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CHAPTER 10

LIGHT-REFLECTION AND REFRACTION

MULTIPLE CHOICE QUESTIONS

Q.1. Rays from sun converge at a point 15 cm in front of a concave mirror. Where should an object be placed so that size of its image is equal to the size of the object?

- (a) 15 cm in front of the mirror
- (b) 30 cm in front of the mirror
- (c) between 15 cm and 30 cm in front of the mirror
- (d) more than 30 cm in front of the mirror

Answer- (b) 30 cm in front of the mirror

Q.2. To determine the focal length of a concave mirror by forming image of a distant object, the screen should be placed

- (a) in any direction
- (b) inclined at angle of 45°
- (c) at right angle to the plane of mirror
- (d) parallel to the plane of mirror

Answer- (d) parallel to the plane of mirror

Q.3. You are given water, mustard oil, glycerine and kerosene. In which of these media, a ray of light incident obliquely at same angle would bend the most?

- (a) Kerosene
- (b) Water
- (c) Mustard oil
- (d) Glycerine

Answer- (d) Glycerine

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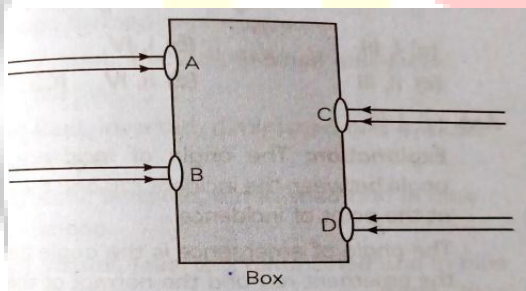
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Q.4. How will the image formed by a convex lens be affected if the upper half of the lens is wrapped with a black paper?

- (a) The size of the image is reduced to one-half.
- (b) The upper half of the image will be absent.
- (c) The brightness of the image is reduced.
- (d) There will be no effect

Answer- (c) The brightness of the image is reduced.

Q.5. Beams of light are incident through the holes A and B and emerge out of box through the holes C and D respectively, as shown in the figure. Which of the following could be inside the box?



- (a) A rectangular glass slab
- (b) A convex lens
- (c) A concave lens
- (d) A prism

Answer- (a) A rectangular glass slab

Q.6. When an object is kept within the focus of a concave mirror, an enlarged image is formed behind the mirror. This image is:

- (a) real
- (b) inverted
- (c) virtual and inverted
- (d) virtual and erect

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Answer- (d) virtual and erect

Q.7. A full length image of a distant tall building can definitely be seen by using:

- (a) a concave mirror (b) a convex mirror
(c) a plane mirror (d) both concave as well as plane mirror

Answer- (b) a convex mirror

Q.8. Magnification produced by a rear view mirror fitted in vehicles:

- (a) is less than one
(b) is more than one
(c) is equal to one
(d) can be more than or less than one depending upon the position of the object in front of it.

Answer- (a) is less than one

Q.9. A student determines the focal length of a device 'X' by focusing the image of a distant object on a screen placed 20 cm from the device on the same side as the object. The device 'X' is

- (a) Concave lens of focal length 10 cm (b) Convex lens of focal length 20 cm
(c) Concave mirror of focal length 10 cm (d) Concave mirror of focal length 20 cm

Answer- (d) Concave mirror of focal length 20 cm

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Q.10. A small bulb is placed at the focal point of a converging lens. When the bulb is switched on, the lens produces:

- (a) a convergent beam of light (b) a divergent beam of light
(c) a parallel beam of light (d) a patch of coloured light

Answer- (b) a parallel beam of light

ASSERTION AND REASON

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

- (a) If both assertion and reason are true and reason is the correct explanation of assertion
(b) If both assertion and reason are true but reason is not the correct explanation of assertion
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

Q.11. **Assertion:** A ray incident along normal to the mirror retraces its path.

Reason: In reflection, angle of incidence is always equal to angle of reflection.

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

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Q.12. **Assertion:** Higher is the refractive index of the medium, lesser is the velocity of light in that medium.

Reason: Refractive index of a medium is inversely proportional to the velocity of light.

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

Q.13. **Assertion:** When a concave mirror is held in water, its focal length will decrease.

Reason: The focal length of a concave mirror depends on the density the medium in which it is placed.

