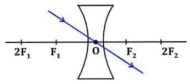
Ray diagram	Position of object	Position of image	Nature of image
	Between F and 2F	Beyond 2F	Real, inverted and enlarged
	At F	At infinity	Real, inverted and enlarged
	Between F and O	On the same side of the lens	Virtual, erect and enlarged



object	Image
1) ∞	F2
2) ∞ 2F1	F2 2F2
3) 2F1	2F2
4) 2F1 F1	2F2 ∞
5) F1	∞
6) F1 O	

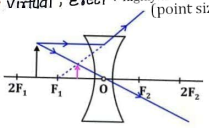
Image Formation → Concave lens





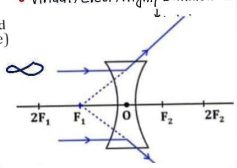
object at finite distance (anywhere except ∞)

characteristics of image
- Image between F1 & O
- Virtual, Erect, highly diminished (point size)



object at ∞

characteristics of image
- Image at F1
- Virtual, Erect, Highly Dimnished



summary of convex and concave lens

convex lens → Inverted; Erect/upright magnified

Concave lens → Erect/Upright Dimnished (seedhi + chatti)

Sign convention, Lens formula & Magnification

1) Here all distances are measured from O [optical centre]
2) Rest all same rule for sign.

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

$$m = \frac{h_1}{h_0} \qquad m = \frac{v}{u}$$

u → -ve
f → +ve
convex → +ve

Power of a lens

- Ability of a lens to converge or Diverge Rays of light.
- it is defined as Reciprocal of focal length.

convex lens → +ve
f → +ve
P → +ve

$P = \frac{1}{f}$ — Diaptore (D) — always in metre — $\frac{cm}{100}$

power of combination

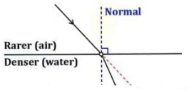
$P = P_1 + P_2 + \dots$

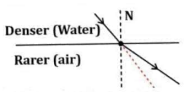
$P = \frac{1}{f_1} + \frac{1}{f_2} \dots$

D — f_1, f_2 → in metres

Refraction of light :-

The Bending of light ray when its travels from one medium to another.





Rarer to Denser Medium Bends towards the normal

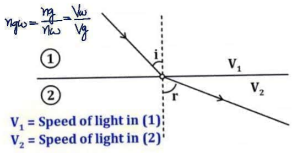
Denser to Rarer Medium Bends away from the normal

No change in medium No Bending

$$n_{21} = \frac{n_2}{n_1} = \frac{V_1}{V_2}$$

Refractive Index (R.I)

Measure of How dense a medium is



V_1 = Speed of light in (1)
V_2 = Speed of light in (2)

R.I of 2 w.r.t 1

$$n_{21} = \frac{n_2}{n_1} = \frac{V_1}{V_2}, \quad n_{gw} = \frac{n_g}{n_w} = \frac{V_w}{V_g}$$

Absolute Refractive index

When first medium is air and second medium is any medium.

R.I of water w.r.t Air

$$n_{wa} = \frac{n_w}{n_a} = \frac{V_a}{V_w}$$

$n = 1$
$V_a = c$

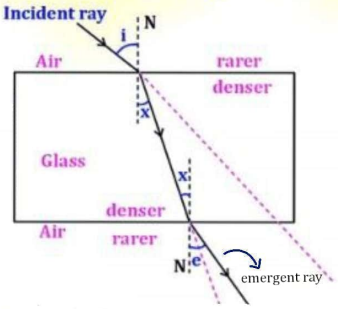
$$n_w = \frac{c}{V_w}$$

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

✓ 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

Refraction Through A Glass Slab



To remember
① emergent ray is parallel to incident ray.
② ∠e = ∠i

Laws of Refraction :-

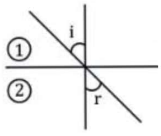
(i) The incident ray, Normal & the refracted ray lies on the same plane.
(ii) The ratio of sine of Angle of incidence to the sine of angle of refraction remains constant for a given pair of media.

Snell's law :-

$$\frac{\sin i_1}{\sin r_1} = \frac{\sin i_2}{\sin r_2}$$

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

i → change i_1, r_1
r → change i_2, r_2

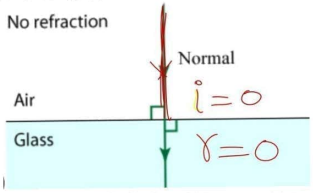


$$n_1 \sin i = n_2 \sin r$$

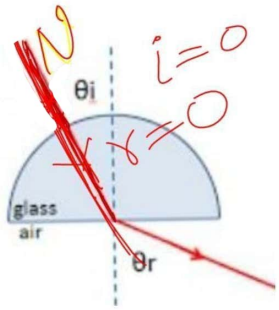
$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = n_{12}$$

Case of NO Bending

1) Normal incidence



2) No medium change or no change in refractive index



LIGHT (CYQ)

Question-1) (i) The Relation R = 2f is valid — CBSE 2021, 2022, 2023

for concave mirrors but not for convex mirror
for convex mirrors but not for concave mirror.
neither for concave mirrors nor for convex mirror
for both concave and convex mirrors

(ii) The radius of curvature of a converging mirror is 30cm. At What distance from the mirror should an object be placed so as to obtain a virtual image?

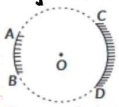
(a) Infinity (b) 30 cm (c) Between 15cm & 30cm (d) Between 0cm & 15cm

(iii) The magnification produced when an object is placed at a distance of 20cm from a spherical mirror is +1/2. Where should the object be placed to reduce the magnification to +1/3 ?

