The following question given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

Q.1 **Assertion** : The focal length of the mirror is f and distance of the object from the focus is u, the magnification of the mirror is f/u.

Reason : Magnification = $\frac{\text{size of image}}{\text{size of object}}$ **[D]**

Q.2 **Assertion** : The mirrors used in search lights are parabolic and not concave spherical.

Reason: In a concave spherical mirror the image formed is always virtual.

[C]

Q.3 **Assertion** : For observing traffic at our back, we prefer to use a convex mirror.

Reason: A convex mirror has a much larger field of view than a plane mirror or a concave mirror **[A]**

Q.4 **Assertion** : We cannot produce a real image by plane or convex mirrors under any circumstances

Reason: The focal length of a convex mirror is always taken as positive **[D]**

Q.5 **Assertion :** The formula connecting u, v and f for a spherical mirror is valid only for mirrors whose sizes are very small compared to their radii of curvature.

Reason : Laws of reflection are strictly valid for plane surfaces, but not for large spherical surfaces. **[IIT-JEE 2007]**

[C]

Q.6 **Assertion :** If object is placed between pole and focus of concave mirror and now mirror is broken and only half portion of mirror is left, then intensity of image will reduce.

Reason : Lesser reflecting surface will be available for reflection. **[D]**

Q.7 **Assertion :** The mirrors used in search lights are parabolic and not concave spherical.

Reason : In a concave spherical mirror, the image formed is always virtual. **[C]**

Q.8 **Assertion :** Convex mirror always form a virtual image.

Reason : Focal length of a mirror is half of the radius of curvature. **[D]**

Q.9 **Assertion :** Human eye can see virtual object.

Reason : Virtual object is formed by apparent intersection of incident rays. **[D]**

Q.10 **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. **[A]**

Q.11 **Assertion :** A concave mirror of focal length in air is used in a medium of refractive index 2. Then the focal length of mirror in medium becomes double.

Reason : The radius of curvature of a mirror is double of the focal length. **[D]**

Q.12 **Assertion :** For observing traffic at our back, we prefer to use a convex mirror.

Reason : A convex mirror has a much larger field of view than a plane mirror of a concave mirror. **[A]**

Q.13 **Assertion :** We cannot produce a real image by plane or convex mirror under any circumstances.

Reason : Focal length of convex mirror can be taken as positive or negative depending on sign convention. **[D]**

Q.14 **Assertion :** Convex mirror always form a virtual image.

Reason : Focal length of a convex mirror is half of the radius of curvature. **[D]**

Q.15 **Assertion :** In convex mirror image formed may be of a size greater than size of object.

Reason : In convex mirror reflected rays are always diverging. **[C]**

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

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

f is positive for u positive, m > 1

(for virtual object)

Q.16 **Assertion :** The mirror used in search light are parabolic and not concave spherical.

Reason : In a concave spherical mirror the image formed is always virtual. **[C]**

Sol. In search light we need intense parallel beam of light. When source of light is placed at focus of concave mirror, only paraxial rays are rendered parallel due to large aperture of mirror. Marginal rays give a divergent beam but in case of parabolic mirror, when source is at focus, beam of light produced over the entire cross-section of mirror is a parallel beam.

Q.17 **Assertion :** The mirrors used in search lights are parabolic and not concave spherical.

Reason : In a concave spherical mirror, the image formed is always virtual. **[C]**

Q.18 **Assertion :** Focal length of spherical mirror is maximum for violet.

Reason : Focal length of spherical mirror remains same for all the wavelengths. **[D]**

Q.19 **Assertion (A) :** Light from an object falls on a concave mirror forming a real image of the object. If both the object and mirror are immersed in water, there is no change in position of the image.

Reason (R) : The formation of image by reflection does not depend on surrounding medium, so there is no change in position of image.

Sol. **[A]**

Both (A) and (R) are true, and (R) is the correct explanation of (A).

Q.20 **Assertion :** A plane convex lens is silvered from plane surface. It can act as a diverging mirror.

Reason : Focal length of concave mirror is independent of medium.

Sol. **[B]**

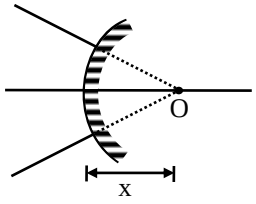
Both (A) and (R) are true but (R) is not the correct explanation of (A).

Q.1 For a concave mirror of focal length 20 cm, match the followings :

	List I		List II
	Object distance		**Nature of image**
A	10 cm	(i)	Magnified, inverted and real
B	30 cm	(ii)	Equal size, inverted and real
C	40 cm	(iii)	Smaller, inverted and real
D	50 cm	(iv)	Magnified, erect and virtual

Ans. (A) → S, (B) → P, (C) → Q, (D) → R

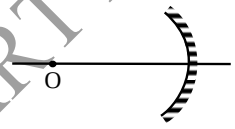
Q.2 A beam of light appears to converge at a point O, x distance behind a convex mirror of focal length 10 cm. Determine nature of image if-



Column I	**Column II**
(A) x = 6 cm	(P) Real
(B) x = 11 cm	(Q) Virtual
(C) x = 16 cm	(R) Magnified
(D) x = 30 cm	(S) Diminished

Ans. (A) → (P, R), (B) → (Q, R), (C) → (Q,R), (D) →(Q,S)

Q.3 A point source is placed on the axis of a concave mirror as shown in the figure.

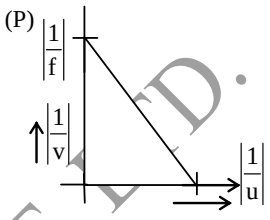


Column I	**Column II**
(A) A part of the mirror	(P) Intensity of the is removed
(B) A part of the mirror black paper	(Q) Position of the is covered by a
(C) The mirror is rotated by a small angle θ	(R) Size of the image may change
(D) The mirror is displaced keeping the principal axis parallel	(S) Focal length of the mirror changes

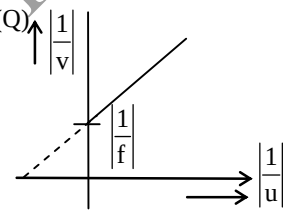
Ans. (A) → P, (B) → P, (C) → P,Q,R, (D) →P,Q,R

Q.4 **Column-I** **Column-II**

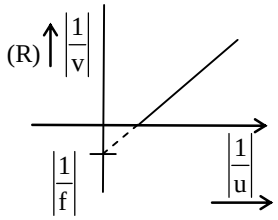
(A) In concave mirror when object is real or virtual & image is real



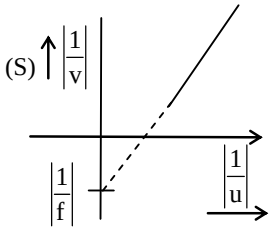
(B) In concave mirror when object is real and image is virtual



(C) In convex mirror when object is real and image is virtual



(D) In convex mirror when object is virtual and image is real



Ans. (A) → P,Q ; (B) → S ; (C) → P,Q ; (D) → R

Q.5 **Column-I** **Column-II**

(A) Concave mirror (P) Virtual image

(B) Plane mirror (Q) Real image

image changes

(C) Convex mirror (R) Sharp image without image changes any error

(D) Parabolic mirror (S) Erect image

Ans. (A) → P,Q,S ; (B) → P,Q,R,S

(C) → P,Q,S ; (D) → P,Q,R,S

Q.6 Consider a linear extended object that could be real or virtual with its length at right angles to the principal axis of a spherical mirror. With regards to image formation by spherical mirror, match column-I with column-II.

