Light—Reflection and Refraction

SYLLABUS

Reflection of light by curved surfaces, Images formed by spherical mirrors, centre of curvature, principal axis, principal focus, focal length, Mirror formula (Derivation not required), Magnification.

Refraction, Laws of refraction, refractive index.

Refraction of light by spherical lens, Image formed by spherical lenses, Lens formula (Derivation not required), Magnification, Power of a lens applications of spherical mirrors and lenses.

Facts that Matter

Introduction

Light waves do not require any material medium for travelling hence called electromagnetic waves.

Speed of light in vacuum is 3×10^8 m/s.

Light travels in straight line. The path along which light travels is called ray of light.

Bundle of light rays is called beam of light.

When light falls on any surface it may reflect regularly/irregularly or it may be refracted or absorbed.

On regular surface like mirror, plane surfaces etc., light reflects regularly and on rough surface light reflects irregularly.

Regular surface | Irregular surface

When light falls on transparent surface it changes its path, bends and gets refracted.

If light travels from denser medium to rarer medium it bends away from the normal (DRAN).

When light travels from rarer medium to denser medium it bends towards the normal (RDTN).

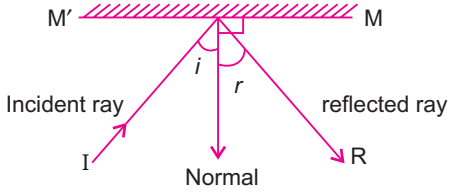
Images are of two types—real image and virtual image.

Real image is formed due to actual meeting of light rays at a point after reflection or refraction.

LAWS OF REFLECTION

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

(*ii*) The incident ray, the normal ray and the reflected ray, all lie in the same plane.



$\angle i = \angle r$

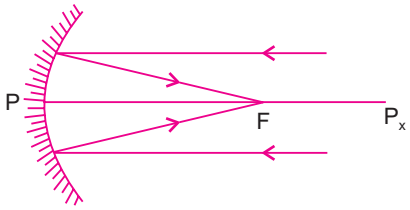
Image Formed by Plane Mirror

(*i*) It is of same size, virtual and erect.

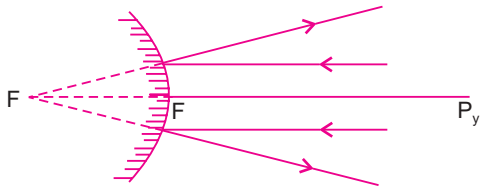
(*ii*) Formed as behind the mirror as the object is in front of it.

(*iii*) The image is laterally inverted.

Image Formed by Spherical Mirror



Concave Mirror: Reflecting surface is curved inward.



Convex mirror: Reflecting surface is bulged out.

Pole: Centre of the mirror.

Principal focus: It is a point where light rays coming parallel to the principal axis actually converge or appear to converge.

Distance from pole to principal focus is called focal length of given mirror.

Focal length is half of the radius of curvature $f = \frac{R}{2}$ in case of mirror.

Concave mirror may form real or virtual image. Convex mirror always forms a virtual, erect and diminished image of an object.

Virtual image is formed when rays do not actually meet, but appear to meet at a point when produced backwards.

Real image can be obtained on the screen but virtual image cannot be obtained on the screen.

LAWS OF REFRACTION

(*i*) The incident ray, the refracted ray and the normal to the separating surface at the point of incidence all lie in the same plane.

(*ii*) The ratio of sine of the angle of incidence (*i*) to the sine of angle of refraction (*r*) is a constant. It is known as Snell's law.

$$\text{Snell's law} = \frac{\sin i}{\sin r} = \text{constant} = n_{21}$$

Here n_{21} is known as the refractive index of the second medium with respect to the first medium.

$$n_{21} = \frac{\text{Speed of light in first medium } (v_1)}{\text{Speed of light in second medium } (v_2)}$$

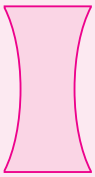
Refractive index of second medium w.r.t. first medium is given by n_{21}.

Absolute refractive index (n)

$$n = \frac{\text{Speed of light in vacuum } (c)}{\text{Speed of light in given medium } (v)}$$

- **Mirror formula** **Lens formula**

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

	Convex lens	***Concave lens***
1.		
2.	Real focus	Virtual focus
3.	Converging lens	Diverging lens
4.	It can form real or virtual image.	It forms only virtual image.

MAGNIFICATION

$$m = \frac{\text{Size of the image } (h')}{\text{Size of the object } (h)} = \frac{v}{u}$$

Power of a lens is the reciprocal of its focal length (f).

$$P = \frac{1}{f}$$

S.I. unit of power = dioptre.

The power of convex lens is positive and concave lens is negative.

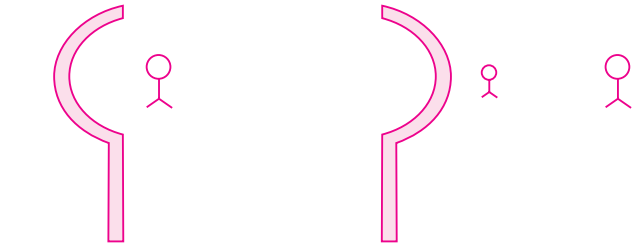
$$P = P_1 + P_2 + P_3 \ldots\ldots\ldots \quad \text{(for combination of lenses)}$$

NCERT IN-TEXT ACTIVITIES SOLVED

ACTIVITY 10.1

- Take a large shining spoon. Try to view your face in its curved surface.

- The image obtained is larger.
- Move the spoon slowly away from your face.
- The image becomes inverted.
- Reverse the spoon and repeat the activity.
- The image is diminished and virtual.



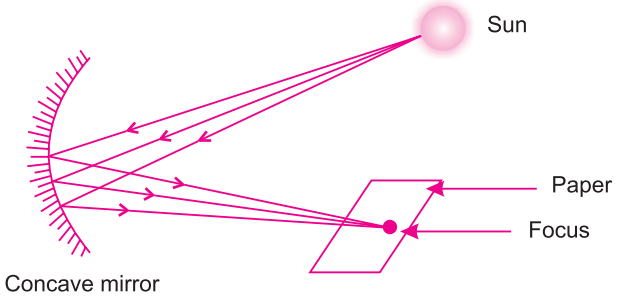
Enlarged image Diminished image

ACTIVITY 10.2

- Hold a concave mirror in your hand and direct its reflecting surface towards the sun.
- Direct the light reflected by the mirror on to a sheet of paper held close to the mirror.
- Move the sheet of paper back and forth gradually until you find on the paper sheet a bright, sharp spot of light.
- Hold the mirror and the paper in the same position for a few minutes.

Observation: The paper initially turns blackish, burns producing smoke. Eventually it catches fire.

Conclusion: The light from the sun is converged at a point on the paper. This point is focus of the concave mirror.



ACTIVITY 10.3

- Take a concave mirror. Find out its approximate focal length. Let f = 10 cm.
- Mark a line on table with a chalk. Place the concave mirror on a stand. Place the stand over the line such that its pole lies over the line.
- Draw with a chalk two more lines parallel to the previous line such that the distance between two successive lines is equal to the focal length of the mirror. These lines will correspond to the positions of the points P, F and C respectively.
- Keep a bright object say a burning candle, at a position far beyond C. Place a paper screen and move it in front of the mirror till you obtain a sharp bright image of the candle flame on it.

- Observe the image carefully. Note down its nature position and relative size with respect to the object size.
- Repeat the activity, by placing the candle—

  (*a*) just beyond C, (*b*) at C, (*c*) between F and C,

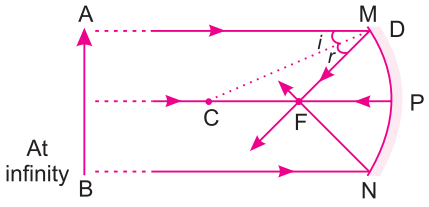
  (*d*) at F, (*e*) between P and F.
- In one of the cases, the image is not obtained on the screen *i.e.,* when object is between P and F.

Observation:

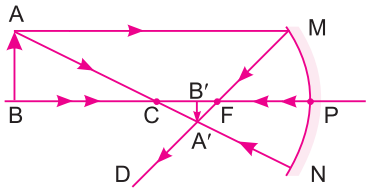
Observation Table

Position the object	***Position of the image***	***Size of the image***	***Nature of the image***
(*a*) At infinity	At F	Highly diminished, point sized	Real and inverted
(*b*) Beyond C	Between F and C	Diminished	Real and inverted
(*c*) At C	At C	Same size	Real and inverted
(*d*) Between C and F	Beyond C	Enlarged	Real and inverted
(*e*) At F	At infinity	Highly enlarged	Real and inverted
(*f*) Between P and F	Behind mirror	Enlarged	Virtual and erect

ACTIVITY 10.4



(a)



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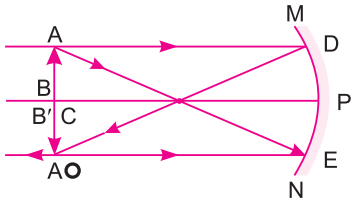

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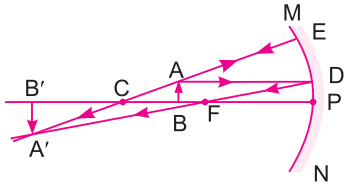

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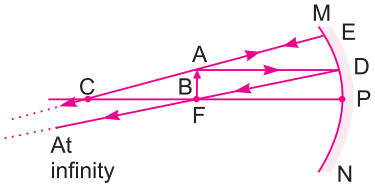
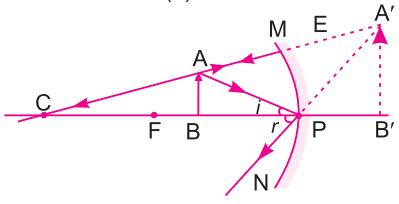


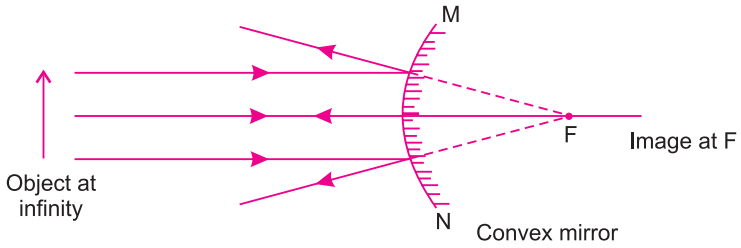
(e)



(f)

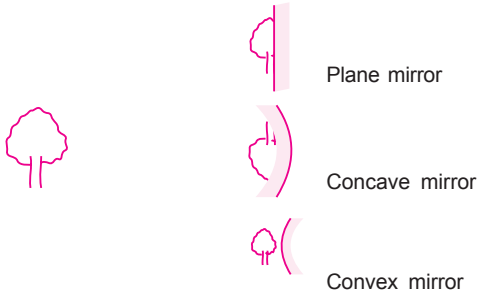
ACTIVITY 10.5

- Take a convex mirror. Hold it in one hand.
- Hold a pencil in the upright position in the other hand.
- Observe the image of the pencil in the mirror.
  Observation: The image is erect, diminished and virtual.
- Move the pencil away from the mirror slowly.
  Observation: The image formed is smaller, and erect.



