THE VILLAGE
INTERNATIONAL SCHOOL

Question Bank with Solution

Grade10

Physics

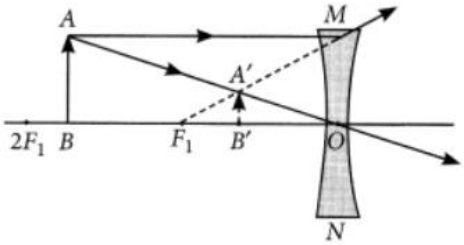
Chapter 10 – Light (Subjective type questions)

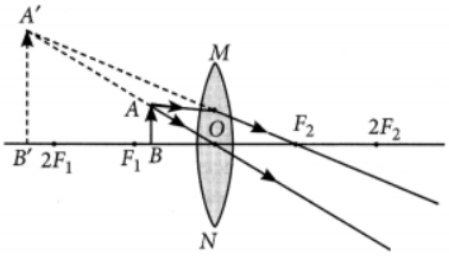
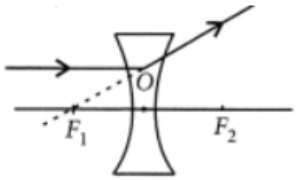
Q.No	Question with solution
1	Define the principal focus of a concave mirror. Answer: Light rays that are parallel to the principal axis of a concave mirror converge at a specific point on its principal axis after reflecting from the mirror. This point is known as the principal focus of the concave mirror.
2	Why do we prefer a convex mirror as a rear-view mirror in vehicles? Answer: Convex mirrors give a virtual, erect, and diminished image of the objects placed in front of them. They are preferred as a rear-view mirror in vehicles because they give a wider field of view, which allows the driver to see most of the traffic behind him.
3	A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why? Answer: The light ray bends towards the normal. When a ray of light travels from an optically rarer medium to an optically denser medium, it gets bent towards the normal. Since water is optically denser than air, a ray of light travelling from air into the water will bend towards the normal.
4	A coin placed at the bottom of a tank appears to be raised when water is poured into it. Explain.

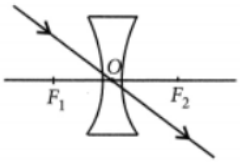
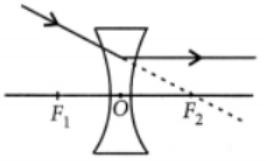
	Answer: This occurs due to the, phenomenon of refraction of light. Here, the ray of light from the coin travels from a denser medium to a rarer medium. In this process it bends away from the normal. The point from which the refracted rays appear to come gives the apparent position of the coin. As the rays appear to come from a point above the coin, so, the coin seems to be raised.
5	Rohit placed a pencil perpendicular to principal axis in front of a converging mirror of focal length 30 cm. The image formed is twice the size of the pencil. Calculate the distance of the object from the mirror. Answer: $Magnification = \frac{h_i}{h_o} = -\frac{v}{u}$ For real image $m = -\frac{v}{u} = -2$ v=2u Now Using the mirror equation, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\frac{1}{2u} + \frac{1}{u} = \frac{1}{-30}$ u=-45 cms. which is between the focal length and the Curvature. For virtual image $m = -\frac{v}{u} = 2$ v=-2u Now Using the mirror equation, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\frac{1}{-2u} + \frac{1}{u} = \frac{1}{-30}$ u=-15 cm which is between the focal length and the pole
6	(a)The refractive index of Ruby is 1.71. What is meant by this statement? (b) The refractive index of some medium are given below: Crown glass- 1.52 Water- 1.33 Sapphire- 1.77 In which of the medium is the speed of light (i)maximum (ii)minimum (iii) Calculate speed of light in sapphire. Answer:

	a. Refractive index of an optical medium is ratio speed of the light in air to the speed of the light in the optical medium.So the refractive index of Ruby is 1.71 means ratio of speed of light in air to the speed of light in ruby is equal to 1.71 b. $Refractive\ Index = \frac{speed\ of\ light\ in\ air}{speed\ of\ light\ in\ optical\ medium}$ $speed\ of\ light\ in\ optical\ medium = \frac{speed\ of\ light\ in\ air}{Refractive\ Index}$ So higher the refractive index, lower the speed So, Speed will be maximum in water and lowest in Sapphire Now $speed\ of\ light\ in Sapphire = \frac{speed\ of\ light\ in\ air}{Refractive\ Index\ of\ Sapphir}$ $= \frac{3\times10^8}{1.77} = 1.69 \times 10^8 m/s$
7	A 10 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 30 cm. The distance of the object from the lens is 20 cm. Find the: (a)Position (b)Nature (c)Size of the image formed. Answer: Given that f=30cm , u= -20cm , v=? Using Lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ $\frac{1}{30} = \frac{1}{v} - \frac{1}{-20}$ v = -60 cm Hence the image is at a distance of 60 cm from the lens.The negative sign indicates it is on same side on lens as the object and it is a real image. Now the size can be obtained using the magnification formula $m = \frac{h_i}{h_o} = \frac{v}{u}$ $\frac{h_i}{10} = \frac{-60}{-20}$ $h_i = 30cm$ Hence Position of image is 60 cm on same side of lens and image is 30 cm and it is erect image
8	Find the focal length of a convex mirror whose radius of curvature is 32 cm. Answer: focal length =32/2 = 16 cm
9	Name the type of mirror used in the following situations: I. Headlights of a car. ii.Side/rear view mirror of a vehicle.