Column-I	**Column-II**
(A) Image of the same size as the object is possible	(P) for concave mirror in case of real object
(B) Virtual image of a size greater than that of object is possible	(Q) for convex mirror in case of real object
(C) Real image of a size smaller than that object is possible	(R) for concave mirror in case of virtual ojbect
(D) Real and erect image is possible	(S) for convex mirror in case of virtual object

Ans. **A → P, Q, R, S** **B → P, S**
C → P, R **D → R, S**

Q.7

Column-I	**Column-II**
(A) Convex mirror, virtual object	(P) Real image
(B) Concave mirror, virtual object	(Q) Virtual image
(C) Concave lens, real object	(R) Magnified image
(D) Convex lens, real object	(S) Diminished image

Ans. **A → P, Q, R, S;** **B → P, S;**
C → Q, S; **D → P, Q, R, S**

Q.8 Regarding reflection by plane and spherical mirrors and, assuming that the object could be real or virtual, match Column-I with Column-II. Also assume (i) length of the object is perpendicular to the principal axis of the mirror in case of spherical mirror and (ii) length of the object is parallel to the plane of mirror in case of a plane mirror :

Column – I	**Column – II**
(A) Image is real and erect	(P) Plane mirror
(B) Virtual image of the same size as the object	(Q) Convex mirror
(C) Virtual image of a size smaller than the object	(R) Concave mirror
(D) Real image of a size greater than the object	(S) This is not possible

Ans. **A → P,Q, R; B → P,Q ; C → Q; D → Q,R**

Q.9 Match the following -

Column I	**Column II**
(A) Concave mirror, u < f	(P) Virtual, diminished image
(B) Convex mirror, u > f	(Q) Real, diminished image
(C) Concave mirror, f < u < 2f	(R) Virtual, enlarged image
(D) Convex mirror, u < f	(S) Real, enlarged image

Sol. A → R ; B → P ; C → S ; D → P

Q.10 Match the column

Column-I	**Column-II**
(A) Concave mirror, real object	(P) Real image
(B) Convex mirror, real object	(Q) Virtual image
(C) Concave lens, real object	(R) Magnified image
(D) Convex lens, real object	(S) Diminished image

Sol. (A) → P,Q,R,S; (B) → Q,S; (C) → Q,S; (D) → P,Q,R,S

Q.11 Match List I with List II and select the correct answer using the codes given below the lists -

List I (Position of the object)	**List II** (Magnification)
(I) An object is placed at $-\infty$ focus before a convex mirror	(a) Magnification is

(II) An object is placed at 0.5 centre of curvature before a concave mirror (b) Magnification is

(III) An object is placed at +1 focus before a concave mirror (c) Magnification is

(IV) An object is placed at –1 centre of curvature before a convex mirror (d) Magnification is

(e) Magnification is 0.33

(A) I-b, II-d, III-a, IV-e

(B) I-a, II-d, III-c, IV-b

(C) I-c, II-b, III-a, IV-e

(D) I-b, II-e, III-d, IV-c

Sol. **[A]**

Q.12 In column II image which may be produce for each case in column I. See all the possiblities and match column I with column II.

Column – I	**Column – II**
(A) Concave mirror, real object	(P) Real image
(B) convex mirror, real object	(Q) virtual image
(C) concave lens, real object	(R) magnified image
(D) convex lens, real object	(S) diminished image
	(T) erect image

Sol. **(A)** $\rightarrow$ P, Q, R, S, T; **(B)** $\rightarrow$ Q, S, T;
(C) $\rightarrow$ Q, S, T; **(D)** $\rightarrow$ P, Q, R, S, T

Q.13 Column I indicate the nature of image formed column II indicate the location of the object, then match column I with column II:

Column-I (Nature of image)	**Column-II (position of object)**
(A) Real	(P) object is between pole & focus of a convex mirror
(B) Virtual	(Q) object is between pole & focus of a concave mirror
(C) Magnified	(R) object is between pole & centre of curvature of a convex mirror
(D) Erect	(S) object is between pole & centre of curvature of a

Sol. **A$\rightarrow$ P,S ; B$\rightarrow$R,Q; C$\rightarrow$P,Q,R,S; D$\rightarrow$P,Q**

PHYSICS

Q.1 If a converging beam of light is incident on a concave mirror, the reflected light -

(A) may form a real image

(B) must form a real image

(C) may form a virtual image

(D) may be a parallel beam **[A,C,D]** []

Q.2 Which of the following (referred to a spherical mirror) do (does) not depend on whether the rays are paraxial or not -

(A) Pole (B) Focus

(C) Radius of curvature (D) Principal axis

[A,C,D]

Q.3 The image of an extended object, placed perpendicular to the principal axis of a mirror, will be erect if -

(A) The object and the image are both real

(B) The object and the image are both virtual

(C) The object is real but the image is virtual

(D) The object is virtual but the image is real

[C,D]

Q.4 Which of the following is/are correct :

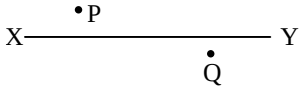
(A) the image and object are never on either side of focus in a spherical mirror

(B) a virtual image must be erect

(C) an image formed in a plane mirror must have same speed as the object has

(D) Laws of reflection are same for all wavelengths **[A,D]**

Q.5 Two points P and Q lie on either side of an axis XY as shown in the figure. It is desired to produce an image of P at Q using a spherical mirror, with XY as the optic axis. The mirror must be –



(A) converging

(B) diverging

(C) positioned to the left of P

(D) positioned to the right of Q **[A,C]**

Q.6 In an experiment with a mirror, the object distance u versus image distance v data were obtained. Which of the following graphs will be linear?

(A) $\frac{1}{v}$ versus $\frac{1}{u}$ (B) uv versus (u + v)

(C) $\frac{v}{u}$ versus v (D) v versus u

[A,B,C]

Q.7 The incorrect statement for a concave mirror producing a virtual image of the object is -

(A) the linear magnification is always greater than one, except at the pole

(B) the linear magnification is always less than one

(C) the magnification tends to one as the object moves nearer to the pole of the mirror

(D) the distance of the object from the pole of the mirror is less than the focal length of mirror **[B]**

Q.8 A short linear object is placed along the optic axis of a concave mirror between focus and curvature centre, then –

(A) a real elongated image will be formed

(B) an elongated virtual image will be formed

(C) an inverted, enlarged image will be formed

(D) a diminished virtual image will be formed

[A,C]

Sol. If an object is placed between focus and curvature centre of a concave mirror, then a real, elongated image is formed. Hence, option (A) is correct.

Since, real image is always inverted; therefore, option (C) is also correct.

Q.9 Which of the following statements are correct ?

(A) Real image of a real object cannot be formed by a plane mirror

(B) Real image of a real object cannot be formed by a convex mirror

(C) Real image of a real object cannot be formed by a concave lens

(D) None of the above **[A,B,C]**

Sol. If a real object is placed in front of a plane mirror, then its image will be formed behind the mirror. Since, the image formed behind the mirror is always virtual, therefore, a real image of a real object cannot be formed by a plane mirror. Hence, option (A) is correct. Convex mirror is a diverging mirror. If a real object is placed in front of a convex mirror then rays coming from the object will be diverging. It means, diverging light rays will be incident on a diverging mirror which will further diverge these rays. Hence, the reflected rays will also be diverging. Therefore, the image will be formed behind the mirror. Hence, the image will be virtual. Therefore, option (B) is correct.

A concave lens is a diverging lens. If a real object is placed on its optic axis then light rays coming from the object on the lens will be diverging which will be further diverged by the lens after refraction. Hence, the reflected light rays will be diverging. The position of image will be the point of divergence of refracted rays. It means, the image will be virtual. Hence, option (C) is also correct.

Q.10 Rays converging at a point behind a convex mirror are incident on the mirror. Image formed will be –

(A) virtual (B) real

(C) erect (D) inverted **[B, C]**

Sol. When highly converging rays are incident on the convex mirror, image formed is real, magnified and erect.

Q.11 A point object P moves towards a convex mirror with a constant speed v, along its optic axis. The speed of the image –

(A) is always < v

(B) may be >, = or < v depending on the position of P

(C) increases as P comes closer to the mirror

(D) decreases as P comes closer to the mirror

[A, C]

Q.12 A short linear object is placed along the optic axis of a concave mirror between focus and curvature centre, then –

(A) a real elongated image will be formed

(B) an elongated virtual image will be formed

(C) an inverted, enlarged image will be formed

(D) a diminished virtual image will be formed

[A, C]

Sol. If an object is placed between focus and curvature centre of a concave mirror, then a real, elongated image is formed. Hence, option (A) is correct.

Since, real image is always inverted, therefore, option (C) is also correct.

Q.13 Which of the following is (are) correct –

(A) The image and object are never on different sides of focus in a spherical mirror

(B) A virtual image must be erect

(C) An image formed in a plane mirror must have same speed as the object has

(D) Laws of reflection are same for all wavelengths **[A,D]**

Sol. B is wrong-think for virtual object (VO) in convex mirror but F and ∞.

C is wrong because it is with respect to mirror.