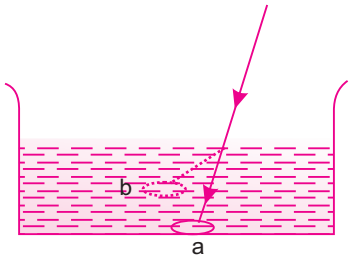
ACTIVITY 10.6

- Observe the image of a distant object, say a distant tree, in a plane mirror.
  Observation: The full length is not seen in a small plane mirror.
- Now use concave mirror to see the full length image of the object.
  Observation: The full length image is not obtained in concave mirror.
- Now use convex mirror to see the same.
  Observation: In this case, a full length image of an object is obtained in a small mirror.



ACTIVITY 10.7

- Place a coin at the bottom of a bucket filled with water.
- With your eye to a side above water, try to pick up the coin in one go.
  Observation: One cannot pick up the coin in one go, because of refraction of light, the coin does not appear to be at its original position.



a - Real position of coin
b - Apparent position of coin

ACTIVITY 10.8

- Place a large shallow bowl on a table and put a coin in it.
- Move away slowly form the bowl. Stop when the coin just disappears from your sight.
- Ask a friend to pour water gently into the bowl without disturbing the coin.
- Keep looking for the coin from your position.

Observation: The coin becomes visible again and slightly raised above its actual position on pouring water into the bowl. This is because of refraction of light.

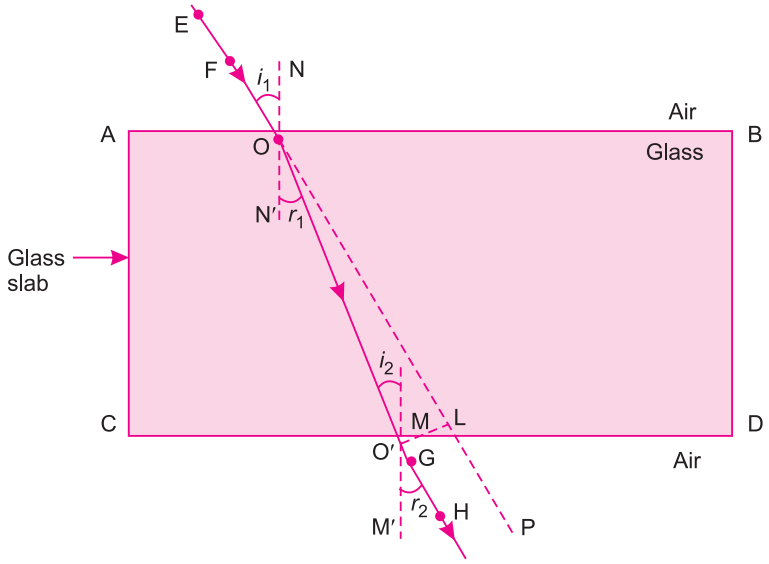
ACTIVITY 10.9

- Draw a thick straight line in ink, over a sheet of white paper placed on a table.
- Place a glass slab over the line in such a way that one of its edges makes an angle with the line.
- Look at the portion of the line under the slab from the sides. The line appears to be bent at the edges.
- Now, place the glass slab such that it is normal to the line. The part of line under the glass slab appears to be bent.
- Look at the line from the top of the glass slab. The line appears to be raised.

  It is due to the refraction of light.

ACTIVITY 10.10

- Fix a sheet of white paper on a drawing board using drawing pins.
- Place a rectangular glass slab over the sheet in the middle.
- Draw the outline of the slab with a pencil. Let us name the outline as ABCD.
- Take four identical pins.
- Fix two pins, E and F vertically such that the line joining the pins is inclined to the edge AB.
- Look for the images of the pins E and F through the opposite edge. Fix two pins, say G and H, such that these pins and the images of E and F lie on a straight line.
- Remove the pins and the slab.
- Join the positions of tip of the pins E and F and produce the line up to AB. Let EF meet AB at O. Similarly, join the positions of tip of the pins G and H and produce it up to the edge CD. Let HG meet CD at O′.
- Join O and O′. Also produce EF up to P, as shown by a dotted line.

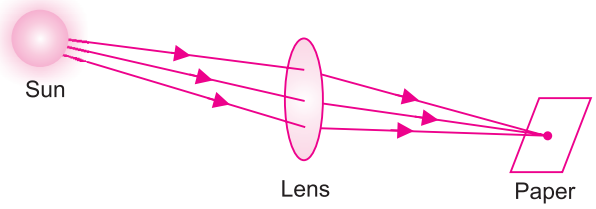


ACTIVITY 10.11

- Hold a convex lens in your hand. Direct it towards the sun. (Do not look at the sun through the lens, or else it may cause permanent damage to eye).
- Focus the light from the sun on a sheet of paper. Obtain a sharp bright image of the sun.
- Hold the paper and the lens in the same position for a while keep observing the paper.

Observation: The paper begins to burn producing smoke, it may catch fire after a while.

Conclusion: The light rays from the sun gets converged when it passes through the lens and bright spot is formed on the paper, that is the focus of the sun.



ACTIVITY 10.12

- Take a convex lens. Find its approximate focal length in a way described in activity 10.11.
- Draw five parallel straight lines, using chalk, on a long Table such that the distance between the successive lines is equal to the focal length of the lens.
- Place the lens on a lens stand. Place it on the central line such that the optical centre of the lens lies just over the line.
- The two lines on either side of the lens correspond to F and 2F of the lens respectively. Mark them with appropriate letters such as $2F_1$, F_1, F_2 and $2F_2$, respectively.
- Place a burning candle, far beyond $2F_1$ to the left. Obtain a clear sharp image on a screen on the opposite side of the lens.

- Note down the nature, position and relative size of the image.
- Repeat this activity by placing object just behind $2F_1$, between F_1 and $2F_1$, at F_1, between F_1 and O. Note down and tabulate the observations.

Observations for a convex lens

Position of the object	*Position of the image*	*Relative size of the image*	*Nature of the image*
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

ACTIVITY 10.13

- Take a concave lens. Place it on a lens stand.
- Place a burning candle on one side of the lens.
- Look through the lens from the other side and observe the image.
  Try to get the image on a screen, if possible or else observe the image directly through the lens.
- Note down the nature, relative size and approximate position of the image.
- Move the candle away from the lens.
  Note the change in the size of the image. Record your observations by placing a candle at position too far away from the lens.

Observations for a concave lens

Position of the object	*Position of the image*	*Relative size of the image*	*Nature of the image*
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens.	Between focus F_1 and optical centre O	Diminished	Virtual and erect

NCERT IN-TEXT QUESTIONS SOLVED

Q1. *Define the principal focus of a concave mirror.*

Ans. It is a point on the principal axis where the rays of light parallel to principal axis meet.

Q2. *The radius of curvature of a spherical mirror is 20 cm. What is its focal length?*

Ans. $R = 20$ cm

$R = 2f$

$$f = \frac{R}{2}, \qquad f = \frac{20}{2} = 10 \text{ cm.}$$

Focal length is 10 cm.

Q3. *Name a mirror that can give an erect and enlarged image of an object.*

Ans. Concave mirror.

Q4. *Why do we prefer a convex mirror as a rear-view mirror in vehicles?*

Ans. Convex mirror can cover a wider range and give erect and diminished image. Hence convex mirror is used as a rear-view mirror to get wider field of view.

Q5. *Find the focal length of a convex mirror whose radius of curvature is 32 cm.*

Ans. Radius of curvature $R = 32$ cm

$R = 2f$

$$\therefore \quad f = \frac{R}{2} = \frac{32}{2} = 16 \text{ cm.}$$

Q6. *A concave mirror produces three times magnified (enlarged) real image of an object placed at 10 cm in front of it. Where is the image located?*

Ans. Object distance $u = -10$ cm (concave mirror)

Magnification $m = -3$

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

$$\therefore \quad v = -mu = -(-3)\ (-10) = -30 \text{ cm.}$$

Image formed $v = 30$ cm in front of the concave mirror.

Q7. *A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away form the normal? Why?*

Ans. The light bends towards the normal on entry into water because water is optically denser than air.

