Very Short Answer Type Questions

[1 Mark]

Q. 1. What is light?

Ans. Light is a form of energy which gives us the sensation of sight or vision.

Q. 2. What is a ray of light?

Ans. The path along which light travels is called a ray of light.

Q. 3. What is a beam of light?

Ans. A group of light rays originating from a source and travelling in some definite direction is known as a beam of light.

Q. 4. Name a communication device which uses light for its working.

Ans. Optical fibres, which transmit many telephonic messages at the same time.

Q. 5. What is the angle of reflection when a ray of light falls normally on a plane mirror?

Ans. The angle of reflection is 0°.

Q. 6. What kind of image can be obtained on the screen?

Ans. Real image

Q. 7. What type of image is formed:

(i) in a plane mirror, and (ii) on a cinema screen?

Ans. Virtual image, and (i) real image.

Q. 8. Name the type of mirror which always forms a virtual and diminished image.

Ans. Convex mirror.

Q. 9. Which mirror-convex or concave has larger field of view?

Ans. Convex mirror.

Q. 10. If an object is placed at the focus of a concave mirror, where is the image formed?

Ans. At infinity.

Q. 11. What should be the position of the object when a concave mirror is to be used:

(i) as a shaving mirror?, and (ii) as a doctor's mirror?

Ans. (i) Between pole P, and focus F, and
(ii) At focus F.

Q. 12. What sign (+ve or-ve) is given to the focal length of:

(a) a concave mirror?, and (b) a convex mirror?

Ans. (a) Focal length of a concave mirror is - ve, and

(b) Focal length of a convex mirror is + ve.

Q. 13. Give the cartesian sign convention for:

(a) height of a real image, and (b) height of a virtual image.

Ans. (a) - ve, and (b) + ve.

Q. 14. What is the significance of +ve sign of magnification?

Ans. + ve sign of magnification shows that the image is virtual and erect.

Q, 15. Can a plane mirror be called spherical mirror?

Ans. Yes, a plane mirror can be called a spherical mirror of infinite radius of curvature.

Q. 16. A man standing in front of a spherical mirror, finds his image having a very small head, a fat body and legs of normal size. What type of mirrors are used in these three parts?

Ans. A very small head: Convex mirror,
A fat body: Concave mirror, and
Legs of normal size: Plane mirror

Q. 17. Differentiate between virtual image formed by a concave mirror and of a convex mirror.

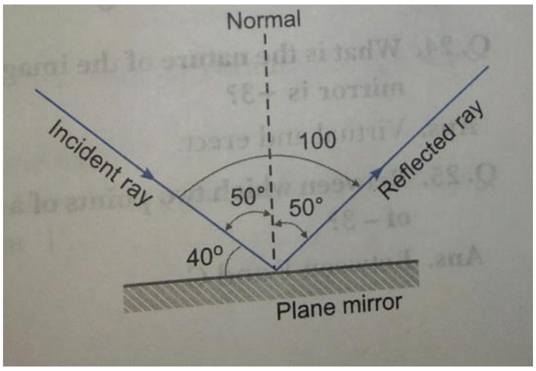
Ans. The virtual image formed by a concave mirror is always magnified whereas the virtual image formed by a convex mirror is diminished.

Q. 18. What is the magnification produced by a plane mirror?

Ans. The magnification of a plane mirror is 1.

Q, 19. The angle between an incident ray and the mirror is 40°.

(i) What is the angle of incidence?
(ii) What is the angle of reflection?
(iii) What is the total angle through which the ray of lightturns?

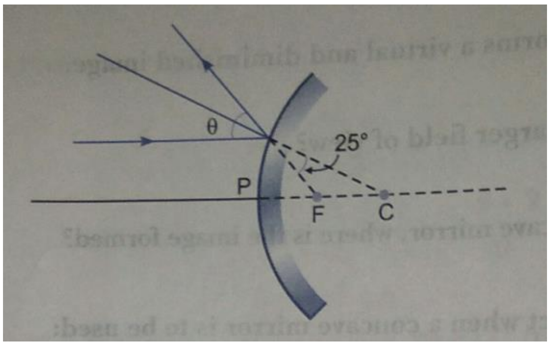


Ans. (i) 50°
(ii) 50°
(iii) 100°

Q. 20. Why does a convex mirror is said to have a virtual principal focus?

Ans. In a convex mirror, the reflected rays do not actually pass through the focus (F). So, a convex mirror has a virtual principal focus, which is situated behind the mirror.

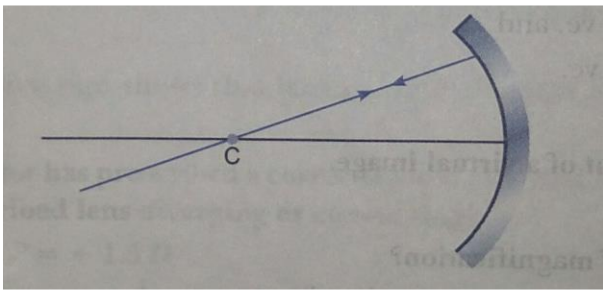
Q. 21. What is the value of θ in the following ray diagram?



Ans. Θ = 25 + 25 = 50°

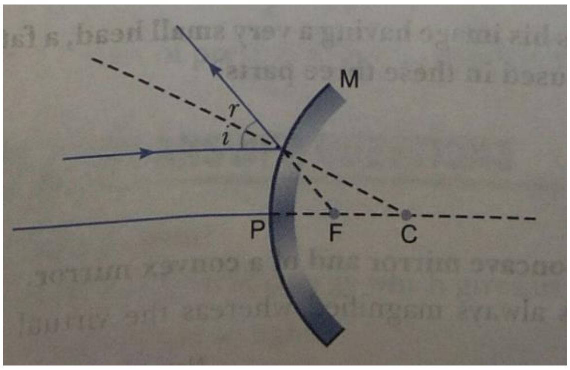
Q. 22. Explain why a ray of light passing through the centre of curvature of a concave mirror gets reflected along the same path after reflection.

Ans. This is because the angle of incidence is 0°. That is the ray passing through the centre of curvature is incident normally to the mirror. The angle of reflection should also be 0°.



Q. 23. Draw a ray diagram to show the path of the reflected ray corresponding to an incident ray of light parallel to the principal axis of a convex mirror and show the angle of incidence and angle of reflection on it.

Ans.



Q.24. What is the nature of the image formed by a concave mirror if the magnification product by the mirror is +3?

Ans. Virtual and erect.

Q, 25. Between which two points of a concave mirror should an object be placed to obtain a magnification of-3?

Ans. Between F and C.

Q. 26. The outer surface of a hollow sphere of aluminium of radius 50 cm is to be used as a mirror. What will be the focal length of this mirror? Which type of spherical mirror will it provide?

Ans. Focal length, $f = \frac{R}{2} = \frac{50}{2} = 25\ cm$

It will provide convex mirror.

Q. 27. Which property of concave mirror is utilised for using them as shaving mirrors?

Ans. When an object is placed between the pole and focus of concave mirror a magnified, erect and virtual image is obtained.

Q. 28. What is an optically rarer medium?

Ans. A medium in which light travels comparatively faster than the other medium is called an optically rarer medium.

Q. 29. What is an optically denser medium?

Ans. A medium in which light travels comparatively slower than the other medium is called an optically denser medium.

Q. 30. Define the term refraction of light.

Ans. The bending of a ray of light falling obliquely on a surface when it passes from one medium to another is called refraction.

Q.31. Define the term angle of incidence.

Ans. The angle between an incident ray and the normal at the point of incidence is called angle of refraction.

Q. 32. Define the term angle of refraction.

Ans. The angle between the refracted ray and the normal at the point of incidence is called angle of refraction.

Q. 33. Define the term refractive index of a medium in terms of speed of light.

Ans. Refractive index of a medium is defined as the ratio of speed of light in vacuum to the speed of light in the medium. i.e.,

Refractive index (of a medium)=$\frac{Speed\ of\ light\ in\ vacuum}{Speed\ of\ light\ in\ medium}$

Q.34. What is absolute refractive index?

Ans. Refractive index of a medium with respect to vacuum is called absolute refractive index.

Q.35. What is relative refractive index?

Ans. Refractive index of a medium with respect to another medium is called relative refractive index.

Q.36. What is the unit of refractive index?

Ans. Refractive index has no units as it is a ratio of two similar physical quantities.

Q. 37. Refractive index of two material mediums X and Y are 1.3 and 1.5 respectively. In which of the two, the light would travel faster?

Ans. In medium 'X' because of lower value of refractive index.

Q. 38. What is the cause of refraction of light?

Ans. Refraction of light takes place when it travels from one medium to another because the speed of light is different in the two media.

Q. 39. What is the relationship between the refractive index of two media?

Ans. The refractive index for the light going from medium '1'to medium ‘2’ is equal to the reciprocal of the refractive index for light going from medium ‘2’ to medium ‘1’.