Q.14 The image of a real object formed by a concave mirror is twice the size of the object. The focal length of the mirror is 20 cm. The distance of the object from the mirror -

(A) 10 cm (B) 30 cm

(C) 25 cm (D) 15 cm **[A,B]**

Sol. $m = \pm\ 2 = \dfrac{f}{f-u} = \pm 2 = \dfrac{-20}{-20+x}$

If $m = +2 = \dfrac{-20}{-20+x}$

$-40 + 2x = -20$

$2x = 20$

$x = 10$ cm

if $m = -2 = \dfrac{-20}{-20+x}$

$40 - 2x = -20$

$x = 30$

Q. 15 Which of the following statements are incorrect for spherical mirror ?

(A) A concave mirror forms only virtual images for any position of a real object

(B) A convex mirror forms only virtual images for any position of a real object

(C) A concave mirror forms only a virtual diminished image of an object placed between its pole and the focus

(D) A convex mirror forms a virtual magnified image of an object placed between its pole and the focus **[A,C,D]**

Q.16 A particle is moving towards a fixed convex mirror. The image also moves. If V_i = speed of image and V_o = speed of the object, then -

(A) $V_i \le V_o$ if $|u| < |F|$

(B) $V_i > V_o$ if $|u| > |F|$

(C) $V_i < V_o$ if $|u| > |F|$

(D) $V_i = V_o$ if $|u| = |F|$

Sol.[A,C] For convex mirror

$|m| < 1$ for any real object

Now, $V_{image} = -m^2 V_{object}$

$\Rightarrow |V_{image}| < |V_{object}|$ always.

Q.17 If a converging beam of light is incident on a concave mirror, the reflected light -

(A) may form a real image

(B) must form a real image

(C) may form a virtual image

(D) may be a parallel beam

Sol. [B]

Q.18 A particle is moving towards a fixed spherical mirror. The image.

(A) must move away from the mirror

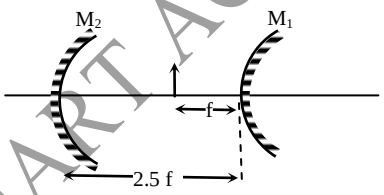
(B) must move towards the mirror

(C) may move towards the mirror

(D) will move towards the mirror, only if the mirror is convex

Sol.[C]

Q.19 The two mirrors M_1 & M_2 of focal length f each are placed coaxially as shown. Consider first reflection from M_1 & second from M_2. The which of the following are correct :



(A) The image after two reelection coincides with object

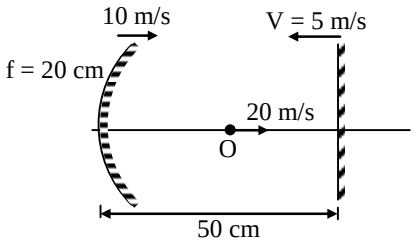
(B) Image after two reflection is inverted and its size is one fourth of object

(C) Image after two reflection is real.

(D) image after two reflection is virtual

Sol.[A,B,C] Obvious

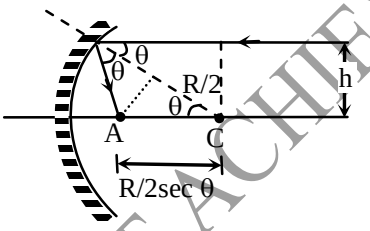
Q.1 When object is at a distance of 30 cm from concave mirror. Consider two reflection first one on plane mirror & second one on concave mirror. Find the velocity of final image after two reflection in m/s.



[0016]

Q.2 Two rays are incidents on a spherical concave mirror of radius R = 5cm parallel to its optical axis at perpendicular distances 3cm and 4cm respectively. Determine the value Δx if distance between the points at which these rays intersect the optical axis after being reflected from the mirror is $\Delta x \times \frac{5}{24}$ cm. **[5]**

Sol.



A is the point where light meet at principal axis

$$CA = \frac{R}{2\cos\theta}$$

$$\cos\theta = \frac{\sqrt{R^2 - h^2}}{R}$$

for two h calculate two value of CA difference of CA is distance between the points at which rays intersect.

Q.3 A point object is located at a distance 15cm from the pole of a concave mirror of focal length 10cm on its principal axis is moving with a velocity $(8\hat{i} + 11\hat{j})$cm/s and velocity of mirror is $4\hat{i} + 2\hat{j}$ cm/s. If $\vec{v}$ is the velocity of image, then value of $|\vec{v}|$ is .....×10 cm/s.

Sol. **[2]**

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

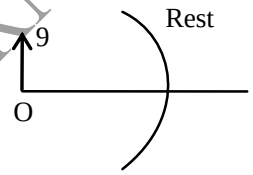
$$\frac{1}{10} = \frac{1}{15} + \frac{1}{v}$$

$$v = +30$$

$$m = -\left(\frac{v}{u}\right) = -\left(\frac{+30}{15}\right) = -2$$

$$\frac{dI}{dt} = m \times \frac{do}{dt}$$

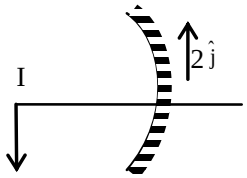
$$= (-2) \times (9) = -18$$



$$v_I = v_{IM} + v_M$$

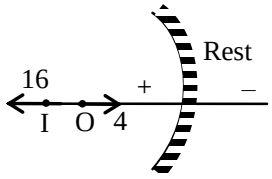
$$v_I = -18\hat{j} + 2\hat{j} = -16\hat{j}$$

in vertical direction



$$v_{IM} = 18$$

$$\frac{dv}{dt} = -m^2 \times \frac{do}{dt}$$



$$= -4 \times (-4)$$

$$v_{IM} = \frac{dv}{dt} = +16$$

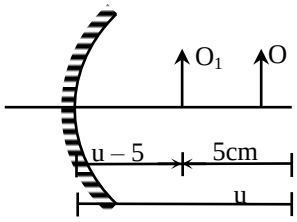
$$vI = -16\hat{i} + 4\hat{i} = -12\hat{i}$$

$$v = \sqrt{16^2 + 12^2} = \sqrt{256+144} = 20\text{cm/s}$$

Q.4 Image produced by a concave mirror is one quarter the size of the object. If the object is moved b = 5 cm closer to the mirror the image will only be half the size of the object. Focal length of the mirror is ….× 10^{-1} cm.

[0002]

Sol.



$m = -\frac{1}{4} - \frac{v}{u} = -\frac{1}{4}$; $4v = u$ …(1)

$\frac{1}{f} = \frac{1}{v_1} + \frac{1}{u_1}$; $m = -\frac{1}{2}$

$\frac{v_1}{u_1} = \frac{1}{2} \Rightarrow u_1 = 2v_1$

$u_1 = 3f$ …(2)

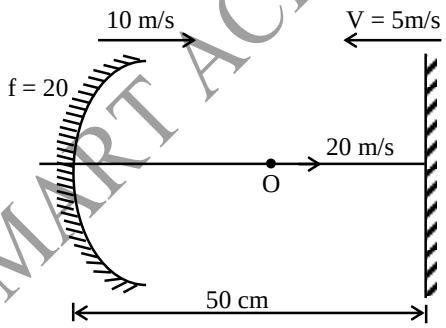
$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{f} = \frac{5}{v}$

$u = 5f$ …(3)

$u - u_1 = 5$

$5f - 3f = 5 \Rightarrow f = 2.5$ cm

Q.5 When object is at distance of 30 cm from concave mirror, consider two reflection first one on plane mirror & second one on concave mirror. Find the velocity of final image after two reflection in m/s.

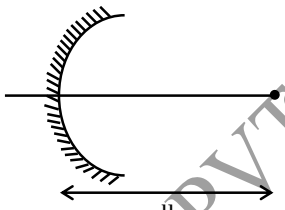


Sol. **[4]**

Q.6 When an object is placed at a distance of 25 cm from a mirror, the magnification is m_1. The object is moved 15 cm away with respect to the earlier position along principal axis, magnification becomes m_2. If $m_1 \times m_2 = 4$, the focal length of the mirror in cm is…. × 10 cm.

Sol.[2] $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

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



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

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

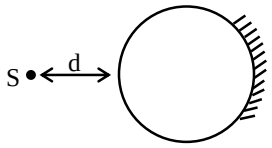
$m_1 \times m_2 = 4$

$\frac{f}{f-25} \times \frac{f}{f-40} = 4$

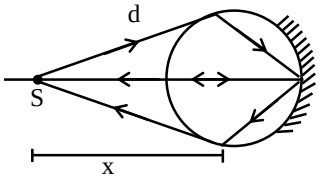
$f^2 = 4[f^2 - 65 + 1000] = 0$

$3f^2 - 260f + 4000 = 0 \Rightarrow f = 20$

Q.7 A very expensive diamond is polished into a perfect sphere of radius 5 cm. The back surface of the sphere is then covered with silver. If d is the distance of source of light from surface of sphere so that image coincide with the source. The index of refraction of diamond is 2.4, then d = …. × 5 cm.