Q8. *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 3×10^8 m/s.*

Ans. The speed of light in vacuum is $= 3 \times 10^8$ m/s

Refractive index of glass $n_g = 1.50$

$$n_g = \frac{c}{v}$$

$$\text{Speed of light in glass } v_g = \frac{c}{n_g} = \frac{3 \times 10^8}{1.50}$$

$$= 2 \times 10^8 \text{ m/s.}$$

Q9 *Find out from following table the medium having highest optical density. Also find the medium with lowest optical density.*

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Canada Balsam	1.53
Ice	1.31		
Water	1.33	Rock sald	1.54
Alcohol	1.36		
Kerosene	1.44	Carbon disulphide	1.63
Fused quartz	1.46	Dense flint glass	1.65
Turpentine oil	1.47	Ruby	1.71
Benzene	1.50	Sapphire	1.477
Crown glass	1.52	Diamond	2.42

Ans. Diamond has highest optical density *i.e.,* 2.42 and air has the lowest optical density *i.e.,* 1.0003.

Q10. *You are given kerosene, turpentine and water. In which of these does the light travel fastest? Use the information given in table above.*

Ans. Refractive index of kerosene = 1.44

Refractive index of turpentine = 1.47

Refractive index of water = 1.33

Lower the refractive index faster is the speed of light in that medium. Hence light will travel fastest in water.

Q11. *The refractive index of diamond is 2.42. What is the meaning of this statement?*

Ans. As refractive index $= \dfrac{\text{speed of light in air}}{\text{speed of light in diamond}}$

This means the ratio of the speed of light in the air and the speed of light in diamond is equal to 2.42.

Q12. *Define 1 dioptre of power of a lens.*

Ans. 1 dioptre is the power of a lens whose focal length is 1 metre.

$$1 \text{ D} = 1 \text{ m}^{-1}$$

Q13. *A convex lens forms a real and inverted image of a needle at a distance of 50 cm from it. Where is the needle placed in front of the convex lens if the image is equal to the size of the object? Also find the power of the lens.*

Ans.

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

$v = +50$ cm. Convex lens as image is of same size hence

$$u = -50 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{(50\text{ cm})} - \frac{-1}{(-50\text{ cm})}$$

$$= \frac{1}{50} + \frac{1}{50} = \frac{1}{25}\text{cm}$$

$$f = +25\text{ cm} = +0.25\text{ m}.$$

Q14. *Find the power of a concave lens of focal length 2 m.*

Ans. Focal length of concave lens $f = -2$ m

Power of concave lens $P = \frac{1}{f}$

$\therefore$ $P = \frac{1}{-2} = -0.5$ D.

QUESTIONS NCERT FROM TEXTBOOK

Q1. *Which one of the following materials cannot be used to make a lens?*

(*a*) *Water* (*b*) *Glass*

(*c*) *Plastic* (*d*) *Clay*

Ans. (*d*) Clay

Q2. *The image formed by a concave mirror is observed to be virtual, erect and larger than the object. Where should be the position of the object?*

(*a*) *Between the principal focus and the centre of curvature*

(*b*) *At the centre of curvature*

(*c*) *Beyond the centre of curvature*

(*d*) *Between the pole of the mirror and its principal focus*

Ans. (*d*) Between the pole of the mirror and its principal focus.

Q3. *Where should an object be placed in front of a convex lens to get a real image of the size of the object?*

(*a*) *At the principal focus of the lens*

(*b*) *At twice the focal length*

(*c*) *At infinity*

(*d*) *Between the optical centre of the lens and its principal focus*

Ans. (*b*) At twice the focal length.

Q4. *A spherical mirror and a thin spherical lens have each a focal length of –15 cm. The mirror and the lens are likely to be*

(*a*) *both concave*

(*b*) *both convex*

(*c*) *the mirror is concave and the lens in convex.*

(*d*) *the mirror is convex but the lens is concave.*

Ans. (*a*) Both concave.

Q5. *No matter how far you stand from a mirror, your image appears erect. The mirror is likely to be*

(*a*) *plane.* (*b*) *concave.*

(*c*) *convex* (*d*) *either plane or convex.*

Ans. (*d*) either plane or convex.

Q6. *Which of the following lenses would you prefer to use while reading small letters found in a dictionary?*

(*a*) *A convex lens of focal length 50 cm.*

(*b*) *A concave lens of focal length 50 cm.*

(*c*) *A convex lens of focal length 5 cm.*

(*d*) *A concave lens of focal length 5 cm.*

Ans. (*c*) A convex lens of focal length 5 cm.

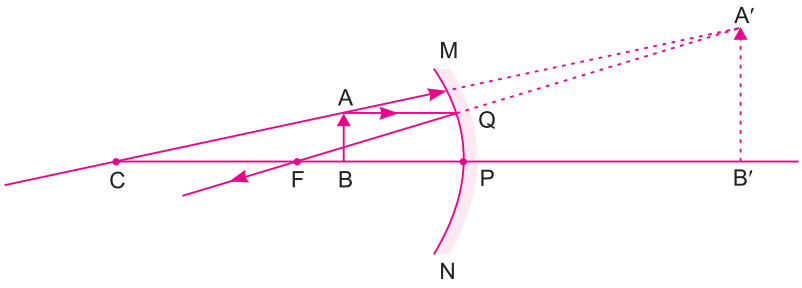
Q7. *We wish to obtain an erect image of an object, using a concave mirror of focal length 15 cm. What should be the range of distance of the object from the mirror? What is the nature of the image? Is the image larger or smaller than the object? Draw a ray diagram to show the image formation in this case.*

Ans. Focal length of concave mirror = 15 cm.

Object should be place in front of given concave mirror at a distance less than 15 cm.

Image formed is virtual and erect.

Image size is larger than object.



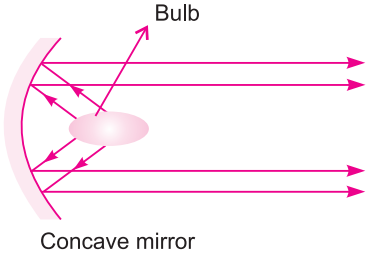
Q8. *Name the type of mirror used in the following situations.*

(*a*) *Headlight of a car.* (*b*) *Side/rear-view mirror of a vehicle*

(*c*) *Solar furnace.*

Support your answer with reason.

Ans. (*a*) For headlight of a car— Concave mirror is used to get a powerful beam of light after reflection.



(*b*) Convex mirror is used for side/rear view mirror of a vehicle. Convex mirror forms an erect and diminished image of vehicles and gives wider view of rear.

(*c*) In solar furnace concave mirror is used as a reflector, it concentrates sun light at a point where the temperature increases sharply to 180°C – 200°C.

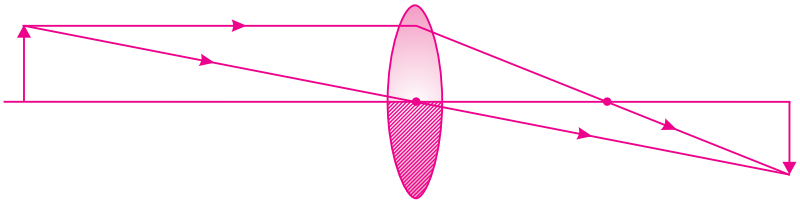
Q9. *One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object? Verify your answer experimentally? Explain your observations.*

Ans. Yes, one-half of a convex lens when covered with a black paper, the lens produces a complete or full image of an object.

To verify experimentally:

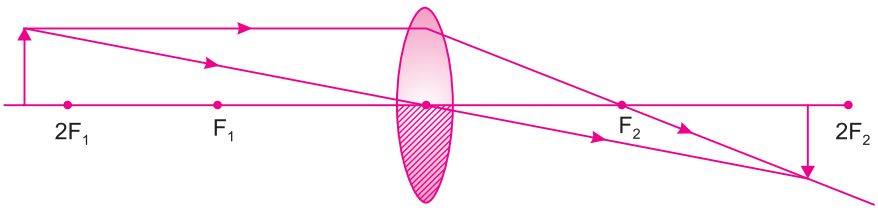
Take a convex lens, cover half part of it as shown in the figure, with a paper. Place it on a stand. Focus a distant object on a screen, the image obtained on the screen is complete.

Observation and conclusion: Image formed on the screen does not depend on the size of the lens. The brightness of the image decreases as less number of rays pass through the lens.



Q10. *An object 5 cm in length is held 25 cm away from a converging lens of focal length 10 cm. Draw the ray diagram and find the position, size and the nature of the image formed.*

Ans.



$f = 10$ cm

$u = -25$ cm

$h_o = 5$ cm

Convex lens

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

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

$$= \frac{1}{10} + \frac{1}{(-25)}$$

$$= \frac{5-2}{50} = \frac{3}{50}$$

$$\therefore \quad V = \frac{50}{3} - 16.67 \text{ cm}$$

Height of the image formed

$$\frac{h_i}{h_o} = \frac{v}{u}$$

$$\frac{h_i}{5} = \frac{16.67}{-25}$$

$$h_i = -3.33$$

Hence, the image formed at 16.67 cm from the lens on the other side. The size of the image is 3.3 cm, *i.e.,* reduced and inverted.

Q11. *A concave lens of focal length 15 cm forms an image 10 cm from the lens. How far is the object placed from the lens? Draw the ray diagram.*

Ans. Concave lens

$$f = -15 \text{ cm}$$

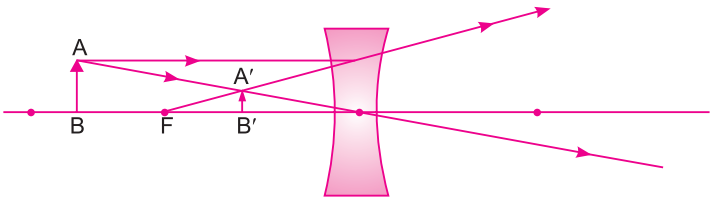
$$v = -10 \text{ cm}$$

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

$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-15}$$

$$\therefore \quad \frac{1}{u} = -\frac{1}{30} \qquad \therefore u = -30 \text{ cm}$$

Ray diagram



Q12. *An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position and nature of the image.*

Ans. Convex mirror

$$f = +15 \text{ cm}, \qquad u = -10 \text{ cm}.$$

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

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

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

$$\frac{1}{v} = \frac{5}{30} \qquad v = +6 \text{ cm}$$

The image is formed 6 cm behind the mirror, virtual image is formed.