	iii.Solar furnace. Answer: a. Concave mirror b. convex mirror c. concave mirror
10	A concave mirror produces three times magnified real image of an object placed at 10 cm in front of it. Where is the image located? Answer: Here, linear magnification (m) = - 3 (Negative sign for real image, which is inverted) Object distance(u)= -10 cm Image distance = x Now m=−v/u or v = 3u = -30 cm The image is located at 30 cm in front of the mirror.
11	State two positions in which a concave mirror produces a magnified image of a given object. List two differences between the two images. Answer: A concave mirror produces a magnified image when the object is placed in front of the mirror: i.between its pole and focus ii.between the focus and centre of curvature For Ist one the image is virtual and erect, whereas in second the image is real and inverted.
12	Light enters from air to glass having refractive index 1.50. What is the speed of light in the glass? The speed of light in vacuum is 3×108m/s3×108m/s Answer: Refractive index is given by n=speed of light in air / speed of light in glass $1.5 = \frac{3\times10^8}{x}$ $x = 2 \times 10^8$
13	A converging lens has a focal length of 250 mm. Calculate its power and express it according to sign convention. Answer:

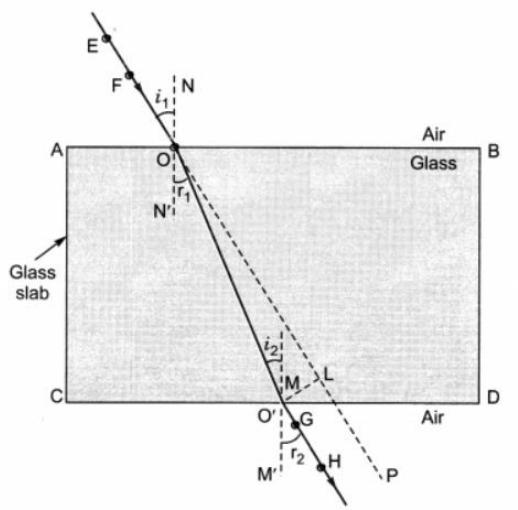
	f = 250 mm = 0.25 m Power = 1 / f = 1/0.25 m = 4 D
14	Write one similarity and one dissimilarity between image formed by pane mirror and convex mirror. Answer: Similarity: - Both produce Virtual Image. dissimilarity: - Convex Mirror produces diminished image while plane mirror produces the Image of the same size as that of the object.
15	Define power of a lens. What is its unit? One student uses a lens of focal length 50 cm and another of -50 cm. What is the nature of the lens and its power used by each of them? Answer: The power of a lens is defined as the reciprocal of its focal length. The SI unit of power is diopter. Case 1 f = 50 cm = 0.50 m P = 1/0.50 = 2D Since the focal length is positive it is a convex lens Case 2 f = -50 cm = -0.50 m P = 1/-0.50 = -2D Since the focal length is negative it is a concave lens
16	If the image formed by a lens for all positions of the object placed in front of it is always virtual, erect and diminished, state the type of the lens. Draw a ray diagram in support of your answer. If the numerical value of focal length of such a lens is 20 cm, find its power in new cartesian sign conventions. Answer: Concave lens always forms virtual, erect and diminished image for all positions of the object.  Focal length of the concave lens f = -20 cm = -0.20 m