Answer- (d) If both assertion and reason are false

Q.14. **Assertion:** A convex lens is made of two different materials. A point object is placed on the principal axis. The number of images formed by the lens will be two.

Reason :The image formed by convex lens is always virtual.

Answer- (c) If assertion is true but reason is false.

Q.15. **Assertion:** Full length image of a distant object, such as a tall building, can be seen in a convex mirror.

Reason: A convex mirror has a greater focal length than a concave mirror of the same aperture.

Answer- (c) If assertion is true but reason is false

CASE BASED QUESTIONS (Que no 16 to 17)

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Q.16. Light is a form of energy which induces sensation of vision to our eyes. It becomes visible when it bounces off on surfaces and hits our eyes. The phenomenon of bouncing back of light rays in the same medium on striking a smooth surface is called reflection of light.

If parallel beam of incident rays remains parallel even after reflection and goes only in one direction is known as regular reflection. It takes place mostly in plane mirrors or highly polished metal surfaces. The mirror outside the driver side of a vehicle is usually a spherical mirror and printed on such a mirror is usually the warning "vehicles in this mirror are closer than they appear."

(i) Which type of mirror is used outside the driver's side of a vehicle?

- a) Plane mirror (b) Concave mirror
(c) Convex mirror (d) Magic mirror

(ii) No matter how far you stand from a mirror, your image appears erect. The mirror can be

- (a) Plane (b) Concave
(c) convex (d) Either plane or convex

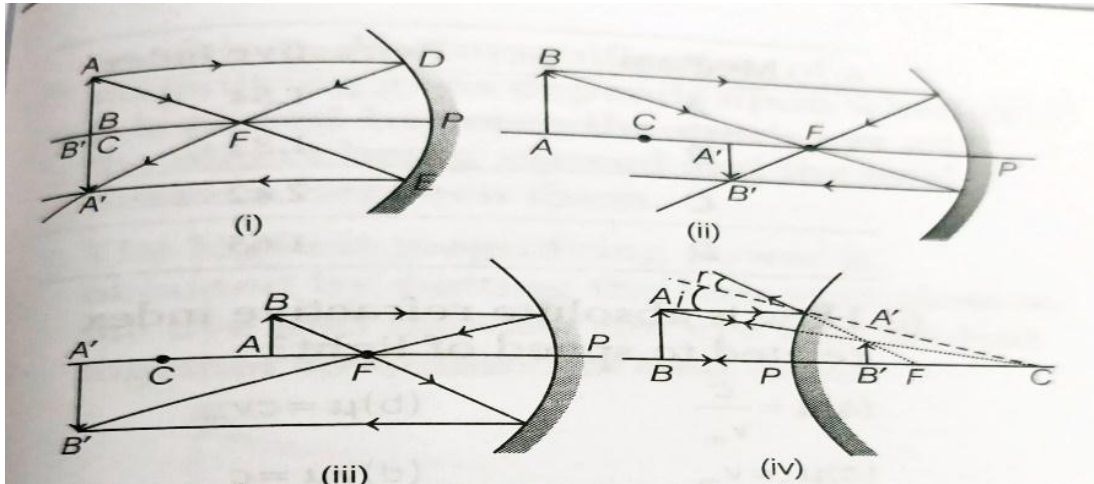
(iii) Which of the following diagrams represents the image formation in above case?

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(a) (i)

(b) (ii)

(c) (iii)

(d) (iv)

(iv) If an object is placed at 10 cm from a convex mirror of radius of curvature 60 cm, then find the position of image.

(a) 4 cm

(b) 7.5 cm

(c) 10 cm

(d) 12.5 cm

(v) The focal length of mirror is 12 cm. The radius of curvature is

(a) 12 cm

(b) 24 cm

(c) 20 cm

(d) 36 cm

Q.17. The refractive index of a medium with respect to vacuum is called absolute refractive index of the medium. It is