Q13. *The magnification produced by a plane mirror is +1. What does this mean?*

Ans. Magnification, $m = +1$

$+$ indicates virtual image.

1 indicates that the object size and image size is same.

Q14. *An object 5.0 cm in length is placed at a distance of 20 cm in front of a convex mirror of radius of curvature 30 cm. Find the position of the image, its nature and size.*

Ans.
$$f = \frac{R}{2} = \frac{30}{2} = 15 \text{ cm}$$

$$f = +15 \text{ cm}, \; u = -20 \text{ cm}, \; h = 5.0 \text{ cm}$$

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

$\therefore$
$$\frac{1}{v} + \frac{1}{(-20)} = \frac{1}{15}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{20}$$

$$\frac{1}{v} = \frac{7}{60} \qquad \therefore v = \frac{60}{7} \text{ cm}$$

Image is virtual behind the mirror and erect.

$$\frac{h_i}{h_o} = \frac{v}{u}$$

$\Rightarrow$
$$\frac{h_i}{5} = \frac{8.57}{20}$$

$$h_i = 3.33 \text{ cm}$$

Q15. *An object of size 7.0 cm is placed at 27 cm in front of a concave mirror of focal length 18 cm. At what distance from the mirror should a screen be placed, so that a sharp focussed image can be obtained? Find the size and the nature of the image.*

Ans. Concave mirror $u = -27$ cm, $f = -18$ cm, $h = 7.0$ cm

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

$\therefore \quad \frac{1}{v} + \frac{1}{(-27)} = \frac{1}{(-18)}$

$\therefore \quad \frac{1}{v} = \frac{-1}{18} + \frac{1}{27} = \frac{-3+2}{54} = \frac{-1}{54}$

$v = -54$ cm.

$\frac{h_i}{h_o} = \frac{v}{u}$

$\therefore \quad h_i = \frac{v \times h_o}{u}$

$= \frac{54 \times 7}{27} = 14$ cm

The image is real, inverted and enlarged.

Q16. *Find the focal length of a lens of power –2.0 D. What type of lens is this?*

Ans. $P = -2.0$ D

$P = \frac{1}{f}$

$\therefore \quad f = \frac{1}{P} = \frac{1}{-2.0\ D} = -0.5$ m.

$\therefore$ The lens is concave lens as f = –ve.

Q17. *A doctor has prescribed a corrective lens of power +1.5 D. Find the focal length of the lens. Is the prescribed lens diverging or converging?*

Ans. $P = +1.5$ D, $\quad P = \frac{1}{f}$

Focal length of the lens $f = \frac{1}{P} = \frac{1}{+1.5\ D} = +0.67$ m

Power of the lens is +ve, and it is converging lens *i.e.,* convex lens.

MORE QUESTIONS SOLVED

I. MULTIPLE CHOICE QUESTIONS

1. Focal length of plane mirror is

(*a*) at infinity (*b*) zero

(*c*) negative (*d*) none of these

2. Image formed by plane mirror is

(*a*) real and erect (*b*) real an inverted

(*c*) virtual and erect (*d*) virtual and inverted

3. A concave mirror gives, real, inverted and same size image if the object is placed

(*a*) at F (*b*) at infinity

(*c*) at C (*d*) beyond C

4. Power of a lens is –40, its focal length is

(*a*) 4 m (*b*) – 40 cm

(*c*) – 0.25 m (*d*) – 25 m.

5. A concave mirror gives virtual, erect and enlarged image if the object is placed:

(*a*) at infinity (*b*) between F and C

(*c*) between P and F (*d*) at F.

6. The mirror that always gives virtual and erect image of the object but image of smaller size than the size of the object is

(*a*) Plane mirror (*b*) Concave mirror

(*c*) Convex mirror (*d*) none of these

7. All the distances in case of spherical mirror are measured in relation to

(*a*) object to image (*b*) the pole of the mirror

(*c*) the focus of the mirror (*d*) the image to the object.

8. The radius of curvature and focal length of a concave mirror are

(*a*) positive (*b*) negative

(*c*) both (*d*) none of these

9. The object distance in both concave as well as convex mirror is

(*a*) negative (*b*) positive

(*c*) zero (*d*) none of these

10. The ratio of the speed of light in vacuum to that in a medium is known as

(*a*) magnification (*b*) refraction

(*c*) refractive index (*d*) Snell's law

11. In optics an object which has higher refractive index is called

(*a*) optically rarer (*b*) optically denser

(*c*) optical density (*d*) refractive index

12. The optical phenomena, twinkling of stars, is due to

(*a*) atmospheric reflection (*b*) total reflection

(*c*) atmospheric refraction (*d*) total refraction

13. Convex lens focus a real, point sized image at focus, the object is placed

(*a*) at focus (*b*) between F and 2f

(*c*) at infinity (*d*) at 2f

14. The unit of power of lens is

(*a*) metre (*b*) centimeter

(*c*) diopter (*d*) m^{-1}

15. The radius of curvature of a mirror is 20 cm the focal length is

(*a*) 20 cm (*b*) 10 cm

(*c*) 40 cm (*d*) 5 cm

16. The refractive indices of some media are given below:

Medium	*Refractive index*
X	1.51
Y	1.72
Z	1.83
W	2.42

In which of these is the speed of light minimum and maximum, respectively.

(*a*) X-minimum, W-maximum (*b*) Z-minimum, W-maximum

(*c*) W-minimum, X-maximum (*d*) X-minimum, Z-maximum

17. The power of a lens is + 1.6 D. The nature of lens is

(*a*) Convex lens (*b*) Concave lens

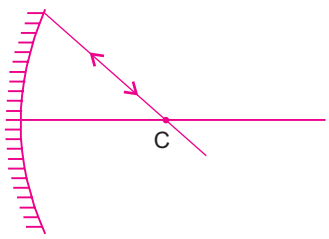
(*c*) both concave an convex (*d*) none of these

18. An incident ray makes 60° angle with the surface of the plane mirror, the angle of its refraction is

(*a*) 60° (*b*) 90°

(*c*) 30° (*d*) 0°

19. The angle of reflection in the given figure is



(*a*) 90° (*b*) 180°

(*c*) 0° (*d*) 30°

20. A mirror that has very wide field view is

(*a*) concave (*b*) convex

(*c*) plane (*d*) none of these

21. If the object is placed at focus of a concave mirror, the image is formed at

(*a*) infinity (*b*) focus

(*c*) centre of curvature (*d*) between F and O.

Answers

1. (*a*)	**2.** (*c*)	**3.** (*c*)	**4.** (*c*)	**5.** (c)	**6.** (*c*)	**7.** (*b*)
8. (*b*)	**9.** (*a*)	**10.** (*c*)	**11.** (*b*)	**12.** (*c*)	**13.** (*c*)	**14.** (*c*)
15. (*b*)	**16.** (*c*)	**17.** (*a*)	**18.** (*c*)	**19.** (*c*)	**20.** (*b*)	**21.** (*a*)

II. VERY SHORT ANSWER TYPE QUESTIONS (*1 Mark*)

Q1. *What is light?*

Ans. Light is a form of electromagnetic radiation that causes the sensation of sight. It doesn't require any material medium to travel.

Q2. *Name some phenomenon associated with light during image formation by mirrors.*

Ans. Reflection.

Q3. *Define reflection of light.*

Ans. The phenomenon of coming back of light in the same medium after striking a plane and polished surface is called reflection of light.

Q4. *Define incident ray, reflected ray, normal ray, angle of incidence and reflection.*

Ans. Incident ray – light which falls on the mirror/ polished surface is called incident ray.

Reflected ray – ray of light which goes back in the same medium after striking the surface is called reflected ray.

Normal – the perpendicular drawn to the reflecting surface is called normal at that point.

Angle of incidence – the angle between the incident ray and the normal is known angle of incidence.

Angle of reflection – the angle between reflected ray and the normal is known angle of reflection.

Q5. *State laws of reflection.*

Ans. Incident ray, reflected ray and normal at the point of incidence all lie in the same plane. The angle of incidence is equal to the angle of reflection.

Q6. *What are the properties of image formed by a plane mirror?*

Ans. Image is virtual and erect.

- Size of the image is equal to that of object
- Image is laterally inverted.
- The image formed by a plane mirror is always at the same distance as the object is in front of it.

Q7. *What are spherical mirrors?*

Ans. Mirrors whose reflecting surface are part of a sphere are called spherical mirrors.

Q8. *Define pole, centre of curvature, radius of curvature, principal axis, aperture, focus and focal length of a spherical mirror.*

Ans. **Pole:** the centre of reflecting surface. It is represented by letter P.

Centre of Curvature: The centre of the sphere of which the mirror forms the part. Represented by "C".

Radius of Curvature: The radius of the sphere of which the mirror forms the part. Represented by "R".

Principal axis: The straight line joining the pole (P) and the centre of curvature. It is normal to the mirror at its pole.

Aperture: The diameter of the spherical mirror is called its aperture. The reflecting surface of the mirror.

Focus: The point of the principal axis at which the rays parallel to principal axis meet (concave mirror) or appear to meet (convex mirror) after reflection. Represented by F.

Focal Length: The distance between the pole and the principal focus of a spherical mirror is called focal length. Represented by *f*.

Q9. *Write the position, nature and size of images formed by concave mirror.*

Ans. **Table:** Image formation by a concave mirror for different positions of the object

Position of the Object	***Position of the image***	***Relative size of the image***	***Nature of the image***
At infinity	At the focus F	Highly diminished point-sized	Real and inverted.
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Same size	Real and inverted
Between C and F	Beyond C	Enlarged	Real and inverted
At F	At infinity	Highly enlarged	Real and inverted
Between P and F	Behind the mirror	Enlarged	Virtual and erect

Q10. *Give some uses of concave mirror.*

Ans. (*a*) Used in torches, search lights and vehicle headlights.

(*b*) Used as shaving mirror.

(*c*) Used by dentist.