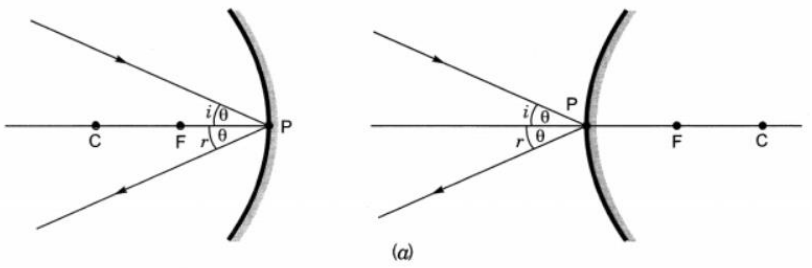
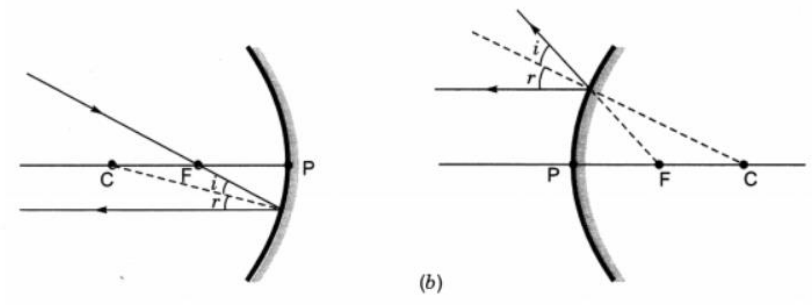
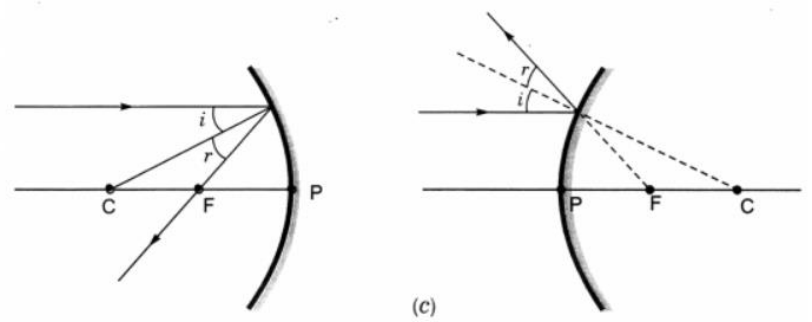
	Power = 1/f = 1/-0.20 m = -5 D
17	The image of a candle flame placed at a distance of 40 cm from a spherical lens is formed on a screen placed on the other side of the lens at a distance of 40 cm from the lens. Identify the type of lens and write its focal length. What will be the nature of the image formed if the candle flame is shifted 25 cm towards the lens? Draw a ray diagram to justify your answer. Answer: Given : u = -40 cm, v = 40 cm $\frac{1}{f} = \frac{1}{40} + \frac{1}{40} = \frac{2}{40} \Rightarrow$ f = 20 cm Type of lens : Convex lens Focal length = 20 cm Nature of the image will be virtual and erect if the candle flame is shifted 25 cm towards the lens. 
18	Draw ray diagram to show the path of the refracted ray in each of the following cases. A ray of light incident on a concave lens (i) is parallel to its principal axis, (ii) is passing through its optical centre and (iii) is directed towards its principal focus. Answer: (i) A ray of light incident on a concave lens is parallel to its principal axis, the diagram can be drawn as follows:  The refracted ray appears to pass through focus on the same side of the lens. (ii) If a ray of light incident on a concave lens is passing through its optical centre then the refracted ray will go without deviation.

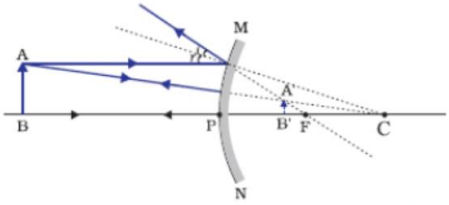
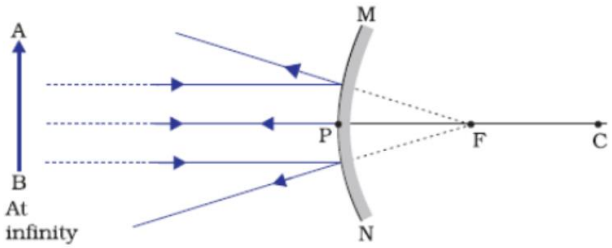
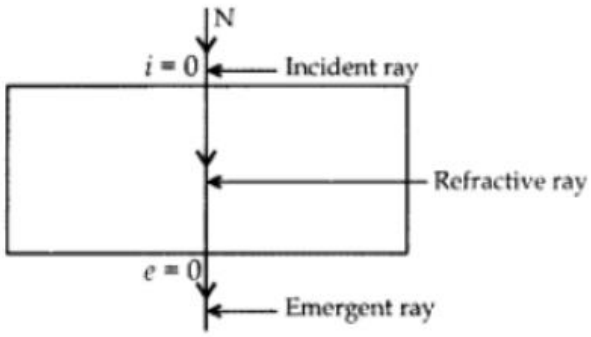
	 (iii) If a ray of light incident on a concave lens is directed towards its principal axis then it will go parallel to principal axis. 
19	Define one dioptre. Answer: 1 dioptre is the power of a lens whose focal length is 1 metre. 1 D = 1 m^{-1}
20	Define 1. Reflection of light 2. Beam of light Answer: (1) Reflection: When light falls on a surface and bounces back to the medium, the phenomena is called reflection. (2) Beam: A beam is a bundle of rays, which originates from a common source and travels in the same direction.
21	Write four difference between real and virtual image. Answer: Real image: 1. When rays of light after reflection meets at a point real image is formed. 2. Real image can be obtained on screen. 3. Real image is formed in front of mirror. 4. Real image is always inverted. Virtual image:

	1. When rays of light do not actually meet but appear to meet at a point after reflection, virtual image is formed. 2. Virtual image cannot be obtained on screen. 3. Virtual image is formed behind the mirror. 4. Virtual image is always erect.
22	An object of height 6 cm is placed perpendicular to the principal axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size and nature of the image if the distance of the object from the lens is 10 cm. Answer: h = 6 cm, f = -5 cm, u = -10 cm $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ $\frac{1}{v}-\frac{1}{-10}=\frac{1}{f}$ $\frac{1}{v}+\frac{1}{10}=\frac{1}{-5} \Rightarrow \frac{1}{v}=-\frac{1}{5}-\frac{1}{10}$ $\boxed{v=\frac{-10}{3}\text{cm}}$ $h=\frac{v}{u}=\frac{\frac{-10}{3}}{-10}=\frac{1}{3}$ Image is diminished and erect.
23	A convex lens of focal length 25 cm and a concave lens of focal length 10 cm are placed in closed contact with each other. Calculate the lens power of the combination. Answer: Power of convex lens, $P_1 = \frac{1}{f_1} = \frac{1}{0.25}$ = 4D Power of concave lens, $P_2 = \frac{1}{f_2} = \frac{1}{-0.1}$ = -10D power of combination, $P = P_1 + P_2$ = 4D − 10D = -6D
24	Write down the uses of concave and convex mirror. Answer: 1. Uses of concave mirrors:

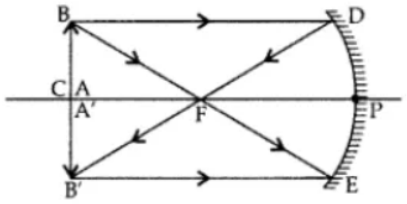
	• Concave mirrors are commonly used in torches, searchlights and vehicle's headlights to get powerful beam of light. • It is used in shaving mirrors to see large image of the face. • Dentists use concave mirror to see large images of the teeth of patients. • Large concave mirrors are used to concentrate sunlight to produce heat in solar furnace. 2. Uses of convex mirrors • Convex mirrors are used as rear-view (wing) mirrors in vehicles. • Convex mirrors are used as street reflectors because they are able to spread light over a bigger area.
25	Write the laws of refraction. Explain the same with the help of ray diagram, when a ray of light passes through a rectangular glass slab. Answer: Laws of refraction: • The incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane. • The ratio of sine of angle of incidence to the sine of angle of refraction is a 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. If i is the angle of incidence and r is angle of refraction. sin i / sin r = constant Refraction through glass slab: • The ray of light enters from rarer to denser medium at point O that is from air to glass and bends towards the normal. • At 'O', the light ray enters from glass to air, that is, from a denser medium to a rarer medium. The light here bends away from normal. • The emergent ray is parallel to the incident ray. However the light ray shifts slightly sideward. • Refraction is due to change in speed of light when it enters from one medium to another.

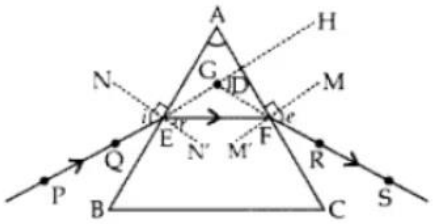
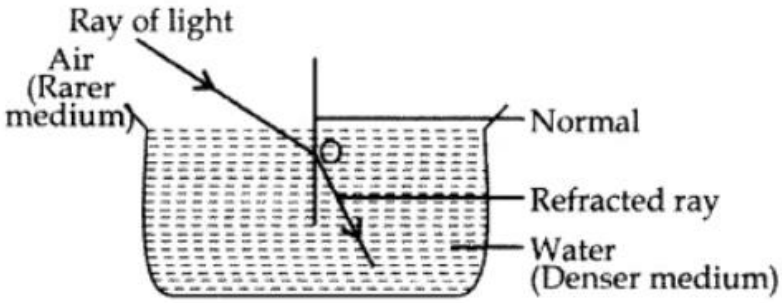
	 *(Refraction of light through a rectangular glass slab)*
26	A spherical mirror produces an image of magnification -1 on a screen placed at a distance of 50 cm from the mirror. (a) Write the type of mirror. (b) Find the distance of the image from the object. (c) What is the focal length of the mirror? Answer: (a) Concave mirror (b) m = -1, u = -50 cm, $m = \frac{h'}{h} = \frac{-v}{u} \quad \Rightarrow -1 = \frac{-v}{-50}$ ∴ v = -50 cm (c) $\frac{1}{u} + \frac{1}{v} = \frac{1}{f} \quad \Rightarrow \frac{1}{-50} - \frac{1}{50} = \frac{1}{f}$ ∴ f = -25 cm
27	Draw a ray diagram to show the path of the reflected ray in each of the following cases. A ray of light incident on a convex mirror and concave mirror (a) strikes at its pole making an angle θ with the principal axis. (b) is directed towards its principal focus. (c) is parallel to its principal axis.

	Answer:  (a)  (b)  (c)
28	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: Convex mirror  **OR** 
29	A ray of light falls normally on the surface of a transparent glass slab. Draw a ray diagram to show its path and also mark angle of incidence and angle of emergence. Answer:  ∠i = 0°; ∠r = 0°; ∠e = 0°

30	"A concave mirror of focal length 15 cm can form a magnified erect as well as inverted image of an object placed in front of it." Justify this statement stating the position of the object with respect to the pole of the mirror in both cases for obtaining the images. Answer: Case 1. When the object is placed between less than 15 cm from the pole, i.e., between the pole and the focus of a concave mirror, a magnified, erect and virtual image will be formed. Case 2. When the object is placed between 15 to 30 cm, i.e., between the focus and the centre of curvature of the concave mirror, a magnified, inverted and real image will be formed.
31	List four characteristics of the images formed by plane mirrors. Answer: The characteristics of the images formed by plane mirrors are: 1. The image formed by a plane mirror is virtual and erect. It cannot be received on a screen. 2. The image formed by a plane mirror is of the same size as the object. 3. The image formed by a plane mirror is at the same distance behind the mirror as the object is in front of the mirror. 4. The image formed in a plane mirror is laterally inverted.
32	"The magnification produced by a spherical mirror is -3". List four informations you obtain from this statement about the mirror/image. Answer: Magnification produced by a spherical mirror, m = -3 • Image is 3 times magnified than the object. • Image is inverted (as m has negative sign) • Image is real. • Nature of the mirror is concave.
33	The refractive indices of glass and water with respect to air are 3/2 and 4/3 respectively. if speed of light in glass is 2×10^8 m/s, find the speed of light in water. Answer:

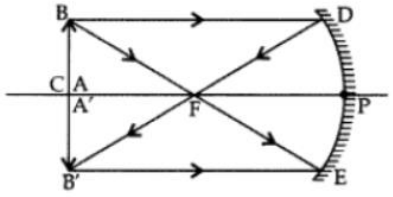
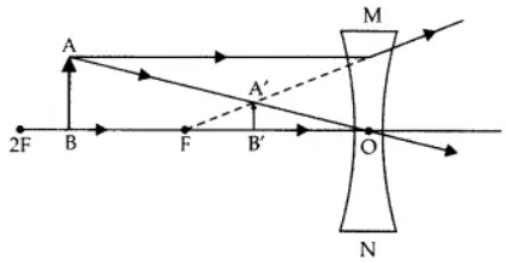
	Refractive index of a medium = $\frac{\text{Speed of light in air}}{\text{Speed of light in that medium}}$ **Given:** $n_g = \frac{3}{2}$, $n_w = \frac{4}{3}$ Speed of light in glass = 2×10^8 m/s; Speed of light in water = v = ? $n_g = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}} \Rightarrow \frac{3}{2} = \frac{\text{Speed of light in air}}{2\times10^8 \text{m/s}}$ $\therefore$ Speed of light in air = $\frac{3}{2} \times 2 \times 10^8 = 3 \times 10^8$ m/s $n_w = \frac{\text{Speed of light in air}}{\text{Speed of light in water}} \Rightarrow \frac{4}{3} = \frac{3\times10^8 \text{m/s}}{v}$ $3 \times 10^8 \times \frac{3}{4} = v \Rightarrow v = 2.25 \times 10^8$ m/s **$\therefore$ Speed of light in water = 2.25×10^8 m/s**
34	Draw the ray diagram and also state the position, the relative size and the nature of image formed by a concave mirror when the object is placed at the centre of curvature of the mirror. Answer: When the object is at the centre of curvature of a concave mirror, i.e., point C:  The image formed is • real, • inverted, • same size as the object at C, and • at C.
35	Draw a ray diagram to show the refraction of light through triangular glass prism and mark angle of deviation on it. Answer:

	Refraction of light through triangular glass prism:  PF – Incident ray EF – Refracted ray FS – Emergent ray ∠A – Angle of the prism ∠i – Angle of incidence ∠r – Angle of refraction ∠e – Angle of emergence ∠D – Angle of deviation
36	A ray of light travelling in air enters obliquely into water. Does the light ray bend towards or away from the normal? Why? Draw a ray diagram to show the refraction of light in this situation. Answer:  When a ray of light travelling in air enters obliquely into water, the light ray will bend towards the normal. Because when a ray of light travels obliquely from rarer medium to denser medium, it will bend towards the normal.
37	A 5 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 12 cm. The distance of the object from the lens is 8 cm. Using the lens formula find the position, size and nature of the image formed.

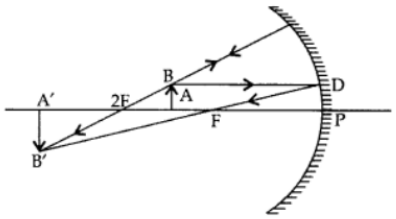
	Answer: f = +12 cm (for convex lens), h_1 = 5 cm, u = -8cm v =? , h_2 = ?, Nature of the image = ? According to lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \quad \Rightarrow \quad \frac{1}{v}-\frac{1}{-8}=\frac{1}{12} \quad \Rightarrow \quad \frac{1}{v}+\frac{1}{8}=\frac{1}{12}$ $\Rightarrow \frac{1}{v}=\frac{1}{12}-\frac{1}{8}=\frac{2-3}{24}=\frac{-1}{24} \quad \Rightarrow \quad v = -24 \text{ cm}$ • Image is formed at a distance of 24 cm from the convex lens. • The negative (-) sign of v shows that the image is formed on the left hand side of the convex lens and only virtual image is formed on the left hand side. A virtual image is formed at 24 cm from the lens. $\therefore m=\frac{v}{u}=\frac{\cancel{24}^{3}}{\cancel{8}}=3 \quad \Rightarrow \quad m=\frac{h_2}{h_1} \quad \Rightarrow \quad \frac{h_2}{5}=3$ $h_2 = 3 \times 5 = 15$ cm • Thus size of the image is 15 cm. • The positive (+) sign shows that the image is formed above the axis. • Thus a virtual, magnified and erect image is formed.
38	The image of a candle flame placed at a distance of 30 cm from a spherical lens is formed on a screen placed at a distance of 60 cm from the lens. Identify the type of lens and calculate its focal length. If the height of the flame is 2.4 cm, find the height of its image. Answer: Object distance, u = -30 cm, Image distance, v = +60 cm [+ve sign is due to the image formed on the screen, hence it is real] f = ?, Type of lens = ? Height of the object, h_1 = 2.4 cm, Height of the image, h_2 = ? According to lens formula: $\frac{1}{f}=\frac{1}{v}-\frac{1}{u} \quad \Rightarrow \quad \frac{1}{f}=\frac{1}{60}-\frac{1}{-30} \quad \Rightarrow \quad \frac{1}{f}=\frac{1}{60}+\frac{1}{30}=\frac{1+2}{60}=\frac{\cancel{3}^{1}}{\cancel{60}_{20}}=\frac{1}{20}$ f = + 20cm The positive (+ve) sign of/shows that the lens is convex having focal length 20 cm. Now Magnification, $m=\frac{v}{u}=\frac{\cancel{60}^{2}}{\cancel{-30}}=-2$ The negative (-ve) sign of h_2 shows that the image is inverted.