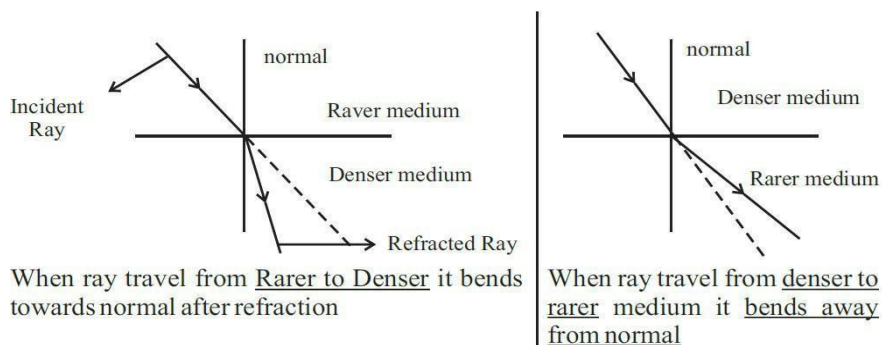
given by, $\mu = \frac{\sin i}{\sin r}$

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Absolute refractive indices of some of the materials A, B, C and D are given in the following table :

Medium	Refractive Index
A	1.54
B	1.33
C	2.42
D	1.65

i) How is absolute refractive index related to speed of light?

(a) $\mu = C/v_m$

(b) $\mu = cv_m$

(c) $\mu = V_m$

(d) $v\mu = c$

(ii) In which of the materials given in the above table, light travels fastest?

(a) A

b) B

(c) C

(d) D

(iii) The speed of light in air is $3 \times 10^8 \text{ ms}^{-1}$ and that in medium A is $2.5 \times 10^8 \text{ ms}^{-1}$. The refractive index of A will be

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(a) 1.2

(b) 0.5

(c) 4.5

(d) 1.5

(iv) When light travels from air to glass,

(a) angle of incidence $>$ angle of refraction

(b) angle of incidence $<$ angle of refraction

(c) angle of incidence = angle of refraction

(d) Can't say

(v) The refractive index of P with respect to Q is 2. Find the refractive index of Q with respect to P.

(a) 0.5

(b) 0.2

(c) 2

(d) 2.5

ANSWERS:

1	2	3	4	5	6	7	8	9	10
B	D	D	C	A	D	B	A	D	C
11	12	13	14	15	16	17			

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A	A	D	C	C	(i) c	(i)			
					(ii) d				
					(iii) d	(ii) b			
					(iv) b	(iii)a			
					(V)	(iv)a			
					b	(V) a			

VERY SHORT ANSWER QUESTIONS

Q.18. If the image formed by a spherical mirror for all positions of the object placed in front of it is always erect and diminished, what type of mirror is it? Draw a labelled ray diagram to support your answer.

Answer- If the image formed by a spherical mirror is always erect and diminished then it is convex mirror.

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Q.19. The linear magnification produced by a spherical mirror is -1. Analysing this value state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw any diagram to justify your answer.

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- Answer- (i) Concave mirror because the image is real, inverted.
(ii) Object is placed at C.

Q.20. State the laws of refraction of light. Explain the term absolute refractive index of a medium' and write an expression to relate it with the speed of light in vacuum.

Answer- (a) Laws of refraction of light:

- (i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
(ii) The ratio of sine of angle of incidence to the sine of the angle of refraction is constant, for the light of a given colour and for the given pair of media.

This law is also known as Snell's law of refraction.

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

where i is the angle of incidence and r is the angle of refraction.

This constant value is called refractive index of the second medium with respect to the first when the light travels from first medium to second medium.

$$\Rightarrow \text{constant} = n_{21} = \frac{v_1}{v_2} \therefore \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

If n is the absolute refractive index of the medium, c is the velocity of light in vacuum and v is the speed of light in a given medium, then $n = \frac{c}{v}$.

Q.21. Draw ray diagrams to show the formation of three times magnified (a) real, and (b) virtual image of an object by a converging lens. Mark the positions of O, F and 2F in each diagram.

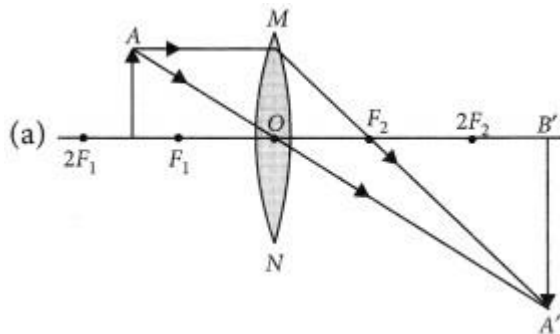
Answer-

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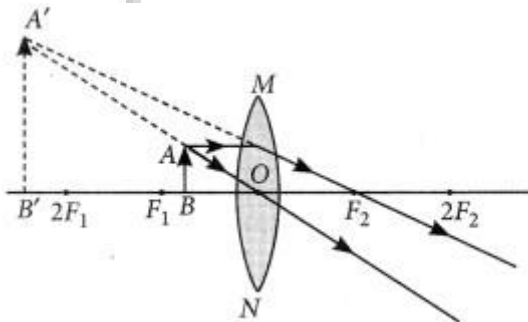
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(b) Ray diagrams of an object placed between F_1 and optical centre O of lens can be drawn as follows:



- (i) The image formed is virtual and erect.
- (ii) Image is formed in front of the lens.
- (iii) Image formed is enlarged.

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Q.22. State the two laws of reflection of light.

Answer- Laws of reflection of light states that

(i) The angle of incidence is equal to the angle of reflection.

(ii) The incident ray, the reflected ray and the normal to the mirror at the point of incidence all lie in the same plane.

SHORT ANSWER TYPE QUESTIONS

Q.23. A concave mirror has a focal length of 20 cm. At what distance from the mirror should a 4 cm tall object be placed so that it forms an image at a distance of 30 cm from the mirror? Also calculate the size of the image formed.

Answer- Given $f = -20$ cm $v = -30$ cm, $u = ?$

Using $1/v + 1/u = 1/f$

$$1/u = 1/f - 1/v = 1/(-20) - /(-30) = (-3+2)/60$$

$$\Rightarrow u = -60 \text{ cm}$$

\therefore Object placed at 60 cm from the mirror.

Also magnification, $m = h'/h = -v/u$

$$\Rightarrow h' = -(-30)/-60 \times 4 = -2 \text{ cm}$$

\therefore The size of the image is 2 cm.

Q.24. The image of an object formed by a mirror is real, inverted and is of magnification -1. If the image is at a distance of 40 cm from the mirror, where is the object placed? Where would the image be if the object is moved 20 cm towards the mirror? State reason and also draw ray diagram for the new position of the object to justify your answer.

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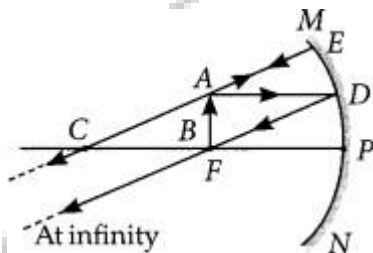
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Answer- Since the image formed by the mirror is real and inverted, therefore the mirror is concave and magnification of the mirror will be

$$m = -v/u \Rightarrow -1 = -v/u \Rightarrow v = u$$

i.e., object and image both are formed at the centre of curvature, i.e., 40 cm from the mirror.

Now, if the object is moved 20 cm towards the mirror, the object will be at the focus of the mirror and therefore the image will be formed at infinity.



Q.25. The refractive indices of glass and water with respect to air are $\frac{3}{2}$ and $\frac{4}{3}$ respectively. If speed of light in glass is 2×10^8 m/s, find the speed of light in water.

Answer-

$$\text{Given: } {}_a n_g = \frac{3}{2}, \quad {}_a n_w = \frac{4}{3}$$

Speed of light in glass, $v = 2 \times 10^8$ m/s

$$\text{We know, } {}_a n_g = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

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

$$\text{Now, } {}_a n_w = \frac{\text{speed of light in air}}{\text{speed of light in water}}$$

$$\Rightarrow \frac{4}{3} = \frac{3 \times 10^8}{v}$$

$$\Rightarrow v = \frac{9}{4} \times 10^8 \text{ m/s} = 2.25 \times 10^8 \text{ m/s}$$

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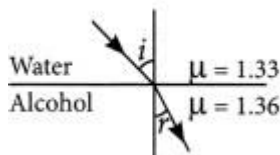
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- Q.26. (a) Water has refractive index 1.33 and alcohol has refractive index 1.36. Which of the two medium is optically denser? Give reason for your answer.
- (b) Draw a ray diagram to show the path of a ray of light passing obliquely from water to alcohol.
- (c) State the relationship between angle of incidence and angle of refraction in the above case.