$1\mu 2 = \frac{1}{2\mu 1}$

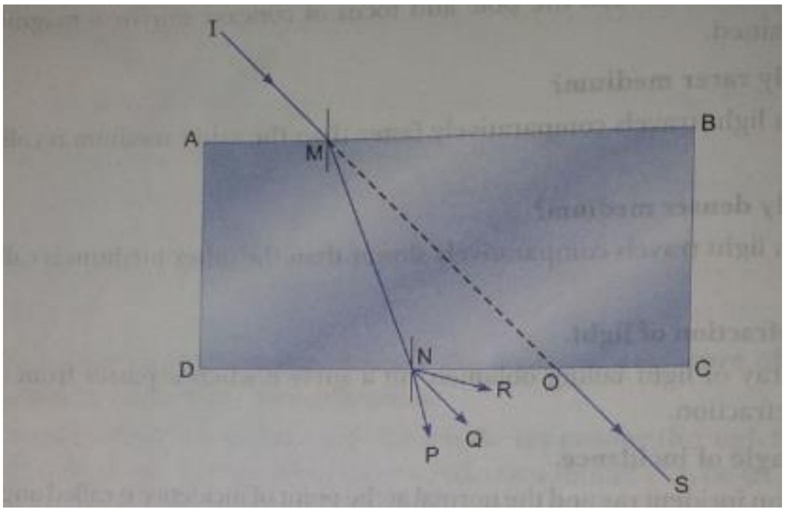
Q. 40. In which direction a ray of light bends when it goes from water to glass?

Ans. We know that glass is denser medium than water. Therefore, a ray of light will bend towards the normal when it goes from water to glass.

Q. 41. If refractive indices of water and alcohol are 1.33 and 1.36 respectively, which of the two is optically denser medium?

Ans. The refractive index of alcohol is more than water, therefore, alcohol is optically denser medium.

Q. 42. If a light ray IM is incident on the surface AB as shown, identify the correct emergent ray.



Ans. Here, NQ is parallel to OS. Therefore, NQ is the correct emergent ray.

Q. 43. Why does a ray of light bend when it travels from one medium into another?

Ans. When a ray of light travels from one medium to another, its speed changes and this in speed of light causes the bending of light (refraction of light).

Q. 44. What is a lens?

Ans. A lens is a piece of transparent medium bounded by two spherical surfaces.

Q. 45. Name a point inside a lens such that a ray of light passing through it goes undeviated.

Ans. Optical centre.

Q. 46. Name the phenomena on which the working of a lens is based.

Ans. The working of a lens is based on the phenomenon of refraction of light.

Q. 47. State two examples of phenomenon of refraction of light in everyday life situations.

Ans. (i) A stick partly immersed in water appears to be bent at the water surface.
(ii) A pool of water appears less deep than it actually is.

Q. 48. What is meant by power of a lens?

Ans. power of a lens is the degree of convergence or divergence of light rays achieved by a lens, P, = $\frac{1}{f}$ (where f = focal length).

Q. 49. Give the SI unit of power of lens. State whether the power of a converging lens is positive or negative.

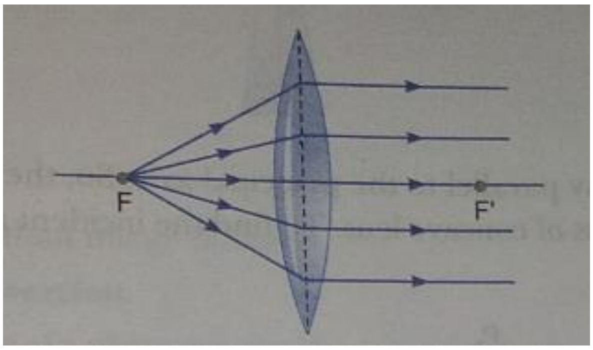
Ans. The SI unit of power of a lens is dioptre.
The power of a converging lens is positive as f is +ve.

Q. 50. A spherical mirror and a lens have same focal length of-20 cm. What type of mirror and lens are these?

Ans. A concave mirror and concave lens have negative focal length. Hence, both mirror and lens are concave.

Q. 51. A small electric lamp is placed at the focus of a convex lens. What is the nature of beam of light produced by the lens?

Ans. The beam of light coming out of lens is parallel beam of light as shown.



Q. 52. An object is placed 80 cm from a converging lens of focal length 25 cm. What is the nature of the image?

Ans. The image is real, inverted and diminished as the object is placed beyond 2F.

Q. 53. What is the power of a combination of lenses?

Ans. If a number of lenses are placed in close contact, then the power of the combination of lenses is equal to algebraic sum of the powers of the individual lenses.

$P = P_I + P_2$

Q. 54. State one advantage of using combination of lenses in optical instruments instead of a lens.

Ans. The use of a combination of lenses increases the sharpness of the image.

Q. 55. What is monochromatic light?

Ans. The light of a single wavelength is called monochromatic light, e.g., Sodium lamp is a source of monochromatic light.

Q. 56. Name the component of white light that has the greatest wavelength.

Ans. Red.

Q. 57. How does phenomenon of lateral inversion occurs?

Ans. The phenomenon of lateral inversion occurs due to the reflection of light by plane mirror.

Q. 58. Under what condition a lens becomes invisible when placed in a transparent liquid?

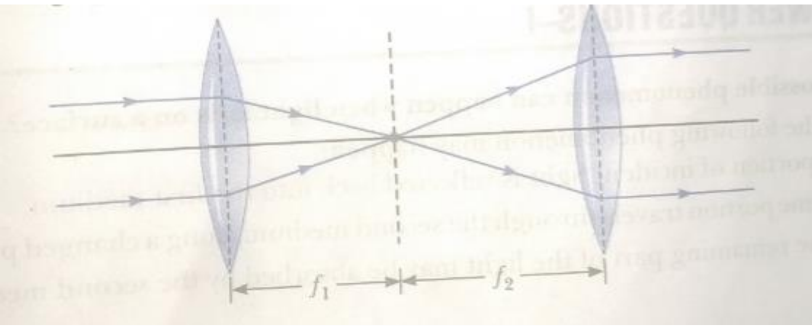
Ans. This happens when the refractive index of the lens becomes equal to that of the liquid.

Q.59. Define the term magnification.

Ans. The ratio of the height of an image to the height of an object is called magnification.

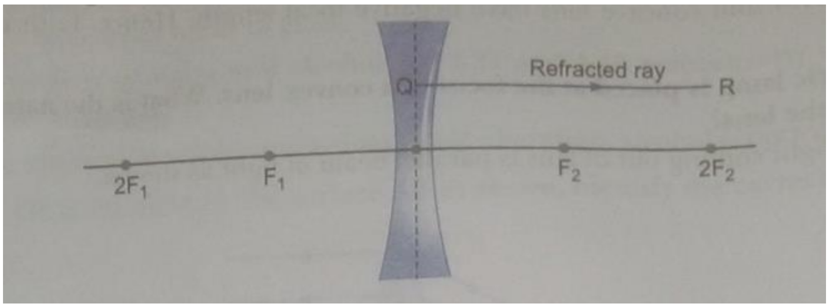
Q. 60. Show diagrammatically, how should two converging lenses be arranged so that a parallel beam becomes parallel after passing through two lenses.

Ans. If the distance between two lenses becomes equal to sum of their focal lengths, then the parallel beam of light will emerge parallel after passing through the second lens.

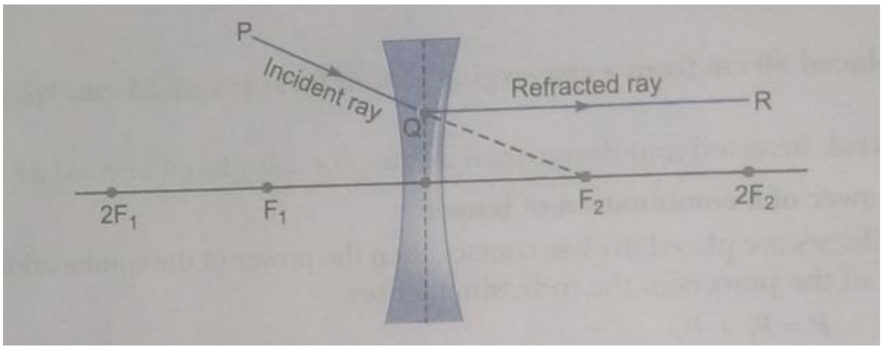


Q. 61. The diagram below shows the refracted ray QR through a concave lens.

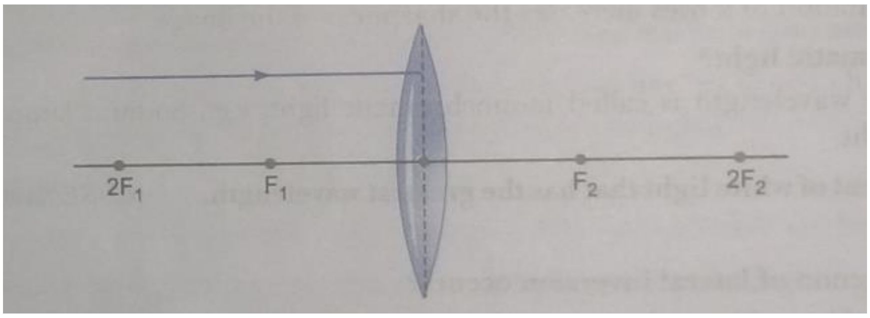
Complete the diagram by drawing the corresponding incident ray.