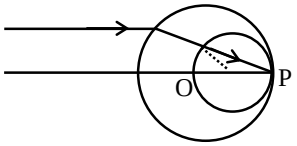
Sol.[5] Considering refraction at curved surface



$$\frac{2.4}{2\times5}+\frac{1}{x}=\frac{2.4-1}{5}$$

x = 25 cm

Q.8 A transparent sphere of radius R has a cavity of radius $\frac{R}{2}$ as shown in figure. Find the refractive index of the sphere if a parallel beam of light falling on left surface focuses at point P.



Sol. **[2]** Let refractive index for glass is μ

after first refraction image distance is v

$$\frac{\mu}{v}-\frac{1}{\infty}=\frac{\mu-1}{R}$$

$$v=\frac{\mu R}{\mu-1}$$

Now second refraction take place

$u_1 = v - R$

$$\frac{\mu R}{\mu-1}-R=\frac{R}{\mu-1}$$ and

image will formed at P i.e. at $v_1 = R$

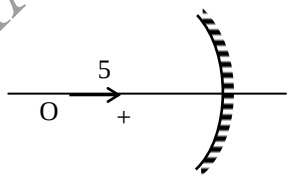
$$\frac{1}{R}-\frac{\mu(\mu-1)}{R}=\frac{2(1-\mu)}{R}$$

$\mu^2 - 3\mu + 1 = 0$

$$\mu=\frac{3+\sqrt{5}}{2}=2.61$$

Q.9 A point object is moving along the principle axis of a concave mirror at rest of focal length 30 cm with speed 5m/s towards the mirror. The speed of image of object when object is at a distance 60 cm from mirror is …. m/s.

Sol. **[5]**



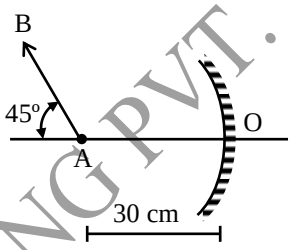
$$\frac{dV}{dt}=-\frac{V^2}{U^2}\times\frac{dU}{dt}$$

$$\frac{1}{30}=\frac{1}{60}+\frac{1}{V}$$

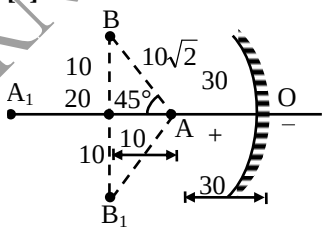
$$\frac{1}{30}-\frac{1}{60}=\frac{1}{V}\Rightarrow V=+60,\ m=1$$

$$\frac{dV}{dt}=-\frac{dU}{dt}=+5\ m/s$$

Q.10 A linear shaped object AB of length $10\sqrt{2}$ cm is placed before a concave mirror as shown in figure. The focal length of concave mirror is 20 cm. Length of image in cm is …. × $10\sqrt{5}$ cm.



Sol. **[1]**



for B, u = 30 + 10 = 40 cm

f = 20 cm

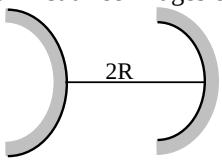
v = 40 cm for B

$$m=-\frac{v}{u}=-1\ \ B_1$$

for A u = + 30 f = + 20, v = + 60

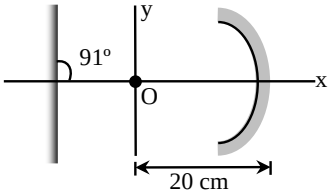
$A_1B_1 = \sqrt{20^2+10^2} = \sqrt{500} = 10\sqrt{5}$ cm

Q.11 Two spherical mirror, one convex and the other concave, each of same radius of curvature R are arranged coaxially at a distance of 2R from each other as shown in figure. A small circle of radius a is drawn on the convex mirror. What is the radii of first three images of the circle ?



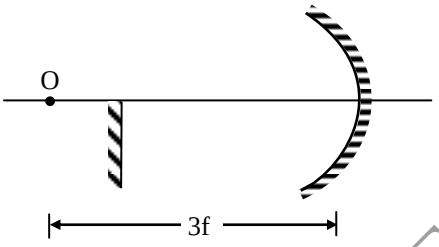
Sol. $\frac{a}{3},\frac{a}{11},\frac{a}{41}$

Q.12 A point object is placed at the centre of curvature of a concave mirror (taken as origin). A plane mirror is also placed at a distance of 10 cm from the object as shown in figure. Consider two reflection first at plane mirror and then at concave mirror. Find the coordinates of the image thus formed.



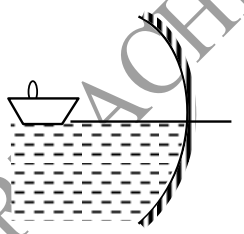
Sol. $\left(\frac{20}{3}\text{cm}, \frac{\pi}{27}\text{cm}\right)$

Q.13 An object O is placed in front of a plane mirror and concave mirror as shown in fig. If 'f' is the focal length of concave mirror then find the separation between the two mirrors so that image obtained after two reflections coincides with object O. (Given f= 4 cm)



Sol. **[9]**

Q.14 A toy boat is floating in river before a concave mirror of f = 20 m as shown



Find number of images (refractive index of water = 1.5)

Q.15 Using a certain concave mirror, the magnification is found to be 4 times as great when the object was 25 cm from the mirror as it was with the object at 40 cm from the mirror, the image being real in each case. Focal length of mirror is 10x cm. Find x, where x is an integer.

Sol. **[2]**

Q.16 Two rays are incident on a concave mirror of radius R = 5cm parallel to its optical axis at a distance h_1 = 0.5 cm & h_2 = 0.3 cm. Determine the distance Δx between the points at which these rays intersect the optical axis after being reflected at the mirror.

Sol. 0.6 cm

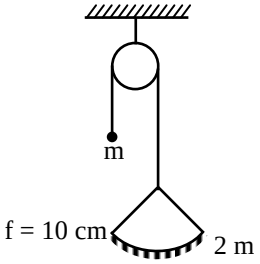
Q.17 A gun of mass 5 kg fires a bullet of mass 0.01 kg with a horizontal speed 500 m/sec. The gun is fitted with a concave mirror of focal length 20 cm facing towards the receding bullet. Find the ratio of speed of separation of the bullet and mirror with the seperation speed between its image and mirror.

Sol. **[1]**

Q.18 A curved mirror is placed in y-z plane with reflecting surface towards positive x side. Four point objects A(10, 1.5), B(20, 2) C(25, 3) and D(25, –2) are placed before it. Arrange these objects according to sharpness of their images greatest first.

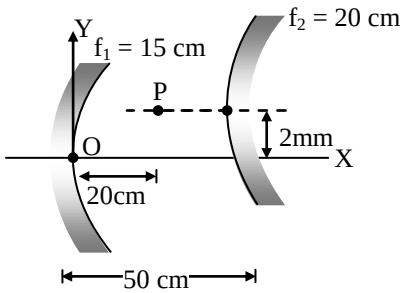
Sol. D > B > C > A

Q.19 The separation between mirror (2m) & mass (m) when they are released is 35 cm. Find angular velocity of image with respect to object (mass 'm'). The diameter of pulley is 4 mm.



Sol. 250 rad/s

Q.20 Find the co-ordinates of image of point object P formed after two successive reflection in situation as shown in figure considering first reflection at concave mirror and then at convex mirror.



Sol. (30 cm, – 14 mm)

Q.1 A light ray traveling parallel to the principal axis of a concave mirror strikes the mirror at angle of incidence θ. If radius of curvature of the mirror is R, then after reflection, the ray meets the principal axis at distance d from the centre of curvature, then d is -

(A) $\frac{R}{2}$ (B) $\frac{R\cos\theta}{2}$

(C) $\frac{R}{2\cos\theta}$ (D) $\frac{R}{2}(1+\cos\theta)$

[C]

Q.2 The image of an object placed on the principal axis of a concave mirror of focal length 12 cm is formed at a point which is 10 cm more distant from the mirror than the object. The magnification of the image is

(A) 8/ 3 (B) 2.5 (C) 2 (D) 1.5

[D]

Q.3 The focal length of a concave mirror is f and the distance from the object to the principal focus is x. The ratio of the size of the image to the size of the object is -

(A) $\frac{f+x}{f}$ (B) $\frac{f}{x}$ (C) $\sqrt{\frac{f}{x}}$ (D) $\frac{f^2}{x^2}$

Sol. **[B]**

$\frac{I}{O}=\frac{f}{f-u}$ here $f = u + x$ so $\frac{I}{O}=\frac{f}{x}$

Q.4 Find the angle of incidence for which angle of deviation from a liquid drop is minimum in a primary rainbow.