- Answer- (a) Here, alcohol is optically denser medium as its refractive index is higher than that of water. When we compare the two media, the one with larger refractive index is called the optically denser medium than the other as the speed of light is lower in this medium.
- (b) Since light is travelling from water (rarer medium) to alcohol (denser medium), it slows down and bends towards the normal.



where i = angle of incidence and r = angle of refraction.

(c) According to Snell's law,

$$\sin i / \sin r = \mu_{\text{alcohol}} / \mu_{\text{water}} = 1.36 / 1.33 = 1.0225$$

$$\therefore \sin i = 1.0225 \times \sin r$$

- Q.27. What is meant by power of a lens? Write its SI unit. A student uses a lens of focal length 40 cm and another of -20 cm. Write the nature and power of each lens.

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Answer- Power is the degree of convergence or divergence of light rays achieved by a lens.

It is defined as the reciprocal of its focal length.

i.e., $P = 1/f$

Given that: Focal length of lens A, $f_A = +40$ cm

Focal length of lens B, $f_B = -20$ cm

Lens A is converging. Lens B is diverging.

LONG ANSWER TYPE QUESTIONS

Q.28. Rishi went to a palmist to show his palm. The palmist used a special lens for this purpose.

(i) State the nature of the lens and reason for its use.

(ii) Where should the palmist place/hold the lens so as to have a real and magnified image of an object?

(iii) If the focal length of this lens is 10 cm, the lens is held at a distance of 5 cm from the palm, use lens formula to find the position and size of the image.

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Answer- (i) The lens used here is a convex lens and it is used as a magnifying glass because at close range, i.e., when the object is placed between optic centre and principal focus it forms an enlarged, virtual and erect image of the object.

(ii) When this lens is placed such that the object is between the centre of curvature and the principal focus, the palmist obtain a real and magnified image.

(iii) Given focal length, $f = 10$ cm and $u = -5$ cm According to lens formula,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \quad \text{or} \quad \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$
$$\text{or} \quad \frac{1}{v} = \frac{1}{10} + \frac{1}{-5} = \frac{-5+10}{-50}$$
$$\therefore v = \frac{-50}{5} = -10 \text{ cm}$$

Thus, the image will be formed at 10 cm on the same side of the palm and the size of the image will be enlarged.

Q.29. (a) A 5 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 20 cm. The distance of the object from the lens is 30 cm. Find the position, nature and size of the image formed.

(b) Draw a labelled ray diagram showing object distance, image distance and focal length in the above case.

Answer- (a) Given, $h = 5$ cm, $f = 20$ cm, $u = -30$ cm

Using lens formula, $1/v - 1/u = 1/f$

$$1/v = 1/u + 1/f = 1/(-30) + 1/20 = (-2+3)/60 = 1/60$$

$$\Rightarrow v = 60 \text{ cm}$$

Now, magnification, $m = h'/h = v/u$

$$\Rightarrow h' = v/u \times h = 60/(-30) \times 5 = -10 \text{ cm}$$

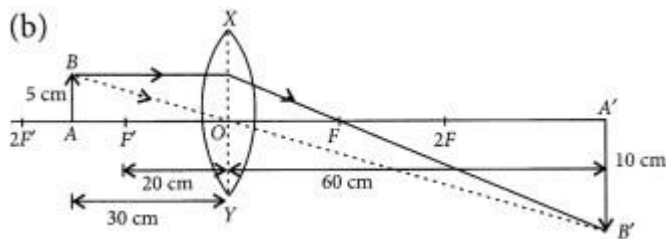
Hence, the image formed at 60 cm, which is real and magnified.

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- Q.30. A convex lens can form a magnified erect as well as magnified inverted image of an object placed in front of it". Draw ray diagram to justify this statement stating the position of the object with respect to the lens in each case. An object of height 4 cm is placed at a distance of 20 cm from a concave lens of focal length 10 cm . Use lens formula to determine the position of the image formed.