(*d*) Used in solar furnance.

Q11. *Give uses of convex mirror.*

Ans. (*a*) Used as rear view mirror in vehicles.

(*b*) Used to see full length image of a tall building.

Q12. *Give the sign conventions for spherical mirrors.*

Ans.

S. No.	***Various distances***	***Concave mirror***	***Convex mirror***
1.	Object distance 'u'	–ve	–ve
2.	Image Distance 'v'	+ve if behind the mirror, –ve if in front of the mirror	always +ve
3.	Focal Length	–ve	+ve
4.	Height of virtual image	+ve	+ve
5.	Height of real Image	–ve	–ve

Q13. *State mirror formula and write it mathematically.*

Ans. The relation between focal length of mirror, distance of the object and distance of the image is known as mirror formula. It is given by

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

u = Image distance

v = Object distance

f = Focal length

Q14. *Give the relation between focal length and radius of curvature.*

Ans. $f = \frac{R}{2}$

Q15. *Define magnification of mirror.*

Ans. The ratio of height of the image to the height of the object is called magnification. It is represented by 'm'.

m = Height of image (h')/Height of object (h) = $\frac{-v}{u}$

Magnification of real image is negative and of virtual image is positive.

Q16. *Define refraction of light.*

Ans. The change in direction of light, when it travels from one medium to another medium is called refraction of light.

Q17. *State laws of refraction.*

Ans. The ratio of sin of angle of incidence to the sin of angle of refraction for a light of given colour and for a given pair of media is constant. This is called Snell's law.

i.e., $\frac{\sin i}{\sin r}$ = Constant

The incident ray, refracted ray and the normal at the point of incidence lie on the same plane.

Q18. *What do you observe when light ray passes through rectangular slab?*

Ans. (*a*) Angle of incidence is equal to angle of emergence.

(*b*) Incident ray is parallel to the emergent ray.

(*c*) Lateral displacement is proportional to the thickness of glass slab.

(*d*) Lateral displacement is proportional to the angle of incidence.

Q19. *Define lateral displacement.*

Ans. Lateral displacement is the perpendicular distance between the incident ray and the emergent ray.

Q20. *Define refractive index.*

Ans. Refractive index is defined as the ratio of speed of light in medium 1 to the speed of light in medium 2 and is represented as n_{21} and is read as refractive index of medium 2 with respect to medium 1.

n_{21} = speed of light in medium 1/speed of light in medium 2.

Q21. *Define absolute refractive index.*

Ans. When medium 1 is vacuum, then refractive index of medium 2 is considered with respect to vacuum. This is called absolute refractive index.

Q22. *What is the unit of refractive index?*

Ans. It has no unit.

Q23. *Define optical density.*

Ans. The ability of the medium to refract light is called optical density.

Q24. *What is the relation between optical density, refractive index and speed of light?*

Ans. The medium with higher refractive index in which speed of light is less is known as optically denser medium and the medium with lower refractive index in which the speed of light is more is known as optically rarer medium.

Q25. *State lens formula and write it mathematically.*

Ans. The **relationship** between object distance (u), image distance (v), and focal length of lens is known as lens formula. It is given by $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Q26. *Define magnification of lens.*

Ans. $$\text{Magnification } (m) = \frac{\text{Height of image } (h')}{\text{Height of object } (h)} = \frac{v}{u}$$

For convex lens 'm' can be more than, less than or equal to one.

For concave lens 'm' is less than one.

Q27. *Define a lens.*

Ans. A transparent material bounded by two surfaces of which one or both surfaces are spherical forms a lens.

Q28. *What are the two types of lenses?*

Ans. **Spherical lens:** combination of two spherical refracting surfaces.

Spherical lens

Convex lens	**Concave lens**
Two spherical surfaces bulging outwards	Two spherical surfaces curved inwards
Thicken at middle, Converging	Thicken at the ends, Diverging

Q29. *Define centre of curvature, principal axis, optical centre, aperture, focus and focal length for a lens.*

Ans. **(a) Centre of curvature:** It is the centre of the spheres of which the each surface of the lens forms a part. Represented by C or 2f.

(b) Principal axis: An imaginary straight line passing through the two centres of curvatures.

(c) Optical centre: It is the central point of the lens. Represented by O.

(d) Aperture: It is the diameter of circular outline of a spherical lens.

(e) Focus: The point at which rays of light parallel to principal axis converges (convex lens) or appears to diverge (concave lens) after refraction. Represented by F.

(f) Focal length: The distance between focus and optical centre is called focal length. It is represented by f.

Q30. *Write nature, position and relative size of image formed by convex lens.*

Ans. **Table:** Nature, position and relative size of the image formed by a convex lens for various positions of the object

Position of the object	***Position of the image***	***Relative size of the image***	***Nature of the image***
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

Q31. *Write nature, position and relative size of image formed by cancave lens.*

Ans. **Table:** Nature, position and relative size of the image formed by a concave lens for various positions of the object

Position of the object	***Position of the image***	***Relative size of the image***	***Nature of the image***
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O	Between focus F_1 and optical centre O	Diminished	Virtual and erect

Q32. *Give sign conventions for spherical lenses.*

Ans.

S. No.	Various distances	Convex lens	Concave lens
1.	Object distance (u)	–ve	–ve
2.	Image (v)	+ve real, –ve virtual	–ve
3.	Focal length (f)	+ve	–ve
4.	Height of the object (h)	+ve	+ve
5.	Height of the image (h')	–ve for real +ve for virtual	+ve

Q33. *Define power of a lens.*

Ans. The degree of convergence or divergence of light rays achieved by lens is expressed in terms of power. It is given by

$$P = \frac{1}{f} \qquad f = \text{focal length in metre}$$

Q34. *What is the S.I. unit of power? Define it.*

Ans. The S.I. unit of power is dioptre denoted by "D" 1 dioptre is the power of a lens whose focal length is 1 metre.

- Power of a convex lens is +ve
- Power of a concave lens –ve

Q35. *What is the magnification of a plane mirror?*

Ans. $m = +1$

Q36. *What is the radius of curvature of plane mirror?*

Ans. Infinity.

Q37. *Which lens bends a light ray more or less with a shorter or with longer focal length?*

Ans. The lens with the shorter focal length bends the light more.

Q38. *If a convex lens is used to focus sunlight on a paper, where the paper should be placed so that it catches fire.*

Ans. At the Principal focus.

Q39. *What happens if a light falls on a glass slab making 90° at its surface?*

Ans. It undergoes normal refraction that is there is no deviation in the light.

40. *Where should be an object placed in front of convex lens so as to use it as a magnifier?*

Ans. Between the pole and the focal length.

Q41. *What is silvering of mirror?*

Ans. Silvering of mirror means coating the surface of mirror with a thin layer of silver, aluminium or some other shiny, opaque material.

III. SHORT ANSWER TYPE QUESTIONS (*2 or 3 Marks*)

Q1. *State the laws of reflection of light.*

Ans. Laws of reflection of light are:

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

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

Q2. *What are the properties of the image formed by plane mirror?*

Ans. Image formed by plane mirror is always virtual and erect. The size of the image is equal to that of the object. The image formed is as far behind the mirror as the object is in front of it and the image is laterally inverted.

Q3. *Define pole and centre of curvature of spherical mirrors.*

Ans. **Pole:** The centre of the reflecting surface of a spherical mirror is a point called the pole. It lies on the surface of the mirror. It is represented by "P".

Centre of Curvature: The reflecting surface of a spherical mirror forms a part of a sphere this sphere has a centre and this point is called the centre of curvature of the spherical mirror.

Q4. *Give the uses of concave mirrors.*

Ans. (*i*) Concave mirror are used in torches, search-lights and vehicle headlights to get powerful parallel beams of light.

(*ii*) They are also used as shaving mirrors to see a large image of the face.

(*iii*) Dentists use concave mirrors to see large images of the teeth of patients.

(*iv*) Large concave mirrors are used in making solar furnaces, solar cookers etc.

Q5. *Give the uses of convex mirrors.*

Ans. Convex mirrors are commonly used as rear-view mirrors in vehicles. As these mirrors can give an erect image, wider field of view, these mirrors are used in vehicles to see the traffic behind.

Q6. *Give the laws of refraction of light.*

Ans. The laws of refraction of light are

(*i*) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence all lie in the same plane.

(*ii*) The ratio of sine of angle of incidence to the sine of angle of refraction is constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.

Q7. *What is refractive index?*

Ans. If '*i*' is the angle of incidence and '*r*' is the angle of refraction then

$$\frac{\sin i}{\sin r} = \text{Constant}$$

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

Q8. *What is absolute refractive index of the medium?*

Ans. When the refractive index of medium 2 is considered with respect to vacuum. This is called the absolute refractive index of the medium.

$$\frac{n}{2} = \frac{\text{Speed of light in 2}}{\text{Speed of light in 1}}$$

Q9. *Two medium with refractive index 1.31 and 1.50 are given. In which case*

(i) bending of light is more?

(ii) speed of light is more?

Ans. (*i*) Bending of light is more in the medium where refractive index is 1.50.

(*ii*) Speed of light is more in the medium with refractive index 1.31

Q10. *When a ray of light entering from air is incident on the surface of a glass slab at an angle of 90°, what will be the measure of angle of refraction. Why does a ray change its path when it passes from one medium to another medium?*

Ans. The angle of refraction will be zero. A light ray changes its path when it passes from one medium to another medium.

Q11. *Refractive index of kerosene oil is 1.44 and that of water is 1.33. A ray of light enters from kerosene oil to water. Where would light ray bend and why?*

Ans. A ray of light enters from kerosene oil to water *i.e.,* refractive index 1.44 to 1.33 *i.e.,* from denser to rarer medium. Hence the ray of light bends away from the normal.