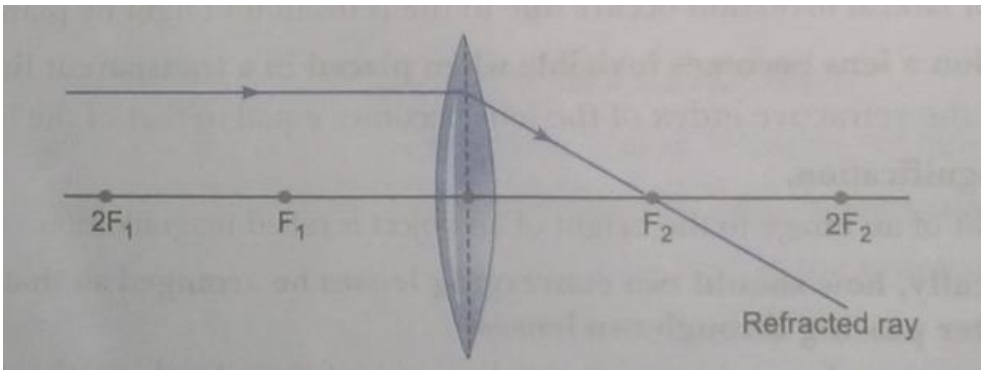
Ans. In figure the refracted ray parallel to the principal axis. So, the Incident ray must be appearing to meet at the principal focus of concave lens. To find the incident ray, F_2 is joined to Q and produced as shown in the figure.



Q. 62. Redraw the given diagram and show the path of the refracted ray.



Ans.



Short Answer Type Questions – I

[2 marks]

Q. 1. What possible phenomenon can happen when light falls on a surface?

Ans. Any of the following phenomenon may happen.

(i) A portion of incident light is reflected back into the first medium.

(ii) Some portion travels through the second medium along a change path, known as refraction.

(iii) The remaining part of the light may be absorbed by the second medium.

Q. 2. List two characteristics of the images formed by plane mirrors?

Ans. (i) Image formed by a plane mirror is always virtual and erect.

(ii) The size of the image is equal to that of the object.

(iii) The image formed is as far behind the mirror as the object is in front of it.

(iv) The image is laterally inverted.

Q. 3. List four specific characteristics of the images of the objects formed by convex mirrors.

Ans. (i) Virtual
(ii) Erect
(iii) Diminished
(iv) Object distance more than image distance.

Q. 4. Explain the term lateral inversion.

Ans. If an word is placed in front of a plane mirror, then the right side of the object appear to be the left side of the image, and the left side of the object appear to be the right if its image. This change of sides of an object and its mirror image is called lateral inversion.

Q. 5. In what way is the word AMBULANCE printed in front of the hospital vans? Why is it printed this way?

Ans. The word AMBULANCE on the hospital vans is written in the form of its mirror image as  because any vehicle which is ahead of ambulance van can see the laterally inverted alphabets correctly from his rear-view mirror and make way for it to pass through and enable it to reach the hospital quickly.

Q. 6. How can you distinguish between a plane mirror, a concave mirror and a convex mirror without touching them?

Ans. By observing the virtual images formed by the three mirrors, we can distinguish between the mirrors as:

(i) Plane mirror will produce an image of the same size,
(ii) Concave mirror will produce a magnified image, and
(iii) Convex mirror will produce a diminished image.

Q. 7. State the laws of refraction of light. If the speed of light is vacuum is 3 x 10^8 m\s, find the absolute refractive index of a medium in which light travels with a speed of 1.4 x 10^8 m\s.

Ans. Laws of refraction of light:

First law: The incident ray, the refracted ray, and the normal at the point of incidence all lie in the same plane.

Second law (Snell's law): The ratio of sine of angle of incidence to the sine of angle of refraction is a constant for a given pair of media.
i.e., $\frac{\sin i}{\sin r} = Constant$

Speed of light in vacuum, c = 3 x 10^8 m\s
speed of light in medium, v = 1.4 x 10^8 m\s
Absolute refractive index = $\frac{Speed\ of\ light\ in\ vacuum}{Speed\ of\ light\ in\ medium}$

$$= \frac{3\ x\ 10^8\ m\backslash s}{1.4\ x\ 10^8\ m\backslash s} = 2.14$$

Q. 8. The two positions in which a concave mirror produces a magnified image of given object. List two differences between the two images.

Ans. A concave mirror produces a magnified image when the object is placed in front of the mirror:

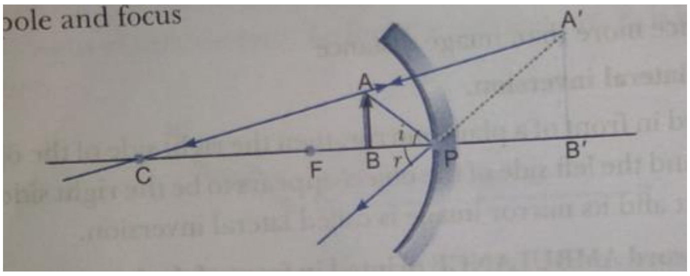
(i) between its pole and focus
(ii) between the focus and centre of curvature

In case (i) the image is virtual and erect, whereas in case (ii) the image is real and inverted.

Q. 9. The linear magnification produced by a spherical mirror is +3. Analyse this value and state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw ray diagram to show the formation of image in this case.

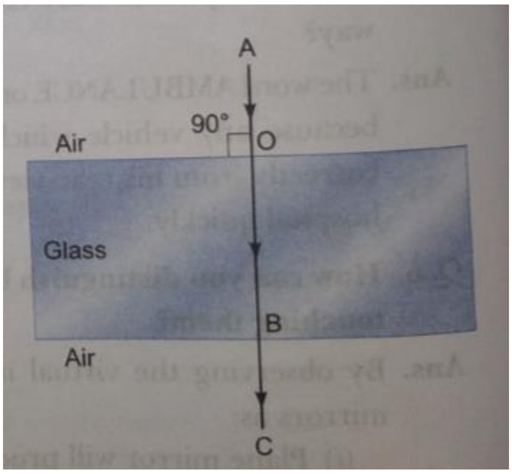
Ans. (i) Concave mirror

(ii) Between the pole and focus



Q. 10. What will happen to a ray of light when it falls normally on a surface? Show it diagrammatically.

Ans. When a ray of light falls normally on the surface of a medium, then, no bending of light ray occurs. It means the light ray goes straight from one medium to another.



Q. 11. Identify the device used (a spherical mirror or lens) in following cases, when the image formed is virtual and erect in each case.

(a) Object is placed between device and its focus, image formed is enlarge and its focus, image formed is enlarged and behind it.

(b) Object is placed between the focus and device, image formed is enlarged and on the same side as that of the object.

(c) Object is placed between infinity and device, image formed is diminished and between focus and optical centre on the same side as that of the object.

(d) Object is placed between infinity and device, image formed is diminished and between pole and focus, behind it.

Ans. (a) Concave mirror (b) Convex lens
(c) Concave lens (d) convex mirror

Q. 12. A convex lens of focal length 20 cm can produce a magnified virtual as well as real image. Is this a correct statement? If yes, where shall the object be placed in each case for obtaining these images?

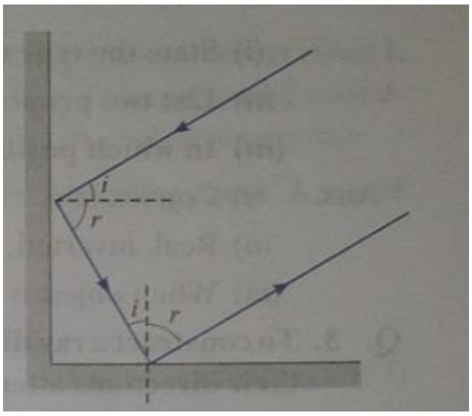
Ans. Statement is correct if the object is placed within 20 cm from the lens in the first case and between 20 cm and 40 cm in the second case.

Q. 13. How are power and focal length of a lens related? You are provided with two lenses of focal length 20 cm and 40 cm respectively. Which lens will you use to obtain more convergent light?

Ans. $P = \frac{1}{f}, p \infty \frac{1}{f}$, Power of a lens is inversely proportional to its length therefore lens having focal length of 20 cm will provide more convergence.

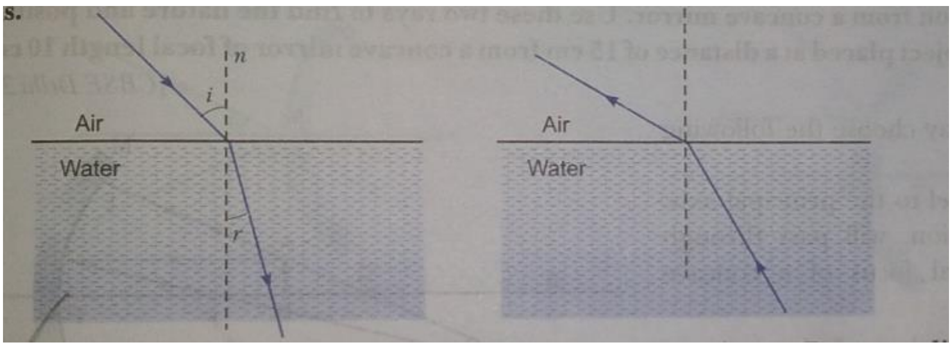
Q. 14. Under what condition in an arrangement of two plane mirrors, incident ray and reflected ray will always be parallel to each other, whatever may be angle of incidence. Show the same with the help of a ray diagram.