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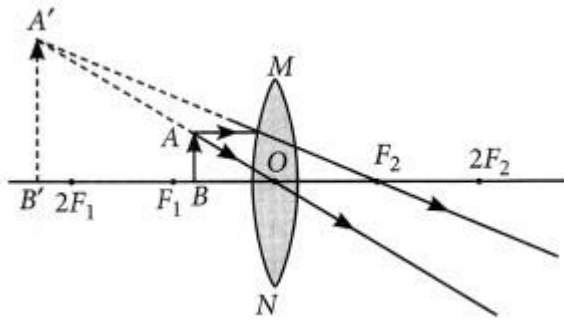
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Answer- Magnified erect image:



Magnified inverted image:

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Given that $h = 4$ cm, $u = -20$ cm, $f = -10$ cm

Lens formula:

$$1/v - 1/u = 1/f \therefore 1/v - 1/(-20) = 1/(-10)$$

$$\text{or } 1/v = -1/10 - 1/20 = (-2-1)/20 = -3/20 \text{ or } v = -20/3 \text{ cm}$$

- Q.31. Size of image of an object by a mirror having a focal length of 20 cm is observed to be reduced to 1/3rd of its size. At what distance the object has been placed from the mirror? What is the nature of the image and the mirror?

Answer-

$$f = +20 \text{ cm}, m = \pm \frac{1}{3} = \frac{-v}{u}$$

$$\text{When } m = \frac{1}{3}, \text{ then } \frac{1}{3} = \frac{-v}{u} \Rightarrow u = -3v$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{20} = \frac{1}{v} + \frac{1}{-3v} = \frac{2}{3v} \Rightarrow v = \frac{40}{3} \Rightarrow u = -40 \text{ cm}$$

Therefore the mirror is convex and the image is virtual, erect, and diminished.

$$\text{When } m = \frac{-1}{3}, \text{ then } \frac{-1}{3} = \frac{-v}{u} \Rightarrow u = 3v$$

$$-\frac{1}{f} = \frac{-1}{20} = \frac{1}{v} + \frac{1}{u} = \frac{1}{v} + \frac{1}{3v} = \frac{4}{3v}$$

$$\Rightarrow v = \frac{-80}{3}$$

$$\Rightarrow v = \frac{-80}{3} \times 3 = -80 \text{ cm.}$$

Therefore, the mirror is concave and the image is real, inverted and diminished.

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Q.32. (i) A doctor has prescribed a corrective lens of power +1.5 D. Find the focal length of the lens. Is the prescribed lens diverging or converging?

(ii) A concave lens of focal length 15 cm forms an image 10 cm from the lens. How

far is the object placed from the lens? Draw the ray diagram.

Answer- (i) Power of lens (P) = $1/f$

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

$$\frac{1}{u} - \frac{1}{v} = \frac{1}{f} = -\frac{1}{10} - \frac{1}{-15} = -\frac{1}{10} + \frac{1}{15}$$

$$v = -\frac{5}{150} = -30\text{cm}$$

$$(v) P = 1.5\text{D}$$

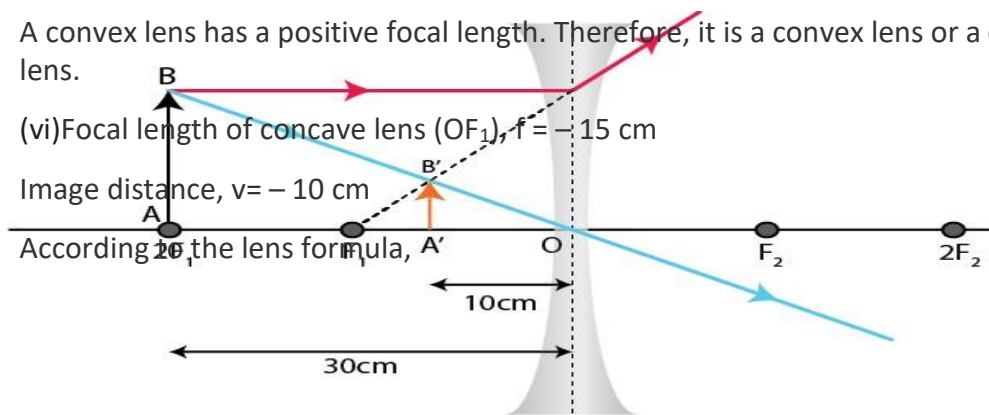
$$f = 1/1.5 = 10/15 = 0.66\text{ m}$$

A convex lens has a positive focal length. Therefore, it is a convex lens or a converging lens.

(vi) Focal length of concave lens (OF_1), $f = -15\text{ cm}$

Image distance, $v = -10\text{ cm}$

According to the lens formula,



The negative value of u indicates that the object is placed 30 cm in front of the lens. This is shown in the following ray diagram.