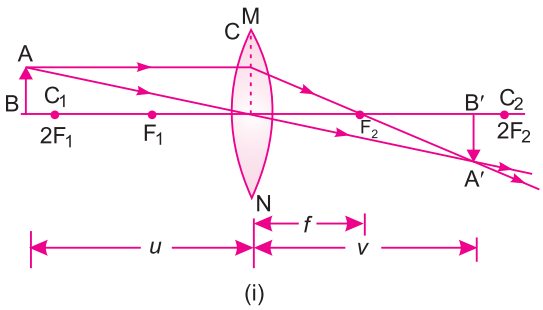
Q12. *Which is optically denser out of the two medium M_1 = 1.71 (refractive index) and M_2 = 1.36 (refractive index). How does speed of light change when it travels from optically rarer to denser medium.*

Ans. Medium M_1 with refractive index 1.71 is optically denser than the other medium M_2. Speed of light decreases when it travels from rarer to denser medium.

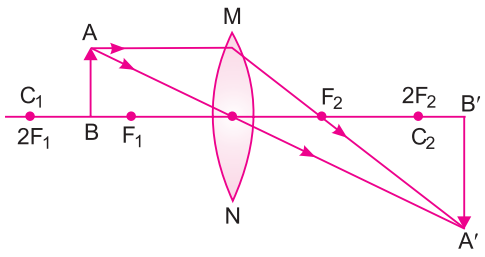
Q13. *Draw a ray diagram of image formed when an object is placed in front of convex lens*

(i) beyond 2 f and (ii) between f and 2f.

Ans.



(i)



(ii)

Q14. *Comment on the size, position of the image formed by a concave mirror of focal length 18 cm when an object is placed:*

(i) at 22 cm (ii) 14 cm (ii) 40 cm.

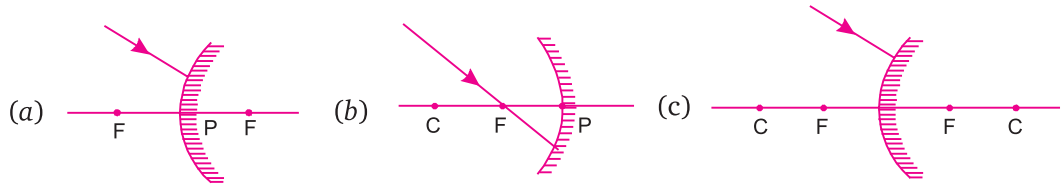
in front of mirror without calculations.

Ans. (*i*) When the object is placed at 22 cm, the image is formed beyond 36 cm, real, inverted image is magnified.

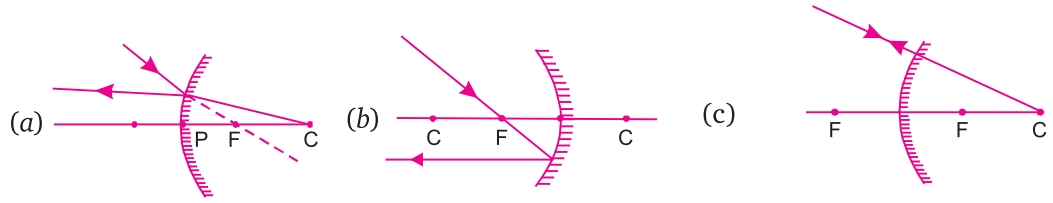
(*ii*) When the object is at 14 cm then the image formed is virtual, behind the mirror and magnified.

(*iii*) When the object is placed beyond 40 cm, then the image is formed between 18 cm and 36 cm, it is real inverted and diminished image.

Q15. *Complete the following ray diagrams:*

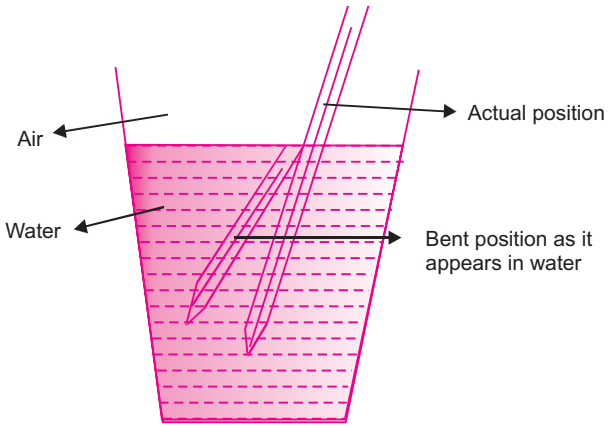


Ans.



Q16. *With the help of a ray diagram show how a pencil appears when dipped in water.*

Ans.



A ray of light (as we see pencil in air passing into water) travels from rarer to denser medium *i.e.,* from air to water, it bends towards the normal, hence the pencil appears to be bent in water as shown in the diagram.

Q17. *State the mirror formula, lens formula and power of lens.*

Ans. Mirror formula

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

(v = image distance, u = object distance, f = focal length)

Lens formula

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

Power of lens

$$P = \frac{1}{f} \qquad f = \text{focal length in metres}$$

Q18. *Define power of lens. What is the S. I. unit of power of a lens? If power of lens is +2D what is the nature and focal length of the lens?*

Ans. **Power of lens:** The degree of convergence or divergence of light rays obtained by a lens is expressed in terms of its power.

Power of a lens is defined as the reciprocal of its focal length.

$$P = \frac{1}{f}$$

S.I. unit of power of a lens is 'diopter'

$$P = +2 \text{ D.}$$

Lens is convex and the focal length of the lens is +0.50 m.

$$\left(P = \frac{1}{f}, \qquad 2 \text{ D} = \frac{1}{f}, \qquad \therefore f = \frac{1}{2} = 0.05\right)$$

Q19. *If the speed of light in water is 2.25 × 10^8 m/s and the speed in vacuum is 3×10^8m/s. Calculate the refractive index of water.*

Ans. $$\text{Refractive index of water} = \frac{\text{Speed of light in 1 medium (air)}}{\text{Speed of light in 2 medium (water)}}.$$

$$\therefore \qquad n_m = \frac{c}{v}$$

$$n_m = \frac{3 \times 10^8}{2.25 \times 10^8}$$

$$n_m = 1.33$$

∴The refractive index of water = 1.33.

Q20. *The refractive index of water is 1.33 and kerosene is 1.44. Calculate the refractive index of kerosene with respect to water.*

Ans. Refractive index of water = n_w = 1.33

Refractive index of kerosene = n_k = 1.44

∴Refractive index of kerosene with respect to water is

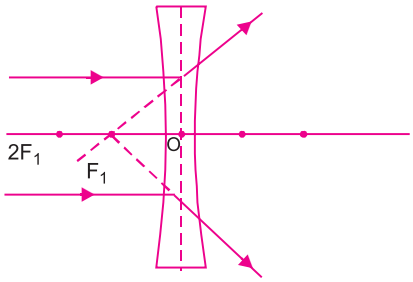
$$n_{kw} = \frac{n_k}{n_w} = \frac{1.44}{1.33}$$

$$= 1.082$$

Q21. *Draw ray diagrams to show the image formed by a concave lens for the object placed at*

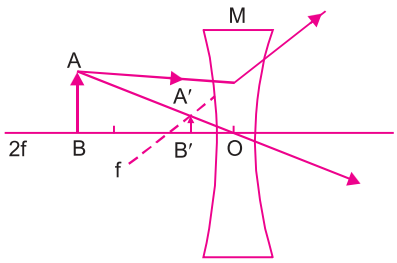
(i) infinity *(ii) Between f and 2f of the lens.*

Ans. (*i*) object at infinity



Object ⟶ at infinity
Image ⟶ at focus
Size of image ⟶ Point sized
Nature ⟶ virtual and erect

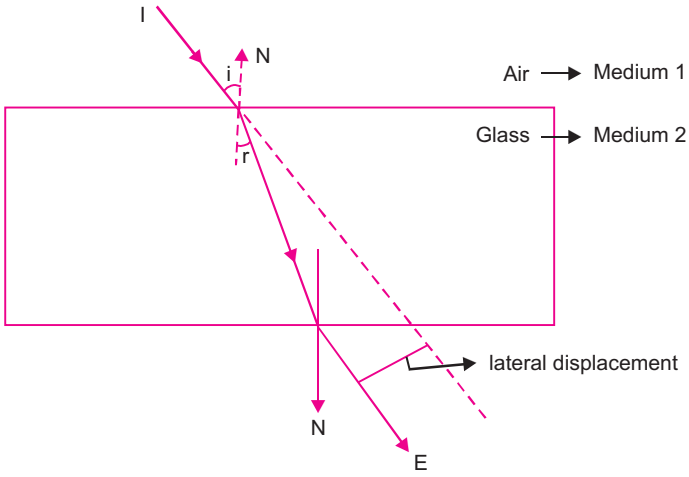
(*ii*) object between *f* and 2*f*



Object ⟶ between *f* and 2*f*
image ⟶ between O and F.
Size of image ⟶ Diminished
Nature ⟶ virtual and erect.

Q22. *Draw a ray diagram to show the path of light when it travels through glass slab.*

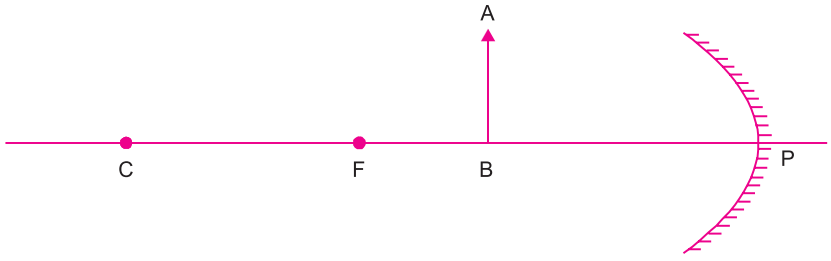
Ans.