Ans. When two plane mirrors are placed at right angle to each other, then the incident and reflected rays will always be parallel to each other.



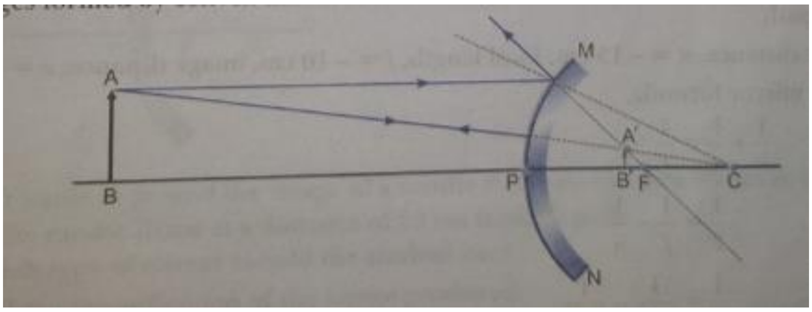
Q. 15. Draw a ray diagram showing the path of rays of light when it enters with oblique incidence (i) from air into water; (ii) from water into air.

Ans.



Q. 16. List two properties of the image formed by convex mirrors, Draw ray diagram in support of your answer.

Ans. The images formed by mirrors are: Virtual, erect and smaller than the object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Short Answer Type Questions – II

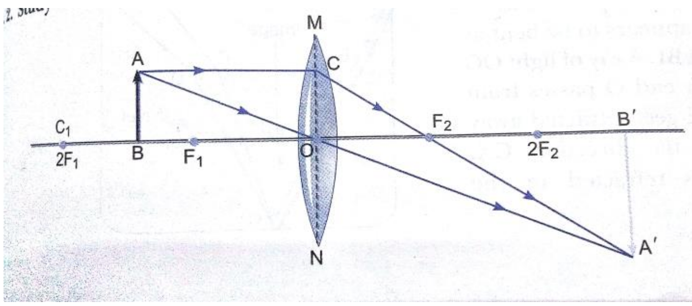
[3 marks]

Q. 1. Distinguish between real image and virtual image.

Ans.

Real Image	Virtual Image
1. It is formed by the actual meeting of reflected (Or refracted) rays. 2. It can be obtained on the screen. 3. It is always inverted. 4. It is formed by concave mirror or convex lens.	1. It is formed when reflected (or refracted) rays appear to meet when produced backwards. 2. It cannot be obtained on the screen. 3. It is always erect. 4. It is formed by concave, convex and plane mirrors (or concave and convex lenses).

Q. 2. Study the ray diagram given below and answer the following questions:



(i) State the type of lens used in the figure.

(ii) List two properties of the image formed

(iii) In which position of the object will the margination be - 1?

Ans. (i) Convex lens.s

(ii) Real, inverted, enlarged.]

(iii) When object is at 2F.

Q. 3. To construct a ray diagram we use two rays of lights which are so chosen that it is easy to determine their directions after reflection from the mirror. Choose these two rays and state the path of these ray after reflection from a concave mirror. Use these two rats

find the nature and position of the image of an object placed at a distance of 15 cm from a concave mirror of focal length 10 cm.

Ans. The candidate may choose the following rays:

(i) A ray parallel to the principal axis, after reflection, will pass through the principal focus of a concave mirror.

(ii) A ray passing through the center of curvature of a concave mirror after reflection is reflected back along the same path.
Object distance, $u = -15$ cm, focal length, $f = -10$ cm, image distance, $v = ?$
Apply mirror formula,

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

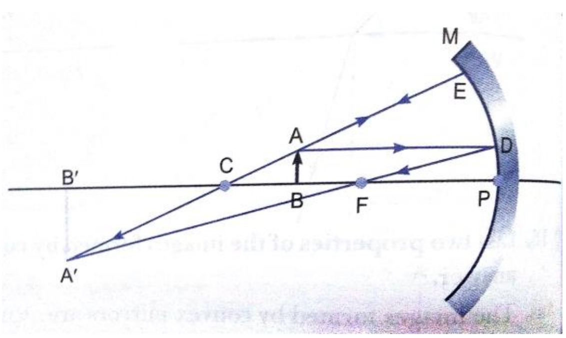
$\therefore \quad \frac{1}{v} + \frac{1}{f} = \frac{1}{u}$

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

$$\frac{1}{v} = \frac{1}{10} + \frac{1}{15} = \frac{-3+2}{30} = \frac{-1}{30}$$

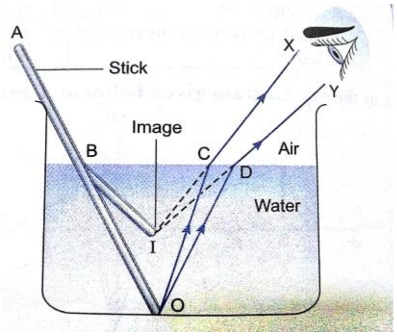
$\therefore \quad v = -30$ cm

The image is foamed at a distance of 30 cm in front of mirror (negative sign means object and image are on the same side). It is real and inverted.



Q. 4. Explain with the help of a ray diagram, why a pencil partly immersed in water appears to be bent at the water surface.

Ans. A stick or a pencil half immersed in water at an angle appears bent due to refraction of light at the air – water surface. Figure shows a straight stick AO whose lower portion BO is immersed in water. It appears to be bent at point B in the direction BI. A ray of light OC coming from the lower end O passes from water into air at C and get refracted away from the normal in the direction CX. Another ray OD get refracted in the direction DY. The two refracted ray CX and DY, when produced backward, appear to meet at point I, nearer to the water surface then O. Similar each part of the immersed portion of the stick raised As a result immersed portion of the stick raised As a result immersed portion of the stick appears to be bent when viewed at an angel from outside.



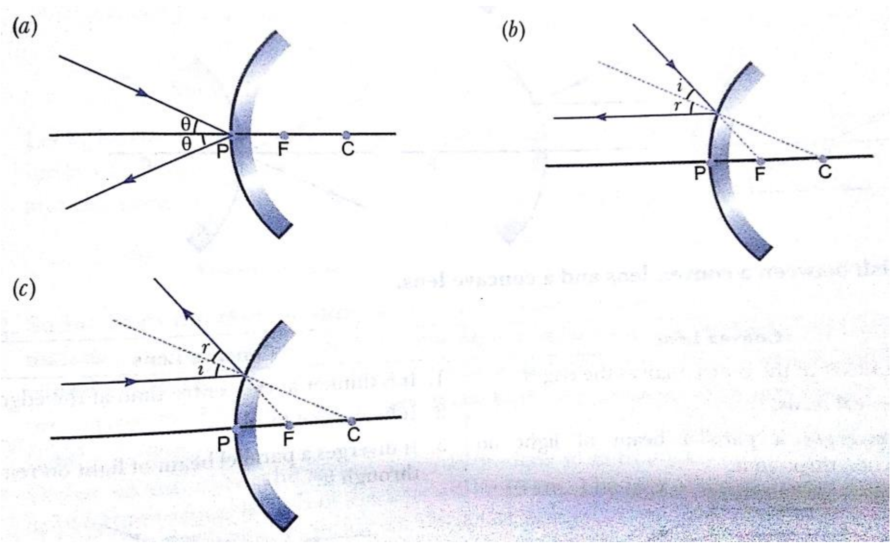
Q. 5. Draw a ray diagram to show the part of the reflected ray in each of the following cases. A ray of light incident in a convex mirror

(a) Strikes at its pole marking an angle 0 from the principal axis.

(b) Is directed towards its principal focus.

(c) is parallel to its principal axis.

Ans.



Q. 6. A student want to project the image of a candle flame on a screen 80 cm in front of a mirror by keeping the candle flame at a distance of 20 cm from its pole.

(i) Which type of mirror should the student use?

(ii) Find the magnification of the image produced.

(iii) Find the distance between the object and its image.

(iv) Draw a ray diagram to show the image formation in this case and mark the distance between the object and its image.

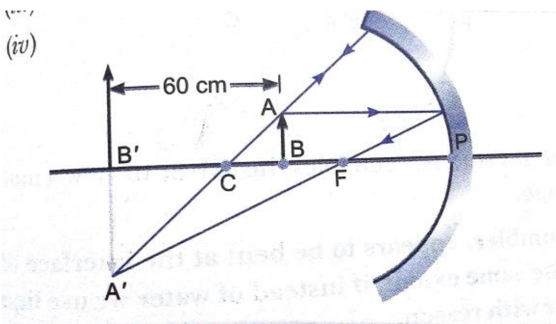
Ans. (i) concave mirror should be used.