39	An object of height 6 cm is placed perpendicular to the principal axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size and nature of the image if the distance of the object from the lens is 10 cm. Answer: Height of the object, h_1 = 6 cm, Focal length of the concave mirror, f = -5 cm Position of the image, v = ?, Size of the image, h_2 = ? Object distance, u = -10 cm According to lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} - \frac{1}{-10} = \frac{1}{-5} \Rightarrow \frac{1}{v} + \frac{1}{10} = \frac{-1}{5}$ $\Rightarrow \frac{1}{v} = \frac{-1}{5} - \frac{1}{10} = \frac{-2-1}{10} = \frac{-3}{10} \quad \therefore v = \frac{-10}{3} = -3.3 \text{ cm}$ $\frac{h_2}{h_1} = \frac{v}{u} \Rightarrow \frac{h_2}{6} = \frac{\frac{10}{3}}{10} \Rightarrow \frac{h_2}{6} = \frac{10}{3 \times 10} = \frac{1}{3}$ $\Rightarrow h_2 = \frac{6}{3} \quad \therefore h_2 = +2 \text{ cm}$ Thus the image is formed at a distance of 3.3 cm from the concave lens. The negative (-) sign for image distance shows that the image is formed on the left side of the concave lens (i.e., virtual). The size of the image is 2 cm and the positive (+) sign for hand image shows that the image is erect. Thus a virtual, erect, diminished image is formed on the same side of the object (i.e., left side).
40	A student focussed the image of an object on a white screen using a converging lens. He noted down the positions of the object, screen and the lens on a scale as given below: Position of object = 10.0 cm; Position of lens = 50.0 cm; Position of screen = 90.0 cm (a) Find the focal length of the converging lens. (b) Find the position of the image if the object is shifted towards the lens at a position of 30.0 cm. (c) State the nature of the image formed if the object is further shifted towards the lens. Answer: Object distance, u = -40 cm, Image distance, v = (90 – 50) = +40 cm (a) Focal length of converging lens, f = ? According to lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{40} - \frac{1}{-40} = \frac{1}{40} + \frac{1}{40} \Rightarrow \frac{1}{f} = \frac{2}{40} = \frac{1}{20}$

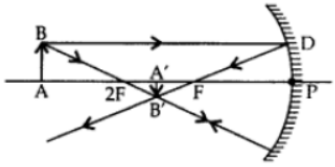
	Focal length of converging lens, f = +20 cm (b) If u = -20 cm (Object is shifted from 10 cm to 30 cm with respect to 50 cm) f = +20 cm $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \quad \Rightarrow \quad \frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{20}+\frac{1}{-20}=\frac{1}{20}-\frac{1}{20}=0 \quad \Rightarrow \quad \frac{1}{v}=0$ $\Rightarrow v=\frac{1}{0}$ $\therefore v=\infty$ (∵Reciprocal of 0 is ∞) So image is formed at infinity. If the object is shifted from 30 cm towards 50 cm, the object lies between the focus and optical centre of the lens. Then the image formed will be behind the object, virtual, erect and enlarged (larger than the object).
41	A spherical mirror produces an image of magnification -1 on a screen placed at a distance of 50 cm from the mirror. (a) Write the type of mirror. (b) Find the distance of the image from the object. (c) What is the focal length of the mirror? (d) Draw the ray diagram to show the image formation in this case. Answer: If magnification, m = -1; v = 50 cm If the magnification has minus sign, then the image is real and inverted. ∴ v = -50 (for real image) ∵ m = −v/u ⇒ -1 = −(−50)/u u = -50 cm (a) Since image is formed on the screen therefore the mirror formed real image which is formed by concave mirror only. (b) Image distance = 50 cm in front of the mirror. (c) $\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \quad \Rightarrow \quad \frac{1}{f}=\frac{1}{-50}+\frac{1}{-50} \quad \Rightarrow \quad \frac{1}{f}=-\frac{1}{50}-\frac{1}{50} \quad \Rightarrow \quad \frac{-2}{50}=\frac{-1}{25}$ $\therefore f = -25$ cm