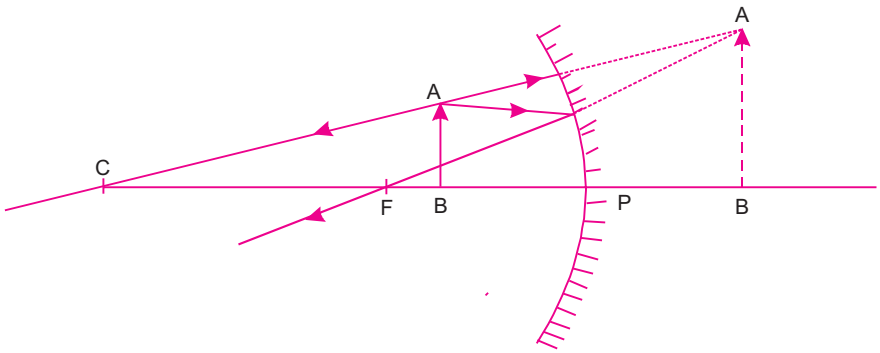
Incident ray I enters the glass slab forms an angle of incidence '*i*'. Its bends towards the normal and forms an angle of refraction '*r*'.

The emergent ray is parallel to the incident ray.

Q23. *Draw the following diagram in your answer book and show the formation of image of the object AB with the help of suitable rays.* (CBSE 2008)



Ans.

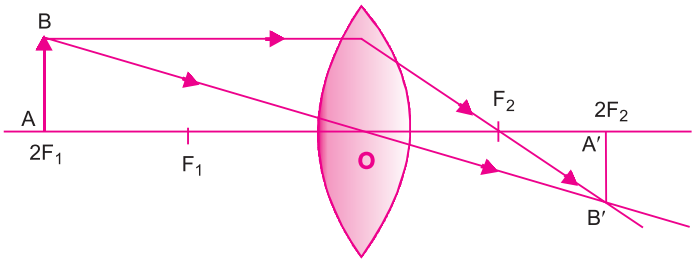


Q24. *Draw ray diagrams to represent the nature, position and relative size of the image formed by a convex lens for the object placed:*

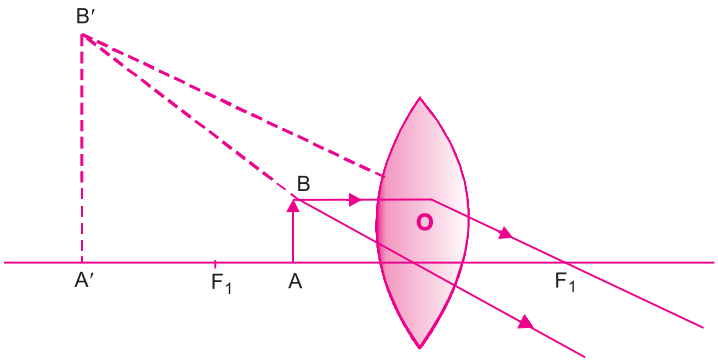
(*a*) *At 2F*

(*b*) *Between F_1 and the optical centre O of lens* (CBSE 2008)

Ans. (*a*)



(*b*)



Q25. *Which kind of mirrors are used in the headlights of a motor-car and why?* (CBSE 2008)

Ans. Concave mirror, to get the parallel beam of light.

Q26. (*a*) *It is desired to obtain an erect image of an object using a concave mirror of focal length 20 cm.*

(*i*) *What should be the range of distance of the object from the mirror?*

(*ii*) *Will the image be bigger or smaller than the object?*

(*iii*) *Draw a ray diagram to show the image formation in this case.*

(*b*) *One-half of a convex lens of focal length 20 cm is covered with a black paper.*

(*i*) *Will the lens produce a complete image of the object?*

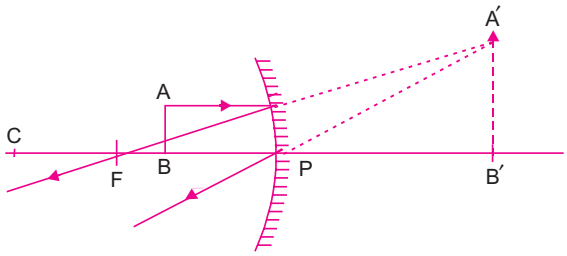
(*ii*) *Show the formation of image of an object placed at $2F_1$ of such covered lens with the help of a ray diagram.*

(*iii*) *How will the intensity of the image formed by half covered lens compare with non-covered lens?* *(CBSE 2008)*

Ans. (*a*) (*i*) Range of the object distance is 0 to 20 cm from the pole.

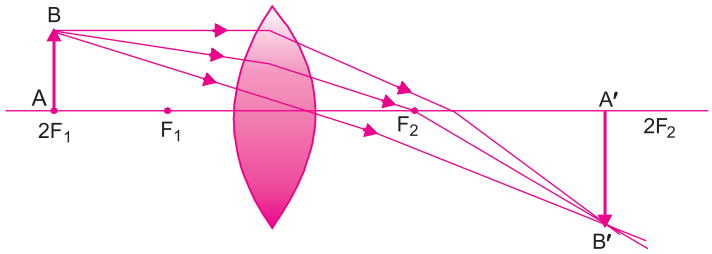
(*ii*) Image will be bigger than the object.

(*iii*) Ray diagram:



(*b*) (*i*) Yes, complete image will be formed.

(*ii*)

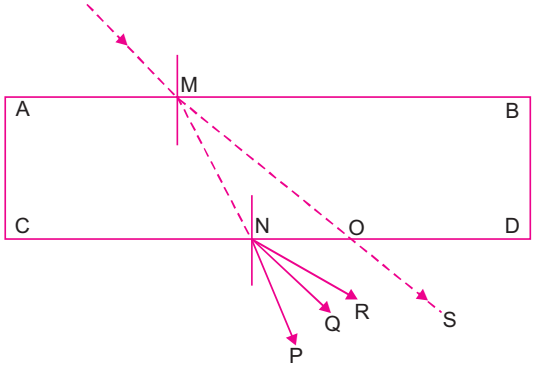


(*iii*) Intensity will be reduced as the light falling on the lower (covered) portion will not reach the position of image.

Q27. *Which type of mirrors are used to give an erect and enlarged image of an object?* (CBSE 2008)

Ans. Concave mirror.

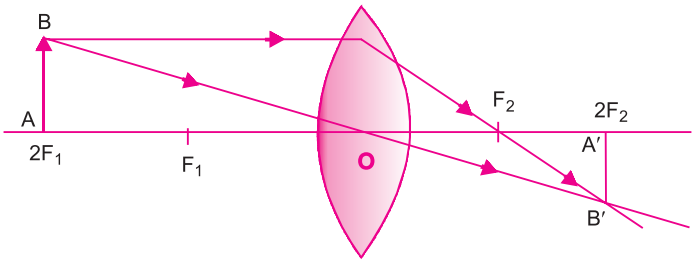
Q28. *If a light ray IM is incident on the surface AB as shown, identify the correct emergent ray.* (CBSE 2008)



Ans. Q as it has to be parallel to S.

Q29. *An object of 2 cm high is placed at a distance of 64 cm from a white screen on placing a convex lens at a distance of 32 cm from the object it is found that a distant image of the object is formed on the screen. What is the focal length of the convex lens and size of the image formed on the screen? Draw a ray diagram to show the formation of the image in this position of the object with respect to the lens.* (CBSE 2008)

Ans. Since the object-screen distance is double of object-lens separation, the object is at a distance of $2f$ from lens and the image should be of the same size of the object.



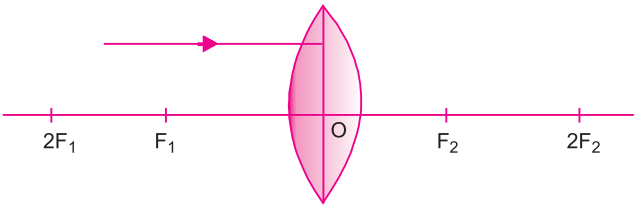
So $2f = 32 \Rightarrow f = 16$ cm

Height of image = Height of object = 2 cm

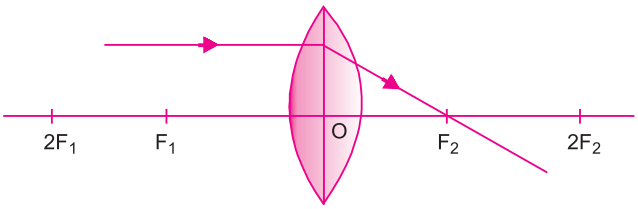
Q30. *The power of a lens is –4.0 D. What is the nature of this lens?* (CBSE 2008)

Ans. Negative power is associated with only concave lens.

Q31. *Redraw the given diagram and show the path of refracted ray.* (CBSE 2008)



Ans.



Q32. *A convex lens has a focal length of 10 cm. At what distance from the lens should the object be placed so that it gives a real and inverted image 20 cm away from the lens? What would be the size of the image formed if the object is 2 cm high? With the help of a ray diagram show the formation of the image by the lens in this case.* (CBSE 2008)

Ans. $f = +10$ cm, $v = +20$ cm as image is real and inverted. Height of the object = 2 cm (say +ve)

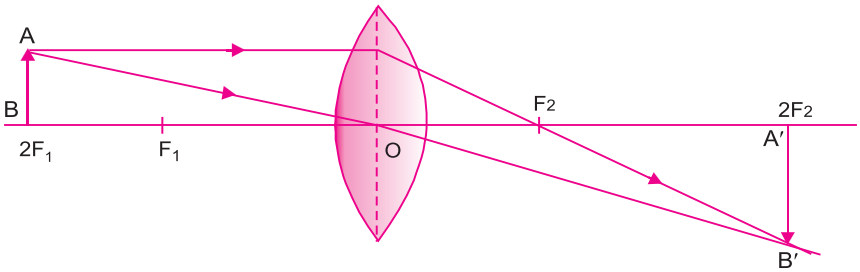
Using $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get

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

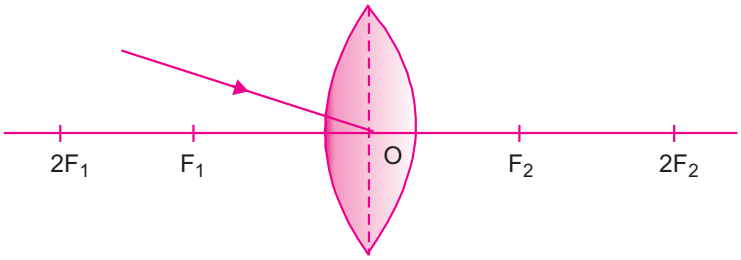
$$= \frac{1}{+20} - \frac{1}{10} = \frac{+1-2}{20} = \frac{-1}{20}$$

$u = -20$ cm $(= 2f)$

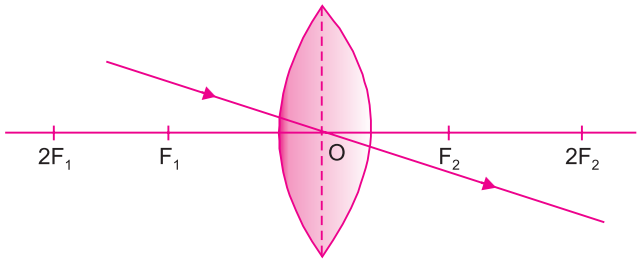
Image will be of the same size as that of object (as $u = v$) and hence, the height of the image will be 2 cm.