(ii) Object distance, $u = -20$ cm; image distance, $v = -80$ cm;

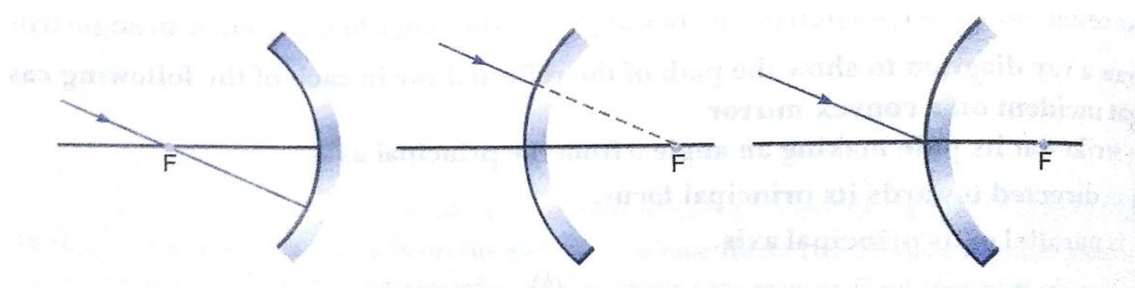
Magnification, m =?

$$M = -\frac{v}{u} = -\frac{(-80\text{ cm})}{(-20\text{ cm})} = -4$$

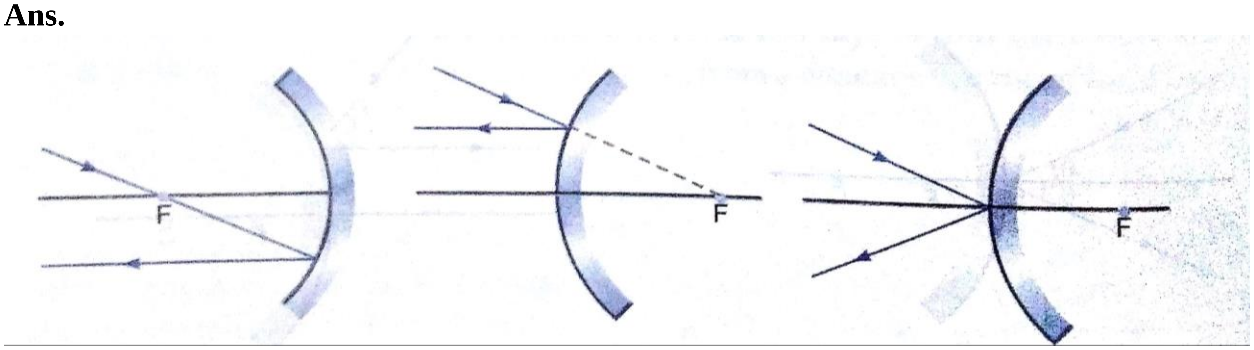
(iii) Distance between object and its image = $v - u - 60$ cm



Q. 7. Draw the following diagram, in which a ray of light is incident on a concave/convex mirror, on your answer sheet. Show the part of this ray, after reflection, in each case.

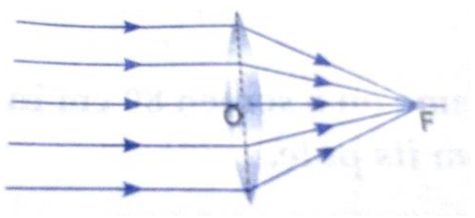
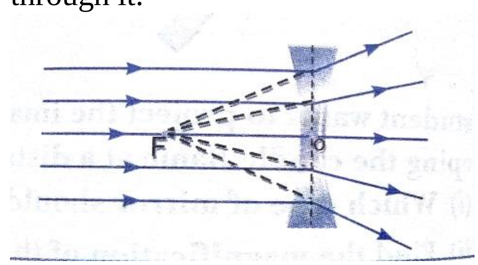


Ans.



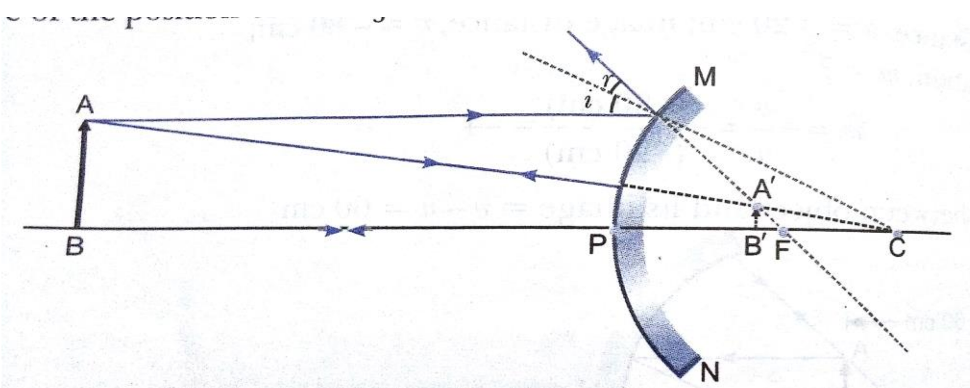
Q. 8. Distinguish between a convex lens and a concave lens.

Convex Lens	Concave Lens

1. It is thicker at the Centre than at the edges. 2. It has real focus. 3. It converges a parallel beam of light on reification through it.  	1. It is thinner at the Centre than at the edges. 2. It has virtual focus. 3. It diverges a parallel beam on refraction through it. 

Q. 9. If the image fumed by a 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 ray diagram to justify your answer. Where and why do we generally use this type pf mirror?

Ans. A convex mirror always produces an erect and diminished image of the object placed in front of it irrespective of the position of the object.



A convex mirror is used as a rear view mirror in vehicles. It enables the driver to view a much larger area of the traffic behind. It forms erect image.

Q. 10. A pencil when dipped in water in a glass tumbler, appears to be bent at the interface of air and water. Will the pencil appear to bend to the same extent, if instead of water we use liquids like, kerosene or turpentine. Support your answer with reason.

Ans. No. Bending will be different in different liquids since velocity of light at the interface separating two media depends on the relative refractive index of the medium. A substance having higher refractive index is optically denser than another substance having lower refractive index. Thus higher the refractive index of a substance, more it will change the direction of a beam of light passing through it.

Q. 11. How is the refractive index of a medium related to the speed of light? Obtain an expression for refractive index of a medium with respect in teams of speed of light in these two media?

Ans. The refractive index of the media n_m is giver by

$$n_m = \frac{\text{speed of light in air}}{\text{speed of light in medium}} = \frac{c}{v}$$

Let v_1 be the speed of light in medium 1 and v_2 be the speed of light in medium 2. The refractive index of medium 2 with respect to medium 1 is given by the ratio of the speed of light in medium 1 and the speed of light in medium 2. This is usually represented by the symbol n_{21}.

$$n_{21} = \frac{\text{speed of light in medium 1}}{\text{speed of light in medium 2}} = \frac{v1}{v2}$$

Q. 12. Sudha finds out that the sharp image of the window pane of her science laboratory is foamed a distance of 15 cm from the lens. She now tries to focus the building visible to her outside the window intend of the window pane without disturbing the kens, in which direction will she move the screen to obtain a sharp image of the building? What is the approximate focal length of this lens?

Ans. Sudha should move the screen towards the lens so as to obtain a clear image of the building. The approximate focal length of this lens will be 15 cm. The rats of light coming from distant object such as a tree (or a distant building or electricity pole) can be considered to be parallel to each other. When parallel rays of fight are incident on a convex lens, the after refraction, convection at focus on the other side of the lens.

Long Answer Type Questions

[5 Marks]

Q. 1. It is desired to obtain an arect image of an object, using concave mirror of focal length of 12 cm.

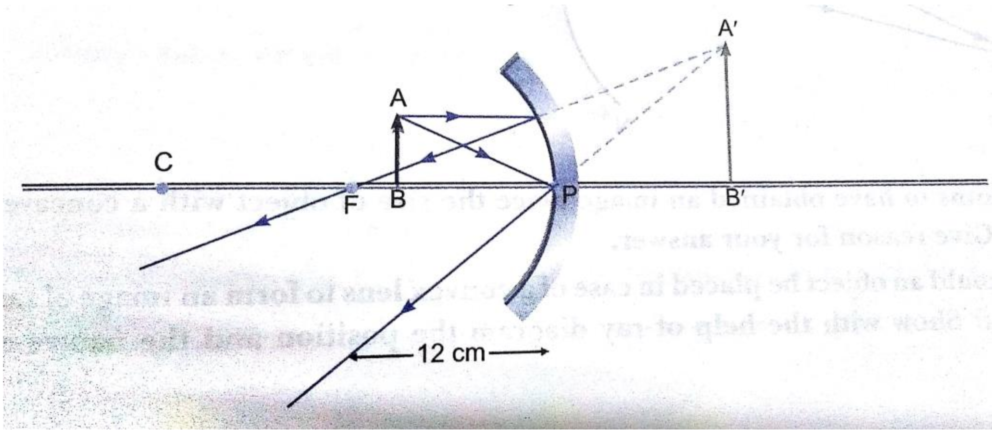
(i) What should be the range of distance of an object placed in front of the mirror?

(ii) Will the image be smaller or larger than the object. Draw ray diagram to show the formation of image in this case.