	(d) 
42	If the image formed by a lens for all positions of an object placed in front of it is always erect and diminished, what is the nature of this lens? Draw a ray diagram to justify your answer. If the numerical value of the power of this lens is 10 D, what is its focal length in the Cartesian system? Answer: This lens is a concave lens.  P = -10D (As lens is concave), f ?, P = $\frac{1}{f}$ So,f = $\frac{1}{p} \Rightarrow \frac{1}{-10}$0.1 m or -10 cm. So, the focal length of the lens is 10 cm.
43	(a) If the image formed by a lens is diminished in size and erect,for all positions of the object, what type of lens is it? (b) Name the point on the lens through which a ray of light passes undeviated. (c) An 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 (i) the position (ii) the magnification and (iii) the nature of the image formed. a) The lens is concave. (b) Optical centre is the point on the lens through which a ray of light passes undeviated. (c) Convex lens: Focal length, f = +20 cm,

	Object distance, u = -30 cm Image distance, v = ?, Magnification, m = ? Nature of the image = ? According to lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{v}-\frac{1}{-30}=\frac{1}{20} \Rightarrow \frac{1}{v}+\frac{1}{30}=\frac{1}{20}$ $\Rightarrow \frac{1}{v}=\frac{1}{20}-\frac{1}{30}=\frac{3-2}{60}=\frac{1}{60} \Rightarrow v = +60\ \text{cm} \therefore m=\frac{v}{u}=\frac{60}{-30}=-2$ Nature: The +ve sign of v shows that the image is formed on the right side of the convex lens, so the image formed is real. • The magnification is two (i.e., more than one) so the image is larger than the object. • The -ve sign for m shows that the image is formed below the principal axis. Hence the image is inverted. ∴ Nature of image: Real, inverted and magnified
44	A student wants to project the image of a candle flame on the walls of school laboratory by using a mirror. (a) Which type of mirror should he use and why? (b) At what distance in terms of focal length 'F' of the mirror should he place the candle flame so as to get the magnified image on the wall? (c) Draw a ray diagram to show the formation of image in this case. (d) Can he use this mirror to project a diminished image of the candle flame on the same wall? State 'how' if your answer is 'yes' and 'why not' if your answer is 'no'. Answer: (a) Concave mirror should be used as only this mirror will produce a real image (i.e., on the wall). (b) The object should be placed between 'F' and '2F' so as to get the magnified image on the wall. (c)



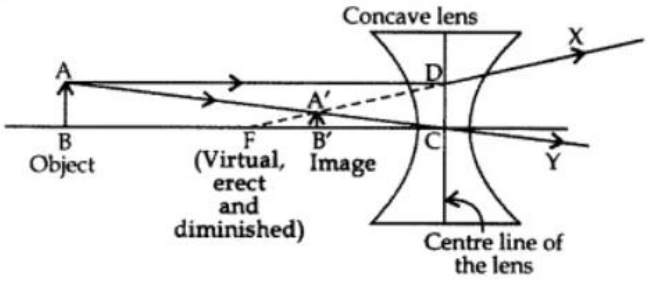
(d) When the candle flame is placed beyond 2F, A diminished real image will be formed on the wall.



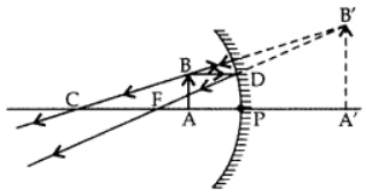
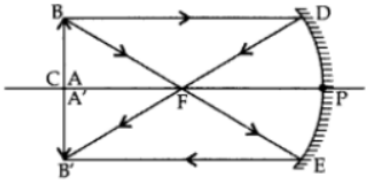
45

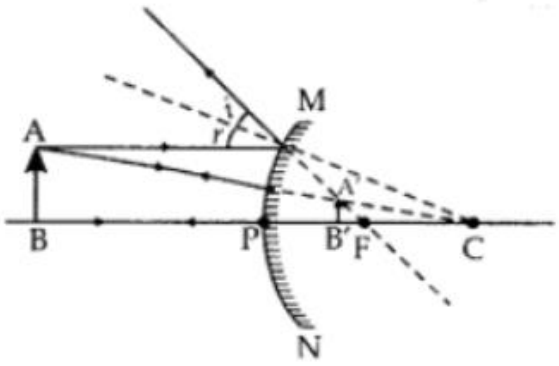
(a) Draw a ray diagram to show the formation of image by a concave lens when an object is placed in front of it.
(b) In the above diagram mark the object-distance (u) and the image-distance (v) with their proper signs (+ve or -ve as per the new Cartesian sign convention) and state how these distances are related to the focal length (f) of the concave lens in this case.
(c) Find the nature and power of a lens which forms a real and inverted image of magnification -1 at a distance of 40 cm from its optical centre.

(a) Concave lens.