(A) 30º (B) 40º

(C) 50º (D) 60º **[D]**

Sol.

$\sin i = \mu \sin r$ … (1)

differentiating eq. (1) $\cos i\, di = \mu \cos r\, dr$

or $\frac{dr}{di}=\frac{\cos i}{\mu\cos r}=\frac{1}{2}$

or $2\cos i = \mu \cos r$

or $4\cos^2 i = \mu^2\cos^2 r = \mu^2(1-\sin^2 r)$

or $4\cos^2 i = \mu^2\left(1-\frac{\sin^2 i}{\mu^2}\right) = \mu^2 - (1-\cos^2 i)$

or $3\cos^2 i = \mu^2 - 1$

or $\cos i = \sqrt{\frac{\mu^2-1}{3}} = \sqrt{\frac{\left(\frac{4}{3}\right)^2-1}{3}} = \sqrt{\frac{7}{27}}$

or $\cos i = \sqrt{.26} = .5$

or $i = 60^o$

Q.5 A concave mirror is used to focus the image of a flower on a nearby well 120 cm from the flower. If a lateral magnification of 16 is desired, the distance of the flower from the mirror should be -

(A) 8cm (B) 12cm

(C) 80cm (D) 120cm

Sol. **[A]**

$\frac{v}{u} = 16$ $\quad v = u + 120$

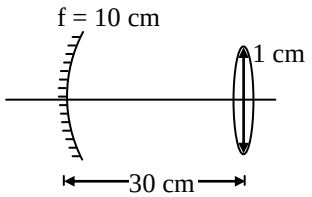
$\therefore \frac{120+u}{u} = 16 \Rightarrow u = 8\text{cm}$

Q.6 A particle moves in a circle of diameter 1 cm with a constant angular velocity. A concave mirror of focal length 10 cm is placed with its principal axis passing through the centre of the circle and perpendicular to its plane. The distance between the pole of the mirror and the centre of the circle is 30 cm. The ratio of acceleration of image to that of object is -

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$

(C) 2 (D) 4 **[A]**

Sol.



$|m| = \left|\frac{f}{f-u}\right| = \left|\frac{-10}{-10+30}\right| = \frac{1}{2}$

$$\frac{r_I}{r_o} = m = \frac{1}{2}$$

$$\omega_o = \omega_I$$

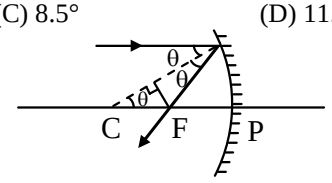
$$\therefore \frac{a_I}{a_o} = \frac{r_I}{r_o} = \frac{1}{2}$$

Q.7 Parallel rays striking a spherical mirror far from the optic axis are focussed at a different point than are rays near the axis thereby the focus moves toward the mirror as the parallel rays move toward the outer edge of the mirror. What value of incidence angle θ produces a 2 % change in the location of the focus, compared to the location for θ very close to zero ?

(A) 3.5° (B) 5.5°

(C) 8.5° (D) 11.5° **[D]**

Sol.



$$f = PF = R - \frac{R}{2}\sec\theta$$

for $\theta = 0$, $f = \frac{R}{2}$

$$0.98\, f = R - \frac{R}{2}\sec\theta$$

$$\Rightarrow 0.98\, f = \frac{R}{2}(2 - \sec\theta)$$

$$\Rightarrow 0.98 = 2 - \sec\theta$$

$$\Rightarrow \sec\theta = 1.02$$

$$\Rightarrow \cos\theta \simeq 0.98$$

$$\Rightarrow 1 - \frac{\theta^2}{2} = 0.98$$

$$\Rightarrow \theta = 0.2 \text{ radian} =$$

$$\frac{0.2\times 180}{\pi} \simeq 11.5°$$

Q.8 A concave mirror of focal length 15 cm forms an image having twice the linear dimensions of the object. The position of the object when the image is virtual will be-

(A) 22.5 cm (B) 7.5 cm

(C) 30 cm (D) 45 cm **[B]**

Sol. $f = -15$cm

for virtual & 2 times large image

$m = +2$

$$m = \frac{f}{f-u} \quad \text{or} \quad +2 = \frac{-15}{-15-u}$$

$$-30 - 2u = -15$$

$$-2u = 15$$

$$u = -7.5 \text{ cm}$$

Q.9 What will be the height of the image when an object of 2 mm is placed at a distance 20 cm infront of the axis of a convex mirror of radius of curvature 40 cm ?

(A) 20 mm (B) 10 mm

(C) 6 mm (D) 1 mm **[D]**

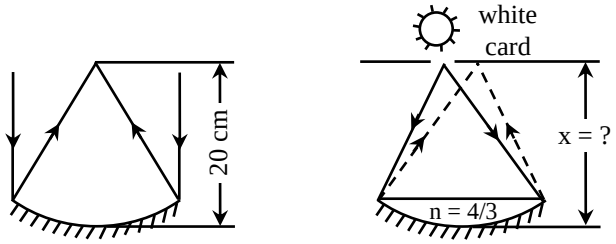
Sol. $f = R/2$

$\therefore$ $f = +20$ cm, $u = -20$ cm, $h_0 = 2$ mm

$$m = \frac{h_i}{h_0} = \frac{f}{f-u} \quad \therefore \quad \frac{h_i}{2} = \frac{20}{20-(-20)}$$

$h_i = 1$ mm

Q.10 A curved mirror brings collimated light to focus at x = 20 cm. as shown in figure (1). Then it is filled with water $n = \frac{4}{3}$ (as shown in Fig. (2)) and illuminated through a pinhole in a white card. A sharp image will be formed on the card at what distance, X?



(1) (2)

Fig.

(A) 10 cm (B) 20 cm

(C) 30 cm (D) 40 cm

Sol.(C) From (a), we find that the focal length of the mirror is $f_a = 20$ cm (in air).

Suppose the focal length is f_b when the mirror is filled with water. When paraxial rays are refracted at a plane surface, the object distance y and the image distance y' are related by

$$y' = \frac{n'y}{n},$$

Q.11 A man standing in front of a concave spherical mirror of radius of curvature 120 cm sees an erect image of his face four times its natural

size. Then the distance of the man from the mirror is -

(A) 180 cm (B) 300 cm

(C) 240 cm (D) 45 cm **[D]**

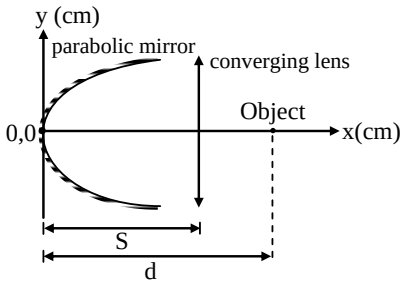
Sol. $m = \frac{f}{f-u}$, $m = +4$

$f = \frac{-120}{2} = -60\text{cm}$

$\therefore \quad +4 = \frac{-60}{-60-u} \quad \therefore \quad -60 = -240 - 4u$

$\therefore \quad 4u = -180 \quad \therefore \quad u = -45$ cm

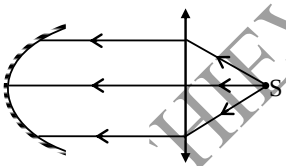
Q.12 Focal length of converging lens is 20 cm, S = 80 cm and d = 100 cm. Find the position co-ordinate of final image after one refraction and reflection at mirror –



(A) 3.16 cm, 0 (B) 8.23 cm, 0

(C) 10.53 cm, 0 (D) 1.16 cm, 0 **[A]**

Sol,



In parabolic mirror, parallel incident ray converge at focus

$y^2 = \frac{x}{8}$

Here $t = \frac{1}{32}$ m

Image will formed at $\frac{1}{32}$ m or 3.16 cm

Q.13 An object is placed at 20cm from a convex mirror of focal length 10cm. The image formed by the mirror is -

(A) Real and at 20cm from the mirror

(B) Virtual and at 20cm from the mirror

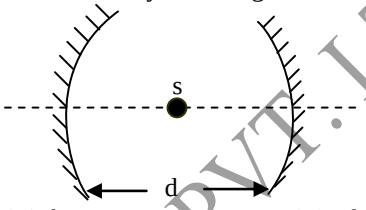
(C) Virtual and at 20/3cm from the mirror

(D) Real and at 20/3 cm from the mirror

Sol. **[C]**

$\frac{1}{10} = \frac{1}{v} - \frac{1}{20} \Rightarrow v = \frac{20}{3}$ virtual image

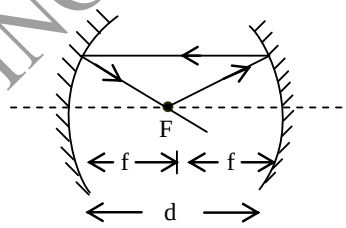
Q.14 Two concave mirror each of focal length f. A point source is placed at a point midway between two mirror. The minimum value of d for which only one image of s is formed –



(A) f (B) 2f

(C) 3f (D) 4f **[B]**

Sol.