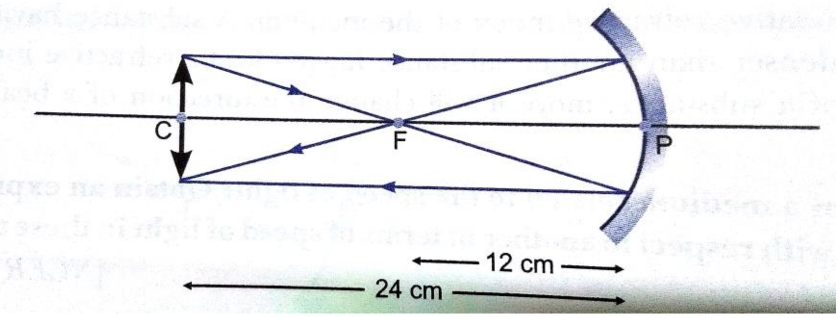
(iii) Where will the image of this object be, if it is placed 24 cm in front of the mirror? Draw ray diagram for this situation also to justify your answer. Show the positions of pole, principal focus and the centre of curvature in the above ray diagrams.

Ans. (i) Range of distance should be 0 cm to < 12 cm.

(ii) The image will larger than the object.



(iii) Image will be 24 cm in front of the mirror.



Q. 2. Suppose you have three concave mirrors A, B and C of focal length 10 cm, 15 cm and 20 cm. For each concave mirror you perform the experiment of image formation for three values of object distance of 10 cm, 20 cm and 30 cm. Giving reason answer the following:

(a) For the three object distances, identify the mirror\mirrors which will form an image of magnification – 1.

(b) Out of the three mirrors identify the mirror which would be preferred to be used for shaving purpose\makeup.

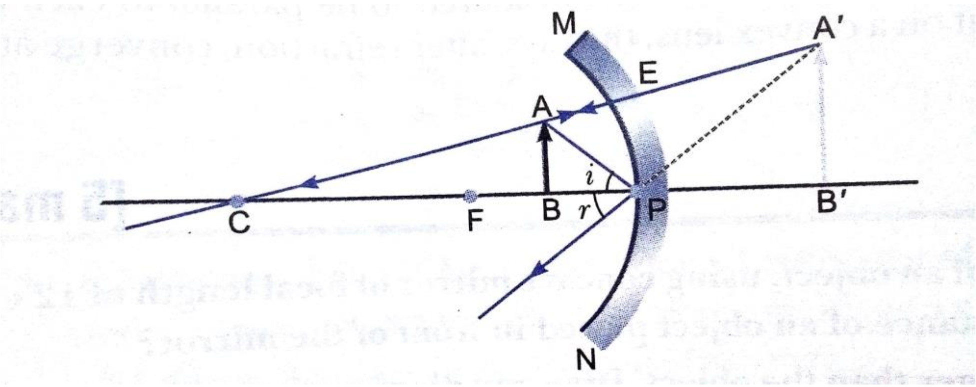
(c) For the mirror B draw ray diagram for image formation for object distances 10 cm and 20 cm.

Ans. Given, $f_a = 10$ cm; $f_b = 15$ cm; $f_c = 20$ cm
$u_1 = 10$ cm; $u_2 = 20$ cm; $u_3 = 30$ cm

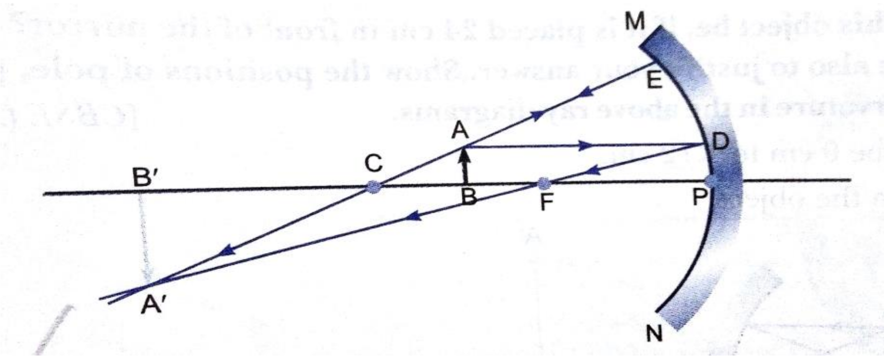
(a) m = - 1 means u = 2 f. For A it will be u_2 and for B it will be u_3.

(b) Mirror B or C can be used for shaving\makeup purposes because the distance should be less than focal length for erect and magnified image. The face is generally kept at a distance more than 10 cm from the mirror.

(c) When u = 10 cm



When u = 20 cm



Q. 3. (i) Rohit claims to have obtained an image twice the size of object with a concave lens, Is he correct? Give reason for your answer.

(ii) Where should an object be placed in case of a convex lens to from an image of same size as of the object? Show with the help of ray diagram the position and the nature of the image formed.

(iii) With the help of ray diagram, illustrate the change in position, nature and size of the image formed if the convex lens in case of (ii) is replaced by concave lens of same focal length.

Ans. (i) No, Rohit is incorrect because magnified image of an object cannot be formed by a concave lens ever.

(ii) The object should be placed at 2f.

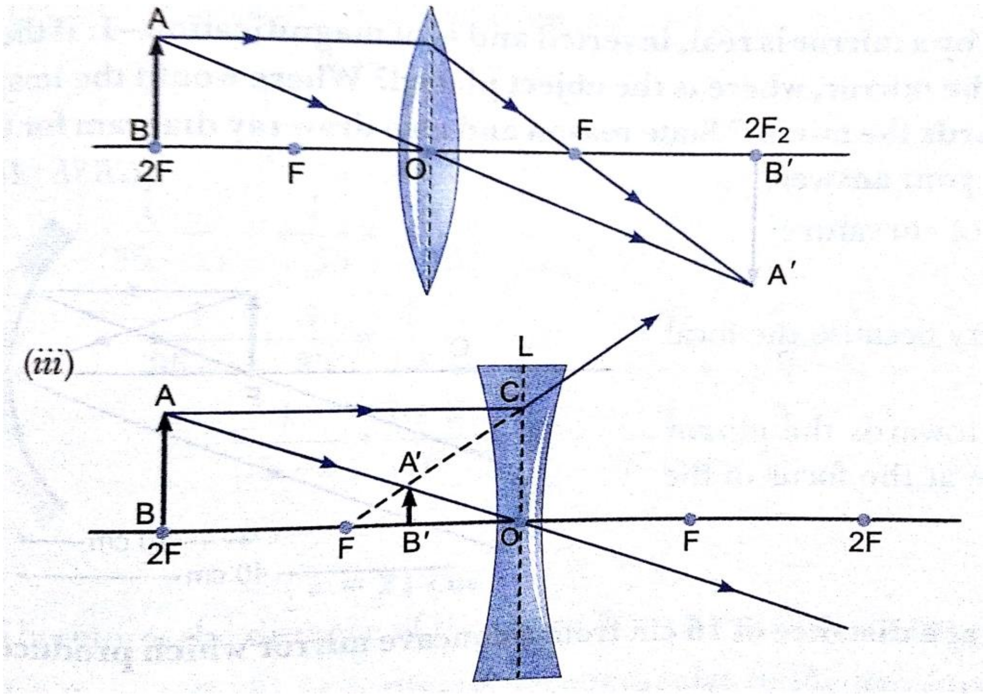


Image obtained is virtual, erect and diminished in case of concave lens.

HOTS (Higher Order Thinking Skills)

Q.1. Which one of the two-glass and water is optically denser and why?

Ans. Glass is denser than water because speed of light in glass is less than that of water.

Q.2. Why does white light split up into different colours while passing through a glass prism?

Ans. Light of different wavelengths (different colours) present in white light have different speed. Hence, these deviate through different angles inside the prism and get separated.

Q.3. Can a convergent lens in one medium become divergent in another medium?

Ans. Yes, a convergent lens in one medium becomes divergent in another medium when the refractive index of the medium is greater than the refractive index of the material of the lens.

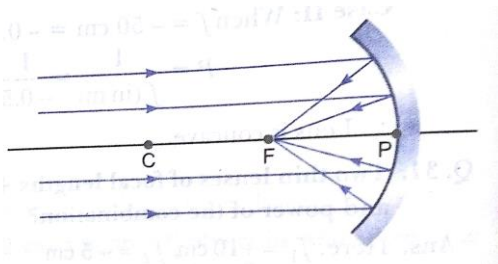
Q.4. A man is going away from the plane mirror with a velocity of 3 m/s. With what velocity is he going away from his own image in the mirror?

Ans. We know that the image formed by a plane mirror is as much behind the mirror as object is in front. So, the speed of image will be same as object but in opposite direction. Thus, net velocity between man and his image will be 3 - (-3) 6 m/s.

Q.5. Under what condition a convex lens when placed in a medium behaves as an ordinary glass plate?

Ans. When the refractive index of a medium relative to lens is one, a convex lens will behave as an ordinary glass plate.

Q.6. Why does a concave mirror has a real principal focus?



Ans. In a concave mirror, all the incident rays parallel to principal axis actually pass through the focus F after getting reflected from the concave mirror. Thus, concave mirror has a real principal focus.

Q. 7. A concave mirror and convex lens are immersed in water. What change, if any, do you expect in the focal length of the two?

Ans. Focal length of the concave mirror does not change because it is about half its radius of curvature and has nothing to do with the external medium. On the other hand, the focal length of the convex lens will increase because the refractive index of glass with respect to water is less than refractive index of glass with respect to air.

Q.8. Which is a better reflector-a plane mirror or a right-angled prism?