	(b) CB = -u, CF = -f, CB' = -v The relation between u, v and f is given by the lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ As both u and v are negative the above equation will change to $\frac{1}{f} = \frac{1}{(-v)} - \frac{1}{(-u)} \quad \Rightarrow \quad \frac{1}{f} = \frac{-1}{v} + \frac{1}{u} \quad \Rightarrow \quad \frac{1}{f} = \frac{1}{u} - \frac{1}{v}$ We know that the focal length of a concave lens is negative, so the above equation will be changed to, $\frac{1}{-f} = \frac{1}{u} - \frac{1}{v}$ $\Rightarrow \frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (c) Magnification in = -1; v = +40 cm (real and inverted); Nature of the lens = ?; Power of the lens, P = ? $\frac{v}{u}$ = m $\Rightarrow \frac{+40}{u}$ = -1 $\Rightarrow$ 40 = -u $\Rightarrow$ u = -40 cm According to the lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \quad \Rightarrow \quad \frac{1}{f} = \frac{1}{40} - \frac{1}{-40} = \frac{1}{40} + \frac{1}{40} = \frac{2}{40} = \frac{1}{20}$ f = +20 cm $\because$ f is +ve thus the lens is convex $\mathbf{P = \frac{1}{f(metres)} = \frac{1 \times 100}{20} = +5D}$ Since power of lens is positive, lens will be converging in nature.
46	It is desired to obtain an erect image of an object, using concave mirror of focal length of 12 cm. (i) What should be the range of distance of an object placed in front of the mirror? (ii) Will the image be smaller or larger than the object? Draw a ray diagram to show the formation of image in this case. (iii) Where will the image of this object be, if it is placed 24 cm in front of the mirror? Draw a ray diagram for this situation also to justify your answer. Show the positions of the pole, the principal focus and the centre of curvature in the above ray diagrams.

	Answer: In a concave mirror an erect image will be obtained when the object is placed between pole and focus of the mirror. Focal length, f = 12 cm  (i) Therefore, the range of object distance is between 0 cm to <12 cm (from zero to less than 12 cm). (ii) Image formed will be magnified, i.e., larger than the object. (iii) If the object is placed at 24 cm in front of the mirror, it means that object is placed at 2f, i.e., at the centre of curvature (at C) of the mirror. The real, inverted and same size (of the object) image will also be formed at 24 cm. 
47	(a) If the image formed by a mirror for all positions of the object placed in front of it is always diminished, erect and virtual, state the type of the mirror and also draw a ray diagram to justify your answer. Write one use such mirrors are put to and why? (b) Define the radius of curvature of spherical mirrors. Find the nature and focal length of a spherical mirror whose radius of curvature is +24 cm. Answer: (a) This mirror is Convex mirror: Such mirrors are used as rear view mirror in automobiles, as convex mirror gives erect, and wider range of view of objects coming behind the automobile.



(b) Radius of curvature of a mirror is the distance between 'P' point (pole) and 'C point (centre of curvature) of a spherical mirror.

$f = \frac{r}{2}$

So, $f = \frac{24}{2}$

∴ f = +12 cm and this mirror is a concave mirror.

48 A concave mirror is use for image formation for different positions of an object. What inferences can be drawn about the following when an object is placed at a distance of 10 cm from the pole of a concave mirror of focal length 15 cm? (A) Position of the image (B) Size of the image (C) Nature of the image Draw a labelled ray diagram to justify your inferences.

Answer:

Position of object, u = – 10 cm

Focal length of concave mirror, f = –15 cm

(a) Using mirror formula,

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

$$\Rightarrow \frac{1}{v} = \frac{1}{-15\ \text{cm}} - \frac{1}{(-10\ \text{cm})} = \frac{1}{30\ \text{cm}}$$

$$\Rightarrow v = 30\ \text{cm}$$

So, the position of image is 30 cm behind the mirror.

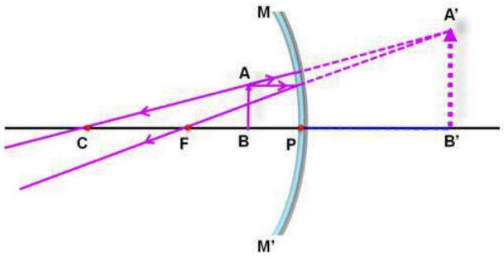
(b) Using magnification formula, $m = \frac{h_i}{h_o} = -\frac{v}{u}$

$$\Rightarrow \frac{h_i}{h_o} = -\frac{30\ \text{cm}}{(-10\ \text{cm})} = 3\ \text{cm}$$

$$\Rightarrow h_i = 3h_o$$

So, the size of the image is three times that of the size of the object.

Here the object is placed in between focus and pole of the concave mirror, so the image formed will be virtual and magnified.

	
49	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 $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\frac{1}{u} = \frac{1}{f} - \frac{1}{v} = \frac{1}{-20} - \frac{1}{-30} = \frac{-3+2}{60}$ ⇒ u = -60 cm ∴ Object placed at 60 cm from the mirror. Also magnification, m = $\frac{h'}{h} = \frac{-v}{u}$ ⇒ h' = $\frac{-(-30)}{-60} \times 4$ = -2 cm ∴ The size of the image is 2 cm.
50	The image formed by a spherical mirror is real, inverted and its magnification is -2. If the image is at a distance of 30 cm from the mirror, where is the object placed? Find the focal length of the mirror. List two characteristics of the image formed if the object is moved 10 cm towards the mirror. Answer: Since the image formed is real and inverted, the mirror is concave. Magnification, m = $\frac{-v}{u}$ ⇒ -2 = $\frac{-v}{u}$ ⇒ v = 2u Now, if v = − 30 cm then u = − 15 cm As focal length of the mirror is f = $\frac{uv}{u+v} = \frac{-15\times-30}{-15-30} = f = \frac{450}{-45}$ = -10 cm If the object is shifted 10 cm towards the mirror, then the object is between principal focus and the optical centre and the image formed will be virtual and erect.