It is only possible if object and image coincide.

Q.15 A virtual image three times the size of the object is obtained with a concave mirror of radius of curvature 36cm. The distance of the object from the mirror is

(A) 5 cm (B) 12 cm

(C) 10 cm (D) 20 cm

Sol. **[B]**

$m = +3$ (virtual)

$f = -\frac{R}{2} = -18$ cm

$m = -\left(\frac{f}{u-f}\right)$

$mu - mf = -f$

$u = \left(\frac{m-1}{m}\right) f$

$= \left(\frac{3-1}{3}\right) \times -18$

$= -\frac{2}{3} \times 18$

$= -12$ cm

Q.16 An object is kept between a plane mirror and a concave mirror facing each other. The distance between the mirrors is 22.5 cm. The radius of curvature of the concave mirror is 20 cm.What should be the distance of the object from the concave mirror so that after two successive reflections the final image is formed on the object itself: [Consider first reflection from concave mirror]

(A) 5 cm (B) 15 cm
(C) 10 cm (D) none of these **[B]**

Q.17 A particle is moving towards a fixed spherical mirror. The image.

(A) must move away from the mirror
(B) must move towards the mirror
(C) may move towards the mirror
(D) will move towards the mirror, only if the mirror is convex **[C]**

Q.18 A point object on the principal axis at a distance 15 cm in front of a concave mirror of radius of curvature 20 cm has velocity 2mm/s perpendicular to the principal axis. The velocity of image at that instant will be:

(A) 2 mm/s (B) 4 mm/s
(C) 8 mm/s (D) none of these **[B]**

Q.19 A point object at 15 cm from a concave mirror of radius of curvature 20 cm is made to oscillate along the principal axis with amplitude 2mm. The amplitude of its image will be:

(A) 2 mm (B) 4 mm
(C) 8 mm (D) none of these **[C]**

Q.20 A luminous point object is moving along the principal axis of a concave mirror of focal length 12 cm towards it. When its distance from the mirror is 20 cm its velocity is 4 cm/s. The velocity of the image in cm/s at that instant is :

(A) 6 , towards the mirror
(B) 6, away from the mirror
(C) 9, away from the mirror
(D) 9, towards the mirror **[C]**

Q.21 In case of concave mirror, the minimum distance between a real object and its real image is -

(A) f (B) 2f
(C) 4f (D) Zero **[D]**

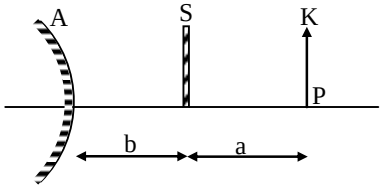
Q.22 A concave mirror of focal length 15cm forms an image having twice the linear dimensions of the object. The position of the object when the image is virtual will be -

(A) 22.5cm (B) 7.5cm (C) 30cm (D) 45cm

Sol. **[B]**

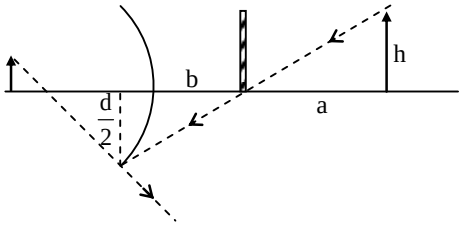
$$-\frac{1}{15}=-\frac{1}{2u}+\frac{1}{u}\Rightarrow u=-7.5m$$

Q.23 A screen S is placed at a distance b = 5 cm from a circular convex mirror as shown in figure. An object KP of height h = 3 cm is arranged at a distance a = 5 cm from the screen. What are the maximum dimensions of the object (with the given arrangement of the object, the mirror and screen) for the mirror to reproduce an image of the entire object diameter of mirror in d = 10 cm.



(A) 5 cm (B) 15 cm
(C) 25 cm (D) 20 cm **[A]**

Sol.



$$\frac{h}{a}=\frac{d}{2b}$$

$$h=\frac{ad}{2b}=\frac{5\times10}{2\times5}=5\ cm$$

Q.24 The focal length of spherical mirror is -
(A) Maximum for red light
(B) Maximum for blue light
(C) Maximum for white light
(D) Same for all lights **[D]**

Q.25 In image formation from spherical mirrors, only paraxial rays are considered because they-
(A) are easy to handle geometrically
(B) contain most of the intensity of the incident light
(C) form nearly a point image of a point source
(D) show minimum dispersion effect **[C]**

Q.26 A short linear object is placed along optic axis of a concave mirror. If distance of nearer end of the object from the mirror is greater than radius of curvature then -
(A) a real and elongated image will be formed
(B) a virtual and elongated image will be formed
(C) a real and diminished image will be formed
(D) a virtual and diminished image will be formed **[C]**

Q.27 A concave mirror is used to form an image of the sun on a white screen. If the lower half on the mirror were covered with an opaque card, the effect on the image on the screen would be -
(A) to make the image less bright than before
(B) to make the lower half of the image disappear
(C) to prevent image from being focused
(D) none of the above **[A]**

Q.28 The image formed by a concave mirror -
(A) is always real
(B) is always virtual
(C) is certainly real if the object is virtual
(D) is certainly virtual if the object is real
[C]

Q.29 A short linear object is placed along optic axis of a concave mirror. If the object is in between pole and focus, then -
(A) a virtual image will be formed
(B) a real diminished image will be formed
(C) If object is in between pole and focus then a real and elongated image will be formed
(D) None of these **[A]**

Q.30 A real inverted and equal in size image is formed by -
(A) A concave mirror
(B) A convex mirror
(C) Plane mirror
(D) None of the above **[A]**

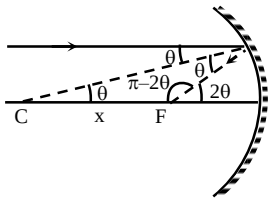
Q.31 A ray of light traveling parallel to the principal axis of a concave mirror strikes the mirror at an angle of incidence θ. If radius of curvature of the mirror is R, then after reflection, the ray meets the principal axis at a distance x from the centre of curvature. Then x is -

(A) $\frac{R}{2}$ (B) $\frac{R}{2\tan\theta}$

(C) $\frac{R}{2\cos\theta}$ (D) $\frac{R}{2\sin\theta}$ **[C]**

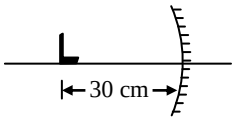
Sol. $\frac{x}{\sin\theta} = \frac{R}{\sin(\pi-2\theta)}$ so $x = \frac{R}{2\cos\theta}$

$\frac{x}{\sin\theta} = \frac{R}{\sin 2\theta}$



Q.32 Check the only wrong statement out of the following -
(A) A convex mirror can give a virtual image
(B) A concave mirror can give a virtual image
(C) A concave mirror can give a diminished virtual image
(D) A concave mirror can give a real image **[C]**

Q.33 A small wire piece of length 2 mm is bent in the form of shape L and is placed at 30 cm away in front of a concave mirror of focal length 20 cm. If both sides of L are equal then length of image formed will be -



(A) 2 mm (B) 4 mm
(C) 6 mm (D) 8 mm **[C]**

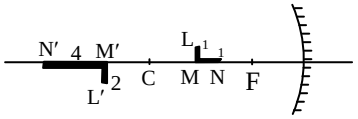
Sol. Transverse magnification

$$m = \frac{f}{f-u} = \frac{-20}{-20+30} = -2$$

Longitudinal/Axial magnification

$m' = -m^2 = -4$

$\therefore$ Length of image = $(1 \times 2) + (1 \times 4) = 6$ mm



Q.34 Which one of the following can produce a parallel beam of light from a point source of light ?
(A) Concave mirror (B) Convex mirror
(C) Plane mirror (D) Concave lens **[A]**