Ans. A right-angled prism is a better reflector, because light incident on its hypotenuse is totally reflected without absorption of light. On the other hand, in case of a plane mirror, there is a possibility of partial absorption of light.

Q.9. A man is holding a lighted cand le in front of a thick glass mirror and on viewing it obliquely he noticed a number of images of the cand le why?

Ans. The front surface of a thick glass mirror is both reflecting and refracting. The back surface is silvered and acts as a mirror. Images arise due reflection of incident light by the front surface then by back surface, following by multiple reflection of light within the glass by the front and back surfaces.

Q.10. A concave mirror of length f produces an image n times the size of the object. What would be the object distance for which the image is real?

Ans. We have given $\frac{Size\ of\ the\ image}{Size\ of\ the\ object} = n$

In case of concave mirror, if the image is real then it must be inverted.

So, $m = -n = \frac{-V}{u}$

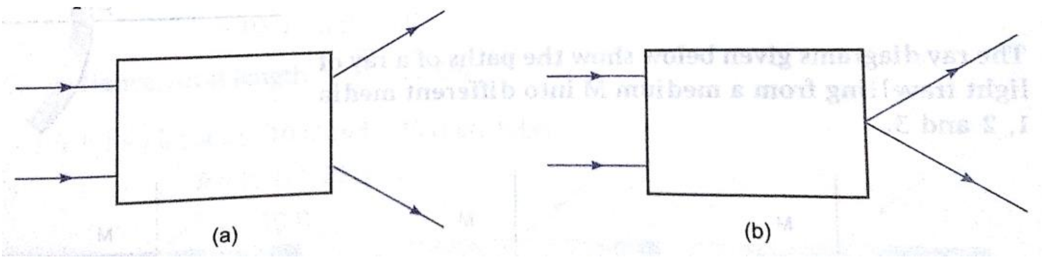
Or $m = n = \frac{v}{u}$

From mirror formula, we get

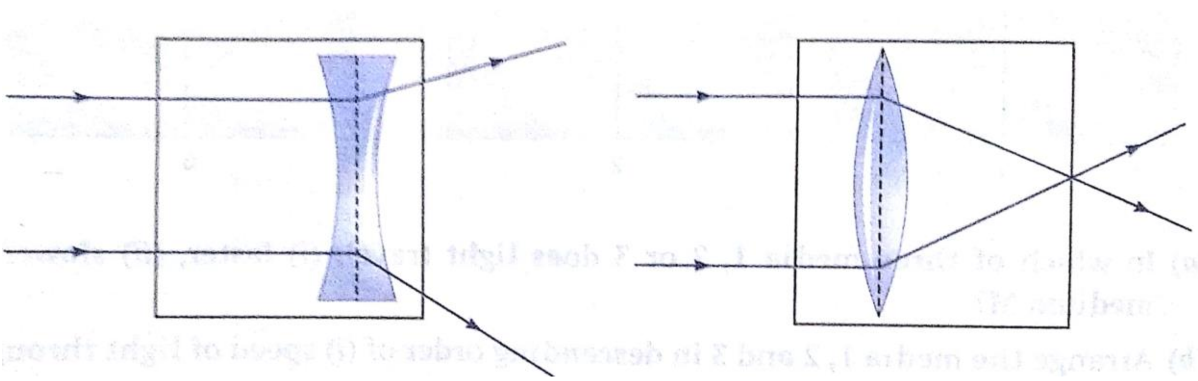
$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ Or $1 + \frac{u}{v} = \frac{u}{f}$

Or $1 + \frac{1}{n} = \frac{u}{f}$ Or $u = \left(\frac{n+1}{n}\right) f$

Q.11. In the following figures, one lens is placed inside each box. State the nature of the lens. Complete the ray diagrams.



Ans.



In figure (a), the incident rays are diverged after refraction, so the lens is concave.

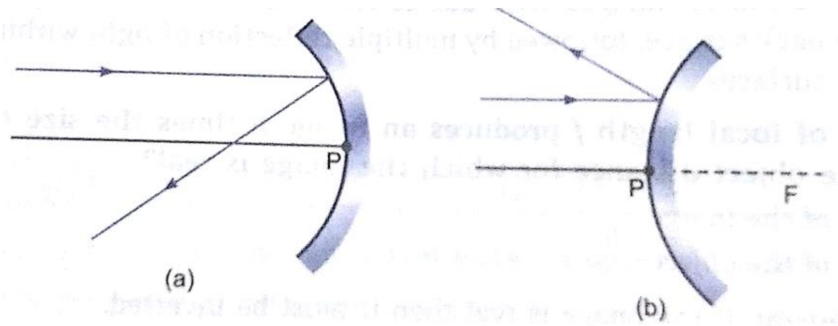
In figure (b), the incident rays are converged after refraction, so the lens is convex.

Q.12. A convex lens forms a blurred image of an object on a screen.
Suggest a suitable way to get a sharp image on a screen without disturbing the object, lens or the screen.

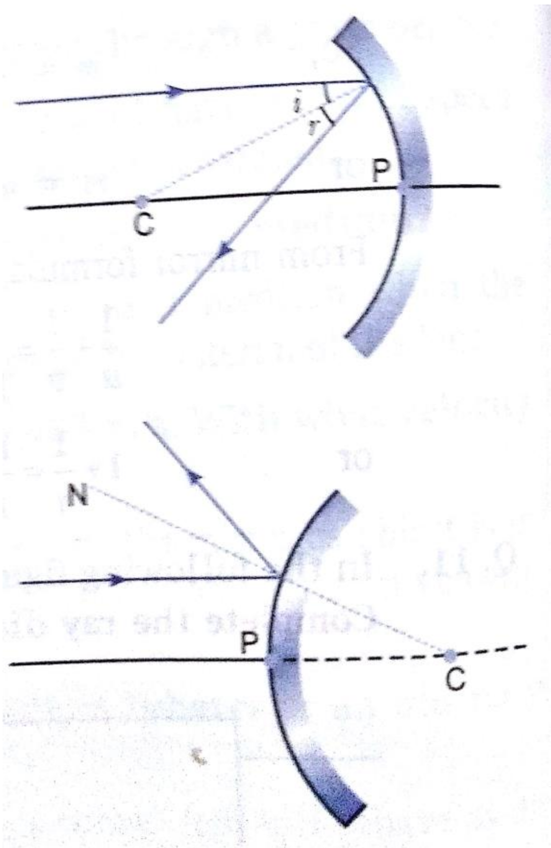
Ans. By placing another lens of suitable nature and focal between the object and the screen.

Q.13. Why does a ray of light parallel to the principle axis

(i) bend towards the principle axis in the case of a concave mirror and
(ii) goes away from the principle axis in the case of a convex mirror as shown here?



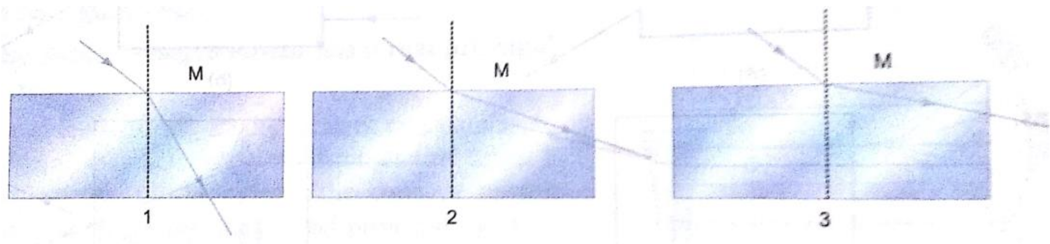
Ans. A ray of light incident on any spherical mirror follows laws of reflection.



(i) In case of a concave mirror, the line joining the point of incidence ray and the centre of curvature forms the normal as shown. The reflected ray goes on the other side of the normal following laws of reflection.

(ii) In the case of convex mirror, the normal at the point of incidence is as shown. The reflected ray goes on the other side of the normal. Following laws of reflection as shown. Hence, it goes away from the principal axis.

Q.14. The ray diagrams given below show the paths of a ray of light travelling from a medium M into different media 1, 2 and 3.



(a) In which of three media 1, 2 or 3 does light travel: (i) faster, (ii) slower than in medium M?

(b) Arrange the media 1, 2 and 3 in descending order of (i) speed of light through them,

(ii) their refractive index.

Ans. (a) (i) faster – in medium 2 and 3

(ii) slower – in medium 1

(b) (i) $v_3 > v_2 > v_1$ or $3 > 2 > 1$

(ii) $1 > 2 > 3$ or $\mu_1 > \mu_2 > \mu_3$

Q.15. If x, y and x denote the object distance, image distance and the radius of curvature respectively of a spherical mirror, which one of the following is the correct relation between them?

(a) $z = 2\frac{xy}{x+y}$ **(b)** $z = 2\frac{x+y}{xy}$

Ans. For a spherical mirror,

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

$\therefore$ $$\frac{2}{Z} = \frac{1}{x} + \frac{1}{y} = \frac{y+x}{xy} \quad \Rightarrow \frac{Z}{2} = \frac{xy}{x+y}$$

$$Z = 2\frac{xy}{x+y}$$

Hence, (a) is the correct answer.

Q.16. You are given lenses with powers + 10 D, + 5 D, - 5 D, - 20 D, and – 10 D. Taking a pair of lenses at a time, which two lenses will you select to have a combination of total focal length when the two lenses are kept in contact in each case.