Question-2) A spherical mirror forms a real, inverted image with a magnification of 2. if the image is at a distance of 30cm from the mirror, determine the object's position and the mirror's focal length. Additionally, list two characteristics of the image if the object is moved 10cm closer to the mirror.

The image of a candle flame placed at a distance of 30cm from a mirror is formed on a screen placed in front of the mirror at a distance of 60cm from its pole. What is the nature of the mirror? find its focal length, if the height of the flame is 2.4 cm. find the height of its image. state whether the image formed is erect or inverted.

AB and CD, two spherical mirrors, from parts of a hollow spherical ball with its centre at O as shown in the diagram. if arc AB = 1/2 arc CD, What is the ratio of their focal lengths? state which of the two mirrors will always from virtual image of an object placed in front of it and why?



CBSE (2016, 2017, 2019, 2020)

Question-3) (a) Draw ray diagrams for the following cases when ray of light.
(i) passing through centre of curvature of a concave mirror is incident on it.
(ii) parallel to principal axis is incident on convex mirror.
(iii) is passing through focus of a concave mirror incident on it. CBSE 2019, 2020

(b) Where should an object be placed in front of a concave mirror of focal length 20cm so as to obtain a two times magnified virtual image of the object?

Question-4) (i) The linear magnification produced by a spherical mirror +3". Based on this statement answer the following questions: What is the type of mirror?

(ii) The image formed by a spherical mirror is real, inverted and its magnification is -2. if the image is at a distance of 30 cm from the mirror. , where is the object placed? find the focal length of the mirror. List two characteristics of the image formed if the object is moved 10 cm towards the mirror. CBSE 2016, 2024

Question-5) study the data given below showing the focal length of three concave mirrors A, B and C and the respective distances of objects placed in front of the mirrors.

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

(a) In which one of the above cases the mirror will form a diminished image of the object? Justify your answer. Also draw a ray diagram to show the type of image formed when an object is placed between pole and focus of a concave mirror as in case 3.

(b) List two properties of the image formed in case 2 and applications of concacave mirror

(ii) Neha visited a dentist in his clinic. she observed that the dentist was holding an instrument fitted with a mirror. state the nature of this mirror and reason for its use in the instrument used by dentist. (CBSE 2020, 2023, 2024)

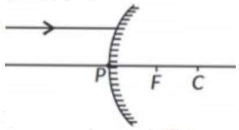
Question-6) (a) Define the principal axis of a concave mirror. if a ray of light is incident on a concave mirror, parallel to its principal axis. After reflection from the mirror passes through the principal axis from a point at a distance of 10cm from the pole of the mirror, find the radius of curvature of the mirror.

(b) An object 4cm in height is placed at 15cm in front of a concave mirror of focal length 10cm. At what distance from the mirror should a screen be placed to obtain a sharp image of the object. Calculate the height of the image. (CBSE 2016, 2019, 2023, 2024)

Question-7) (a) An object is placed at a distance of 10cm from the pole of a convex mirror with a focal length of 15cm. Determine the position of the image. Draw a ray diagram to illustrate image formation in this case. Also, identify the type of mirror that always forms a virtual, erect, and diminished image.

(b) A security mirror used in a big showroom has radius of curvature 5m. if a customer is standing at a distance of 20m from the cash counter, find the position, nature and size of the image formed in the security mirror.

(ii) A ray of light is incident on a convex mirror. Redraw the given diagram and complete the path of the reflected ray. Mark the angle of incidence and the angle of reflection on your diagram.



(CBSE 2017, 2019, 2020, 2023) CBQ

Question-8) (i) Absolute refractive index of glass and water is 3/2 and 4/3 respectively. if the speed of light in glass is 2×10^8 m/s, the speed in water is

(a) $9 \times 4 \times 10^8$ m/s
(b) $5/2 \times 10^8$ m/s
(c) $7/3 \times 10^8$ m/s
(d) $16/9 \times 10^8$ m/s

(ii) Determine the speed of light in diamond if the Refractive index of diamond with respect to vaccum is 2.42. speed of light in vaccum is 3×10^8 m/s.

The refrective index of a medium 'x' with respect to a medium 'y' is 2/3 and the refractive index of medium 'y' with respect to medium 'x'. if the speed of light in medium 'x' is $3 \times 10^8 ms^{-1}$, calculate the speed of light in medium 'y'.

(iii) - medium 'y' with respect to medium 'z' is 4/3

(CBSE 2020, 2023, 2024)

Question-9) (i) The power of a lens is +4D. find the focal length of this lens. An object is placed at a distance of 50cm from the optical centre of this lens. state the nature and magnification of the image formed by the lens and also draw a ray diagram to justify your answer.

(ii) (a) What is the nature (convergent/divergent) of the combination of a convex lens of power +4D and a concave lens of power −2D? (CBSE 2018, 2021, 2022, 2023)

(b) calculate the focal length of a lens of power −2.5D? (CBQ)

(c) Draw a ray diagram to show the nature and position of an image formed by a convex lens of power +0.1D, When an object is placed at a distance of 20cm from its optical centre.

Question-10) (i) if 5cm tall object is placed perpendicular to the principle axis of a convex lens of focal length 20cm. The distance of the object from the lens is 30 cm. find the position, nature and size of the image formed.

(ii) At What distance from a concave lens of focal length 25cm a 10 cm tall object be placed so as to obtain its image at 20cm from the lens. Also calculate the size of the image formed. (CBSE 2015, 2016, 2019, 2020, 2024)