Q.35 Looking into a mirror one finds his image long and thin, the mirror is -
(A) Concave (B) Convex
(C) Cylindrical (D) Parabolic **[C]**

Q.36 A convex mirror is used to form an image of a real object. Then tick the wrong statement-
(A) the image lies between the pole and focus
(B) the image is diminished in size
(C) the image is erect
(D) the image is real **[D]**

Q.37 The focal length of a concave mirror is f and the distance of the object from the focus is u (away from the mirror). The magnification produced by the mirror is -
(A) f / u (B) uf
(C) u / f (D) f^2 / u **[A]**

Q.38 An object is placed 18 cms away from a concave mirror whose focal length is 10 cms. Then the size of area of the image if the object be 4 mm broad and 12 mm long is – (Assume plane of object is perpendicular to axis of mirror)
(A) 1.5 cm^2 (B) 0.5 cm^2
(C) 0.75 cm^2 (D) 2 cm^2 **[C]**

Q.39 A small piece of wire bent into an L shape with upright and horizontal portions of equal lengths, is placed with the horizontal portion along the axis of the concave mirror whose radius of curvature is 10 cms. If the bend is 20 cms from the pole of the mirror, then the ratio of the lengths of the images of the upright and horizontal portions of the wire is -
(A) 1 : 2 (B) 3 : 1
(C) 1 : 3 (D) 2 : 1 **[B]**

Q.40 A motor car is fitted with a convex driving mirror of focal length 20 cm. A second motor car 2 m broad and 1.6 m high is 6 m away from the first car. Then the position of the second car as seen in the mirror of the first car is -
(A) 19.4 cm (B) 17.4 cm
(C) 21.4 cm (D) 15.4 cm **[A]**

Q.41 An inverted image of a real object can be seen in a convex mirror -
(A) Under no circumstances
(B) When object is very far from the mirror
(C) When the object is at a distance equal to the radius of the mirror
(D) When the object is at a distance equal to the focal length of the mirror **[A]**

Q.42 In case of a curved mirror if the distance of object (u) and image (v) are measured from the pole and a graph is plotted between (1/u) and (1/v). The graph is a -
(A) Straight line passing through the origin
(B) Straight line making an intercept with both $\frac{1}{u}$ and $\frac{1}{v}$ axes
(C) Parabola
(D) Hyperbola **[B]**

Q.43 In case of a curved mirror if the object and image distances are measured from the focus and a graph is plotted between them. The graph will be -

(A) Straight line passing through the origin

(B) Straight line not passing through the origin

(C) Parabola

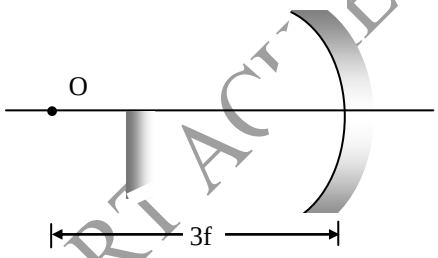
(D) Hyperbola **[D]**

Q.44 A short linear object of length b lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to -

(A) $b\left(\frac{u-f}{f}\right)^{1/2}$ (B) $b\left(\frac{f}{u-f}\right)^{1/2}$

(C) $b\left(\frac{u-f}{f}\right)$ (D) $b\left(\frac{f}{u-f}\right)^{2}$ **[D]**

Q.45 An object O is placed in front of a plane mirror and concave mirror as shown in fig. If 'f' is the focal length of concave mirror then the separation between the two mirrors so that image obtained after two reflections coincides with object O is:



(A) $\frac{9f}{4}$ (B) $\frac{7f}{4}$

(C) f (D) None of these

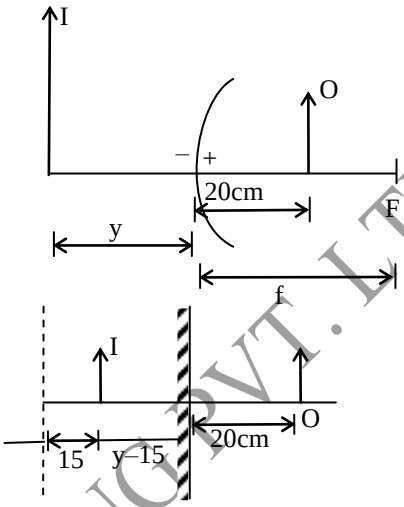
[A]

Q.46 An object is 20 cm away from a concave mirror and it is within the focal length of the mirror. If the mirror is changed to a plane mirror, the image moves 15 cm closer to the mirror.
Focal length of the concave mirror is -

(A) 36.6 cm (B) 56.6 cm

(C) 66.6 cm (D) 46.6 cm

Sol. **[D]**



$\frac{1}{f} = \frac{1}{20} - \frac{1}{y}$

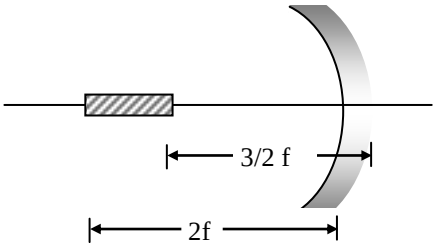
$\frac{1}{y} = \frac{1}{20} - \frac{1}{f}$; $y = \frac{20f}{f-20}$

$y - 20 = 15$ (given)

$\frac{20f}{f-20} = 35$

$f = \frac{700}{15}$ cm

Q.47 A linear object is placed along the axis of a mirror as shown in fig. If 'f' is the focal length of the mirror then the length of image is -



(A) $\frac{2f}{3}$ (B) f

(C) $\frac{f}{3}$ (D) None of these

[B]

Q.48 For a mirror linear magnification m come out to be +2. What conclusions can be drawn from this -

(A) mirror is concave

(B) mirror can be convex or concave but it can not be plane

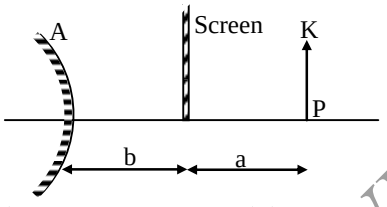
(C) object lies between pole and focus

(D) object lies beyond focus

Sol. **[A,C]**

m = + 2 means image is virtual, erect & magnified. Virtual magnified image can be formed only by a concave mirror & that too when object lies between pole & focus

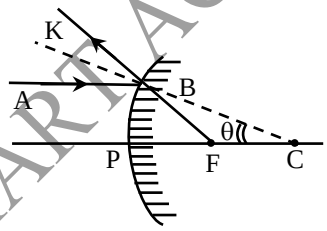
Q.49 A screen S is placed at a distance b = 5 cm from a circular convex mirror as shown in figure. An object KP of height h = 3 cm is arranged at a distance a = 5 cm from the screen. What are the maximum dimensions of the object (with the given arrangement of the object, the mirror and screen) for the mirror to reproduce an image of the entire object. Diameter of mirror is d = 10 cm.



(A) 5 cm (B) 15 cm

(C) 25 cm (D) 20 cm **[A]**

Q.50 In the adjoining figure, AB represents the incident ray and BK the reflected ray. If angle BCF = θ, then ∠ BFP is given by :



(A) θ (B) 2θ

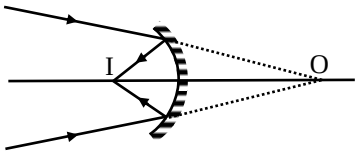
(C) 3θ (D) 2.5θ **[B]**

Sol. **[B]**

∠BFP = θ + ∠CBF = θ + r = θ + θ = 2θ

PHYSICS

Q.1 A beam of light converges towards a point O, 10 cm behind a concave mirror of focal length 20 cm. Where is the image found ?



[20/3 cm]

Q.2 How far must an object be placed in front of a convex mirror of focal length 20 cm to form an image $1/4^{th}$ the size of the object ?

[60 cm]

Q.3 Using a certain concave mirror, the magnification is found to be 4 times as great when the object was 25 cm from the mirror as it was with the object at 40 cm from the mirror, the image being real in each case. Find the focal length of the mirror. **[20 cm]**

Q.4 A convex mirror produces a magnification of 1/2 when an object is placed at a distance of 60 cm from it. Where should the object be placed so that the size of the image becomes 1/3 rd that of the object ? **[120 cm]**

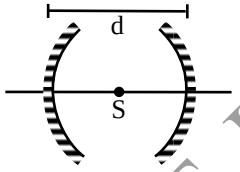
Q.5 If the diameter of the sun is 13.8×10^6 km and if its average distance from the earth is 14.8×10^8 km, then calculate the size of its image formed by a concave mirror of focal length 1.5 metre.