(i) 20 cm **(ii) – 10 cm** **(iii) – 20 cm** **(iv) $\frac{20}{3}\ cm$**

Ans. Total power, P = $P_1 + P_2$ and total length f is $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

(i) When lenses of 10 D and – 5 D are taken, total power

$P = P_1 + P_2$

= 10 D – 5 D = 5 D

Hence, focal length = $\frac{100}{5} = 20\ cm$

(ii) When lenses of 10 D and – 20 D are taken

P = 10 D – 20 D

= - 10 D

Focal length = $\frac{100}{-10} = -100\ cm$

(iii) When lenses of + 5 D and – 10 D

P = - 5 D

F = $\frac{100}{-5}$

F = - 20 cm

(iv) When lenses of 10 D and 5 D are taken

P = 15 D

f = $\frac{100}{5} = \frac{20}{3}\ cm$

Q.17. A student recorded the following data for the values of the object distance and corresponding image distance while performing an experiment on real image formation by a convex lens of power + 4 D. Two of these observations are incorrect.
Without making any calculations, identify these observations and give reason for your choice.

Observation	**A**	**B**	**C**	**D**	**E**
Object Distance u (cm)	**30**	**40**	**50**	**60**	**70**
Image Distance v (cm)	**20**	**60**	**50**	**70**	**30**

Ans. Reading A and D are incorrect.

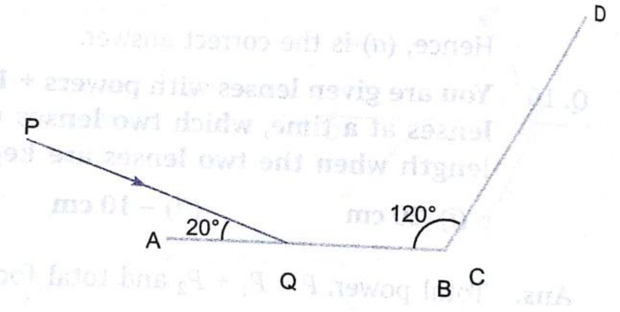
Reason: The focal length of the lens is 25 cm.

(i) In reading A, the object is kept at 30 cm from the lens, i.e., between F and 2F. The image should be formed beyond 2F (50 cm). However, it is shown to be at 20 cm, which is incorrect.

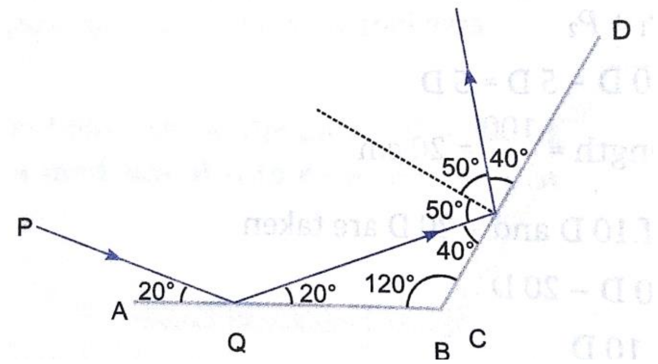
(ii) In reading D, the object is kept beyond 2F, i.e., 50 cm. The image should be formed between F and 2F. However, it is also shown to be formed at 60 cm, i.e., beyond 2F. Hence it is incorrect.

Q.18. The given ray diagram shows a ray of light PQ striking a mirror AB. The mirror AB and CD are at an angle of 120 ° with each other. The ray PQ strikes the surface of the mirror Ab at point Q.

(i) Draw the complete path of reflection of the ray at mirrors AB and CD.
(ii) Calculate the sum of angles which the reflected rays make with the surfaces of mirrors AB and C.



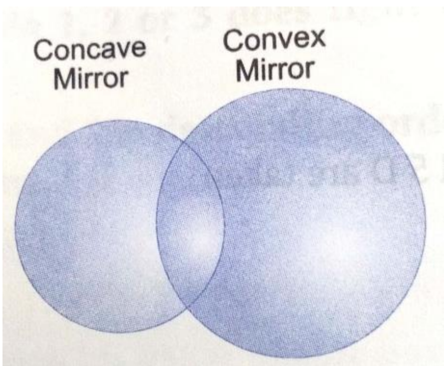
Ans. (i)



(ii) The sum of the angles, made by reflected rays with mirrors AB and Cd is

20 ° + 40 ° = 60 °

Q.19. Compare and contrast between the image formation by a concave and convex mirror. Write the similarities in the common space and the dissimilarities in the left side or the right side.



Ans. Similarity:

(i) Both can form virtual images.

(ii) Both can form erect images.

Dissimilarity:

(i) Concave mirror can form a real as well as virtual image whereas convex mirror can form only virtual image.

(ii) Concave mirror can form magnified as well as diminished image whereas convex mirror forms only diminished image.

(iii) Concave mirror can form erect as well as inverted image whereas convex mirror always forms an erect image.

Q.20. Playing with an old lens one morning, Ravi discovers that if he holds the lens 10 cm away from a wall opposite to a window, he can see a sharp but upside-down picture of outside world on the wall. That evening, he covers a lighted lamp with a piece of opaque paper on which he has pierced, a small hole 1 mm in diameter. By placing the lens between the illuminated card and the wall, he manages to produce a sharp image of diameter 5 mm on the wall.

Answer the following questions based on the above information:

(i) What is the power of the lens?
(i) In the evening experiment, how far away from the opaque paper did he place the lens?
(iii) How far apart were the card and the wall?

Ans. (i) Since the rays from far away object get focussed at the principal focus, distance between lens and wall is equal to focal length 10 cm.
$\therefore$ Power of the lens = + 10 D.

(ii) In the evening experiment,

$$m = \frac{I}{O} = \frac{-5}{1} \Rightarrow m = -5$$

$$m = \frac{v}{u} \therefore v = -5u$$

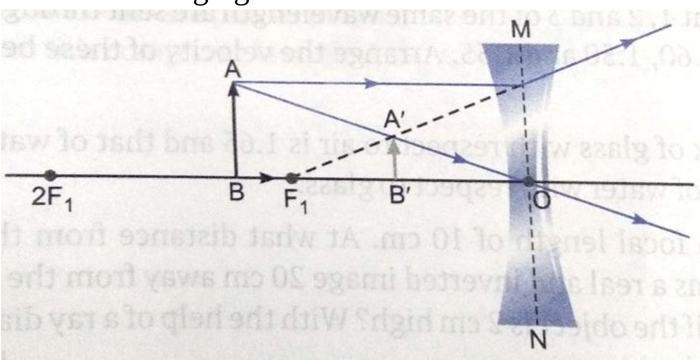
Using $\frac{1}{v} - \frac{1}{u} - \frac{1}{f}, we\ get$

$$\frac{1}{-su} - \frac{1}{u} - \frac{1}{20} \Rightarrow u = -12\ cm$$

(iii) V = 60;

Q.21 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.

Ans. It is diverging lens or concave lens.



Focal length = - 20 cm (lens is concave, hence f is – ve)

Power, $P = \frac{1}{f} = \frac{100}{-20\ cm} = -5D$

Value Based Questions

Q. 1. Shekhar had to go for an important meeting and it was raining heavily. He was getting too late. While driving his car, he saw from his side mirror that the car which was behind his car had met an accident. He suddenly applied the brake to help the injured person though he was getting late for his meeting. He alone took the person to the nearest hospital. The person got the treatment at the right time and his life was saved.

Answer the following questions based on the situation given above.
(i) Name the type of mirror from which Shekhar saw the accident.
(ii) Why this particular mirror is used as a side mirror in vehicles?
(iii) What values are being reflected by Shekhar?

Ans. (i) The mirror is convex mirror.
(ii) Convex mirror is used as a side mirror in vehicles because it always give an erect, though diminished image and it has a wider field of view as it is curved outwards. Thus, it enables the driver to view much larger area than a plane mirror.
(iii) Helpfulness, kindness.

Q. 2. A detective is tracking some criminals. He finds a clue to their whereabouts on a piece of paper. On the paper is written:

He tries to decode it but is unsuccessful. Suddenly it strikes him and he takes a mirror. He places the mirror in front of the paper and voila he decodes the clue-'meet me at noon'.

Answer the following questions based on the situation given above.
(i) What values are being promoted by the detective?
(ii) Write one use of such mirror images on a daily basis. Write STOP as it should be written on the front of a police car.

Ans. (i) Ingenuity, intelligence.

(ii) This type of mirror image is used in ambulance. On the front of a police car STOP should be written as  .

Q. 3. While boating with parents, a child saw a beautiful fish in the lake. He tried to catch it, thinking that it is very close to the boat. His parents told him that the fishes are deep in water and he should not try to catch them. But he did not listen to them and the situation became worse when he fell in the lake instead of cathing it.

Answer the following questions based on the situation given above.

(i) Why did the fish appear close to the boat when in actual it was deep in water?
(ii) What values are neglected by the child?

Ans. (i) This is due to the phenomenon of refraction. Light reflected from the fish travels through the water towards the eye. As it passes from the water into the air, it refracts away from the normal because water is denser than air and thus, the fish appears closer.

(ii) Obeying elders, being careful, understanding reasons for natural phenomena.