Board – ICSE	Class – 9th	Topic – LIGHT

1. Focal length of a convex lens recorded by three students are 10.1 cm, 10.2 cm and 10.0 cm. Find the mean focal length of the convex lens.

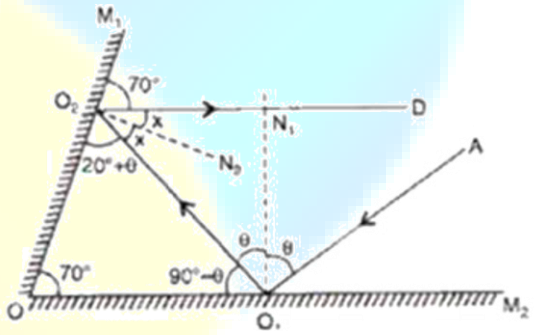
Ans.- Mean focal length of the convex lens

$$f = \frac{10.2\text{cm} + 10.1\text{cm} + 10.0\text{cm}}{3}$$

$$= \frac{30.3\text{ cm}}{3} = 10.1\text{cm}$$

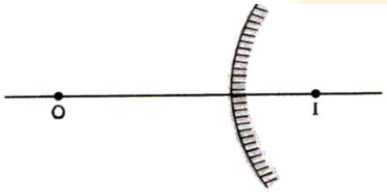
2. Two plane mirrors are inclined to each other at an angle of 70°. A ray of light is incident on one mirror at an angle θ . The ray reflected from this mirror falls on the second mirror from where it is reflected parallel to the first mirror. Determine the value of θ .

Ans.- Ray diagram is drawn as shown in the above figure

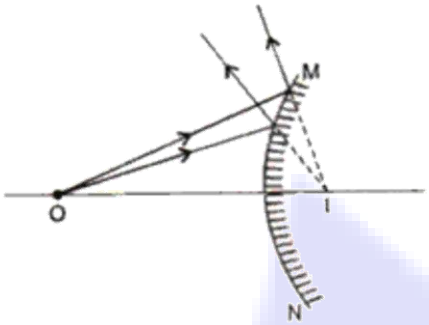


$\angle M_1O_2D = \angle M_1OM_2 = 70°$
From the figure,
$\angle O_2O_1O = 90° - \theta$ and $\angle OO_2O_1 = 180° - (70° + 90° - \theta))$
$= 20° + \theta$
$\angle N_2O_2O_1 = 90° - (20° + \theta) = 70° - \theta$
But $\angle M_1O_2N_2 = 90°$
$x = 90^o - (20^o + \theta) = 70^o - \theta$
As we know that
$\angle M_1O_2D + \angle N_2O_2D = 90°$
$70^o + 70^o - \theta = 90^o$
$\Rightarrow \theta = 50°$

3. Complete the ray diagram.



Ans.-



4. An observer moves towards a stationary plane mirror at a speed of 'v' m/s. With what speed, will his image move towards him?

Ans.- Since the distance of the image from the mirror is equal to the distance of the object (observer) from the mirror at every instant during his motion, the speed of his image with respect to him will be v + v = 2v m/s.

5. Answer the following questions:

(i) Which mirror has the highest radius of curvature?

(ii) Which mirror (plane/spherical) has the least focal length?

(iii) What is the relation between the mirror radius and its focal length?

(iv) Why dish antennas are hemispherical in shape?

Ans.- (i) A plane mirror.

(ii) A spherical mirror.

(iii) Focal length of the spherical mirror,

$$f = \frac{\text{Radius of curvature(R)}}{2}$$

(iv) They receive parallel rays and focus them on the receiver.

6. Two plane mirrors are placed at right angles to each other. A ray strikes one mirror at an angle of incidence θ such that, it is reflected from the second mirror. Show that for any value of λ, the ray reflected from the second mirror is parallel to that incident on the first mirror, but opposite in direction.

Ans.- The distance between the pole and centre of curvature of a mirror is called the radius of curvature.

Consider a concave mirror MN of radius of curvature R and focal length f. P is the pole of mirror, F is its principal focus and C is its centre of curvature, then PC = R and PF = f.
A ray AB parallel to principal axis is incident on the concave mirror at point B. By definition of principal focus, it travels along F after reflection from the mirror. The line joining
from C to B is normal on the mirror at B. Therefore, angle of incidence
$\angle ABC = i$
From law of reflection, Angle of incidence $\angle i$ = Angle of reflection $\angle r$
$\therefore \angle ABC = \angle FBC$

But ∠BCF = ∠ABC

∠BCF = ∠FBC

ΔBCF is an isosceles triangle. Hence,CF = FB.

If aperture of amirror is small, point B is very near to P, so FB ≈ FP

∴ CF = FP

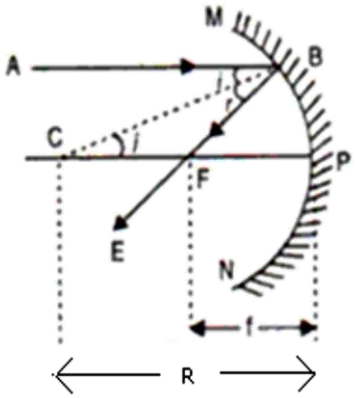
or FP + CF = FP +FP

or FP + CF = 2FP

$FP = \frac{FP + CF}{2} = \frac{PC}{2}$

$or, f = \frac{1}{2}R$

Thus, the radius of curvature of a concave mirror is twice its focal length.