[1.39 cm]

Q.6 Two mirrors, one concave, the other convex each of radius of curvature 20 cm are placed co-axially 40 cm apart, with their reflecting surfaces facing each other and an object is placed midway between them. Find the position of image formed by reflection first at the convex, then at the concave surface.

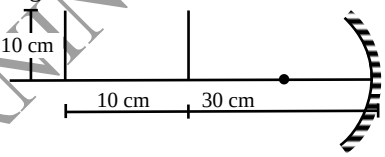
[Real image, 12.73 cm in front of the concave mirror]

Q.7 A point source S is placed midway between two converging mirrors having equal focal length f as shown in figure. Find the values of d, for which only one image is formed.



[2f, 4f]

Q.8 A U-shaped wire is placed before a concave mirror having radius of curvature 20 cm as shown in figure. Find the total length of the image.



[10 cm]

Q.9 Determine the focal length of a concave mirror if :

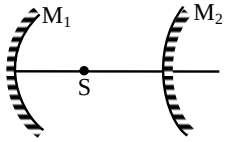
(a) with the distance between an object and its image being equal to ℓ = 15 cm, the transverse magnification $\beta = -2.0$;

(b) in a certain position of the object the transverse magnification is $\beta_1 = -0.50$ and in another positions displaced with respect at the former by a distance ℓ = 5.0 cm the transverse magnification $\beta_2 = -0.25$.

[(a) f = 10 cm, (b) f = 2.5 cm]

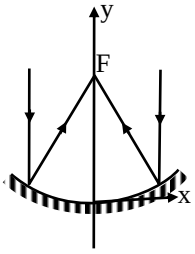
Q.10 A concave mirror and a convex mirror are placed co-axially facing each other. The magnitudes of their focal lengths are equal to 'f' and the distance between them = 4f. A point object is placed on the common principal axis, between the two mirrors such that the final image produced by the two successive reflections, first at the convex mirror, has no parallax with the original object itself. Find the position of the object. **[$f(1 + \sqrt{3})$]**

Q.11 A converging mirror M_1, a point source S and a diverging mirror M_2 are arranged as shown in figure. The source is placed at a distance of 30 cm from M_1. The focal length of each of the mirrors is 20 cm. Consider only the images formed by a maximum of two reflections. It is found that one image is formed on the source itself. (a) Find the distance between the two mirrors. (b) Find the location of the image formed by the single reflection from M_2.



[(a) 50 cm, (b) 10 cm from the diverging mirror further from the converging mirror]

Q.12 A beam of light parallel to y-axis falls on a reflecting surface $y = 2bx^2$ as shown in the figure. Find the point where the beam converge after reflections.

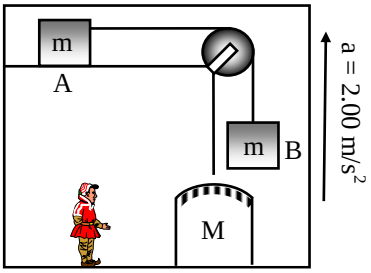


[1 / 8b]

Q.13 The reflecting surface is given by $y = \frac{10L}{\pi}\sin\frac{\pi x}{5L}$. Find the co-ordinates of the point where a horizontal ray becomes vertical after reflection.

$$\left[\frac{5L}{3}, \frac{5\sqrt{3L}}{\pi}\right]$$

Q.14 Consider the situation shown in figure. The elevator is going up with an acceleration of 2.00 m/s^2 and the focal length of the mirror is 12.0 cm. All the surface are smooth and the pulley is light. The mass-pulley system is released from rest (with respect to the elevator) at t = 0 when the distance of B from the mirror is 42.0 cm. Find the distance between the image of the block B and the mirror at t = 0.200 s. Take g = 10 m/s^2.



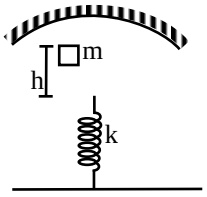
[8.57 cm]

Q.15 A small block of mass m and a concave mirror of radius R fitted with a stand, lie on a smooth horizontal table with a separation d between them. The mirror together with its stand has a mass m. The block is pushed at t = 0 towards the mirror so that it starts moving towards the mirror at a constant speed V and collides with it, The collision is perfectly elastic. Find the velocity of the image (a) at a time t < d/V, (b) at a time t > d/V.

(a) $-\frac{R^2 v}{[2(d-vt)-R]^2}$ **(b)** $v\left[1+\frac{R^2}{[2(vt-d)-R]^2}\right]$

Q.16 A gun of mass M fires a bullet of mass m with a horizontal speed v. The gun is fitted with a concave mirror of focal length f facing towards the receding bullet. Find the speed of separation of the bullet and the image just after the gun was fired. $2\left(1+\frac{m}{M}\right)v$

Q.17 A mass m = 50 g is dropped on a vertical spring of spring constant 500 N/m from a height h = 10 cm as shown in fig. The mass sticks to the spring and executes simple harmonic oscillations after that. A concave mirror of focal length 12 cm facing the mass is fixed with its principal axis coinciding with the line of motion of the mass, its pole being at a distance of 30 cm form the free end of the spring. Find the length in which the image of the mass oscillates.



[1.2 cm]

Q.18 A thin rod of length f / 3 is placed along the optic axis of a concave mirror of focal length f such that the image which is real and elongated, just touches the rod. Find the magnification.

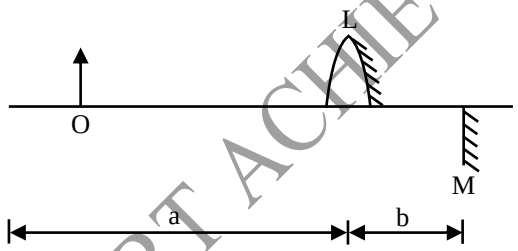
[IIT-JEE 1991]

[–3/2]

Q.19 Two rays are incident on a spherical mirror of radius of R = 5 cm parallel to its optical axis at the distance h_1 = 0.5 cm and h_2 = 3 cm. Determine the distance Δx between the points at which these rays intersect the optical axis after being reflected at the mirror.

[0.625 cm]

Q.20 In fig., L is half part of an equiconvex glass lens (μ = 1.5) whose surfaces have radius of curvature **r** = 40 cm and its right surface is silvered. Normal to its principal axis a plane mirror M is placed on right of the lens. Distance between lens L and mirror M is **b**. A small object O is placed on left of the lens such that there is no parallax between final images formed by the lens and mirror. If transverse length of final image formed



Sol. Since, distance fo object O from plane mirror M is (a + b), therefore, it forms a virtual image at a distance (a + b) behind itself or a distance 2 (a + b) from the object O.

Since, there is no parallax between the images formed by the silvered lens L and plane mirror M, therefore, two images are formed at the same point.

Hence, distance of image from lens L is 2 (a + b) – a = (a + 2b) behind lens.

Since, length of image formed by L is twice the length of image formed by the mirror M and length of image formed by a plane mirror is always equal to length of the object, therefore, modulus of transverse magnification produced by the lens L is equal to 2.

Since, distance of object from L is a, therefore, distance of image from L must be equal to 2a.

$\therefore$ (a + 2b) = 2a or b = a/2 … (1)

The silvered lens L may be assumed as a combination of an equi-convex lens and a concave mirror placed in contact with each other co-axially as shown in Fig.

For the lens,

R_1 = + r, R_2 = – r, μ = 1.5

$\therefore$ Its focal length f_1 is given by

$$\frac{1}{f_1} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{or} \quad f_1 = 40 \text{ cm}$$

For concave mirror, R = – r = – 40 cm

$\therefore$ Its focal length, $f_m = \frac{R}{2}$ = – 20 cm

The combination L behaves like a mirror whose equivalent focal length F is given by

$$\frac{1}{F} = \frac{1}{f_m} - \frac{2}{f_1} \quad \text{or} \quad F = -10 \text{ cm}$$

Hence, for the combination,

μ = – a, v = + 2a, F = – 10 cm

Using mirror formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{F}$

a = 5 cm **Ans.**

Substituting a = 5 cm in equation (1),

b = 2.5 cm **Ans.**