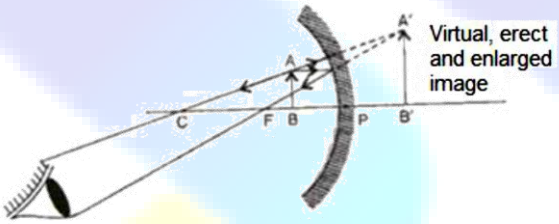


7. (i) A clock having marks instead of numbers on its dial appears to indicate 4:35 when viewed through a plane mirror. What is the correct time? Explain the anomaly.

(ii) Draw a neat ray diagram to illustrate how a concave mirror is used as a shaving mirror.

Ans.- (i) Correct time is 7:25. Anomaly is due to lateral inversion

(ii)



8. (i) The angle between the incident ray and the mirror is 30°.

(a) What is the angle of incidence?

(b) What is the angle of reflection?

(c) What is the total angle turned by the ray of light?

(ii) Where will the image form if the object is placed at the centre of curvature in front of the concave mirror? Also, state the nature of the image.

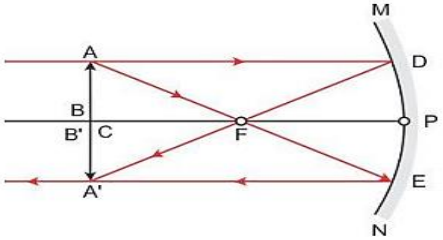
Ans.- (i) Angle of incidence = 90°-30° = 60°

Angle of reflection = Angle of incidence = 60°

Total angle turned by the ray of light = angle of reflection + angle of incidence

= 60° +60° = 120°

(ii)



9. A ray of light is incident on a plane mirror at an angle of incidence of 50°. What is the angle

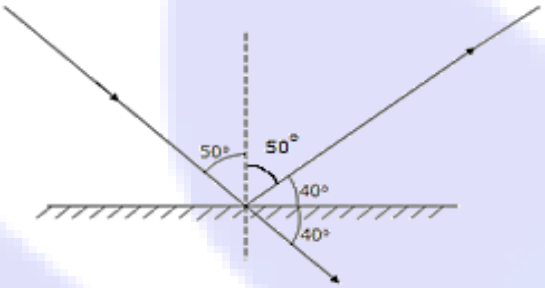
(i) of reflection

(ii) between the incident ray and the mirror

(iii) between the reflected ray and the mirror

(iv) of deviation (angle between the directions of the incident ray and the reflected ray) ?

Ans.-



(i) Angle of reflection = Angle of incidence = 50°

(ii) Angle between the incident ray and the mirror = 90° - Angle of incidence
= 90° – 50° = 40°

(iii) Angle between the reflected ray and the mirror = 90° - Angle of reflection
= 90° – 50° = 40°

(iv) Angle of deviation = 2 (90° – Angle of incidence)
=2 × (90° – 50°) = 2 × 40° = 80°

10. An object is placed between two mirrors inclined at 30° to each other. How many images will you see?

Ans.- Here, $\theta = 30°$

The number of images formed $= \frac{360}{\theta} - 1$

$= \frac{360}{30} - 1$

$= 12 - 1 = 1$

11. Focal length of a convex lens obtained by six students are 38.3 cm, 37.8 cm, 38.0 cm, 37.9 cm, 38.1 cm, 37.2 cm. Express mean focal length of the convex lens up to one place of the decimal.

Ans.-

Mean focal length $= \frac{38.3 + 37.8 + 38.0 + 37.9 + 38.1 + 37.2}{6} = 37.9$ cm

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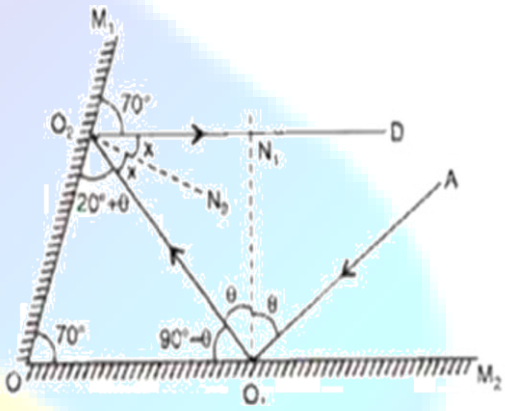

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$\angle M_1O_2D + \angle N_2O_2D = 90°$

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14. The wavelength of yellow light is 589 nm. What is its order of magnitude in meter?

Ans.- Wavelength of yellow light = 589nm

1 nm= 10^{-9} m

589 nm = 589 x 10^{-9}m =5.89 x 10^{-7} m

As numerical value is greater than 3.2, the order of magnitude is 10^{-6} m.

15. A test card of an optician is situated 1.5 m behind the eyes of a patient who is looking through a plane mirror 2 m away from him. What is the distance between him and the image of the test card?

Ans.- Distance of image from the mirror = Distance of object from the mirror = 3.5 m

The patient is sitting 2 m away from the mirror; so, the distance of the image from the patient = 2 + 3.5 = 5.5 m