Q33. *Redraw the given diagram and show the path of the refracted ray.*



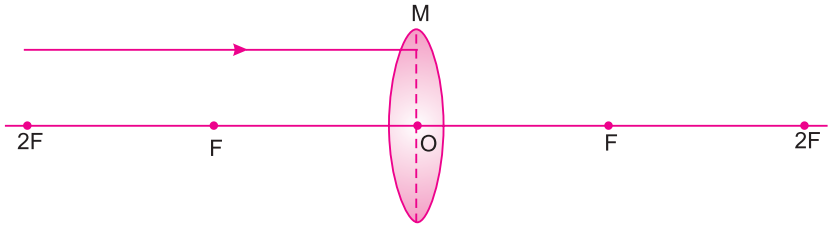
Ans.



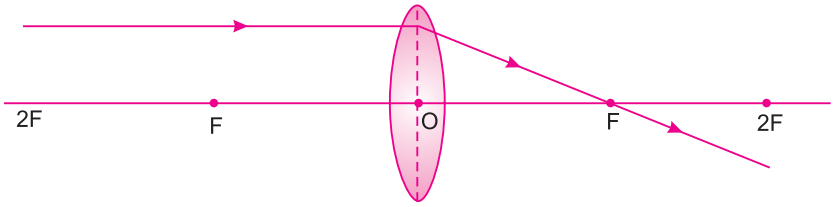
Q34. *Why does a ray of light bend when it travels from one medium into another?*

Ans. Due to change in velocity in the medium and to reduce the time taken to travel the same, a ray of light bends when it travels from one medium to another.

Q35. *Draw the given diagram in your answer book and complete it for the path of ray of light beyond the lens.*

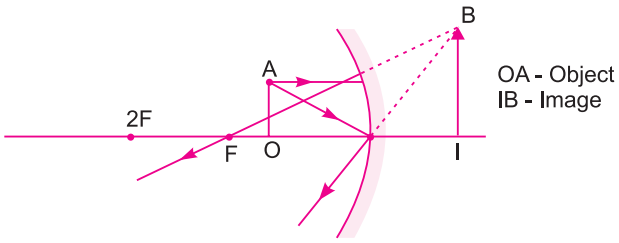


Ans.

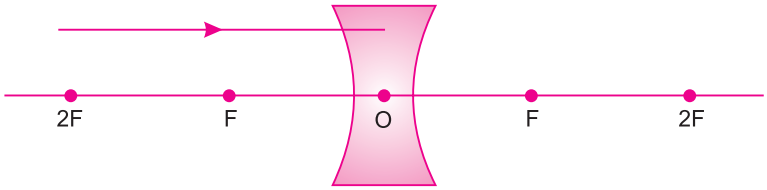


Q36. *What are the minimum number of rays required for locating the image formed by a concave mirror for an object? Draw a ray diagram to show the formation of virtual image by a concave mirror.*

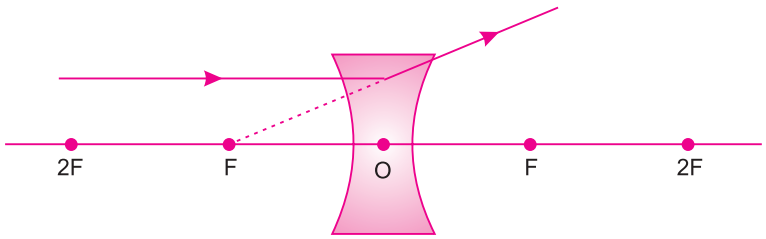
Ans. Two rays:



Q37. *Take down this diagram on to your answer book and complete the path of the ray.*



Ans.

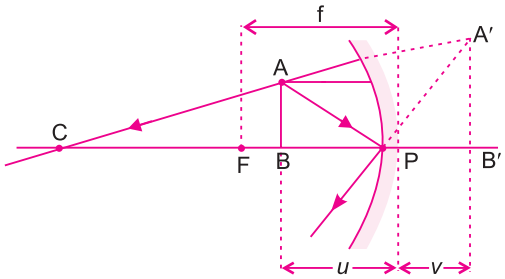


Q38. *What kind of mirrors are used in big shopping stores to watch activities of customers?*

Ans. Convex mirror as the image is independent of position of the object.

Q39. *Draw a ray diagram to determine the position of image formed of an object placed between the pole and the focus of a concave mirror.*

Ans.



IV. LONG ANSWER TYPE QUESTIONS (*5 Marks*)

Q1. *With the help of a ray diagram show the type of images formed when object is placed at the following positions in front of concave mirror.*

(*a*) *at infinity* (*b*) *beyond C*

(*c*) *at F* (*d*) *at C*

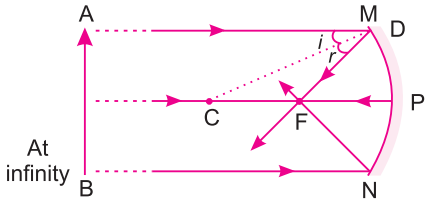
(*e*) *between F and C* (*f*) *between F and O*

$\because$ *C = centre of curvature*

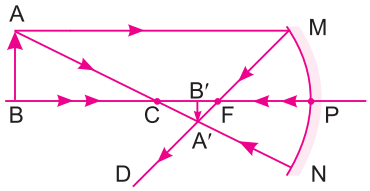
F = focus

O = optical centre of the mirror

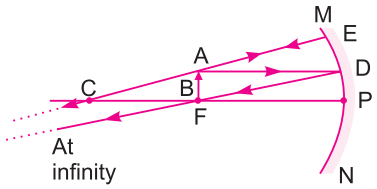
Ans.



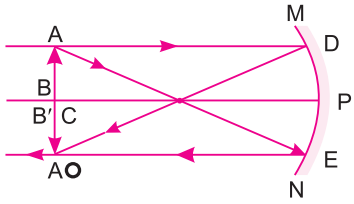
(a)



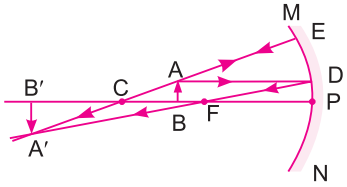
(b)



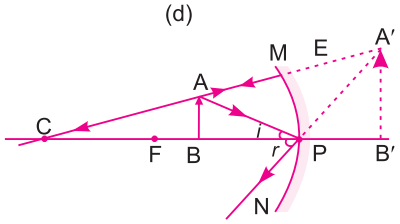
(c)



(d)



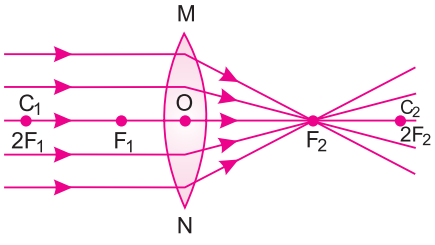
(e)



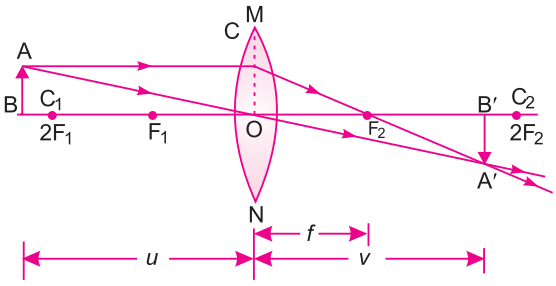
(f)

Q2. *With the help of a ray diagram show the position, size and the nature of the image formed by a convex lens for various positions of the object.*

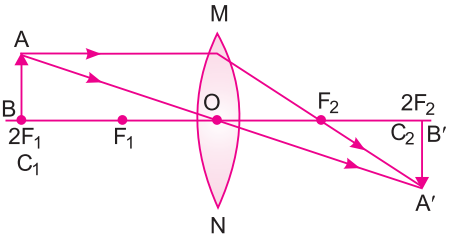
Ans.



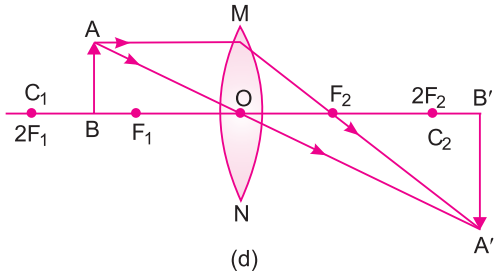
(a)



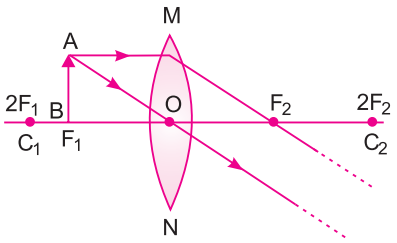
(b)



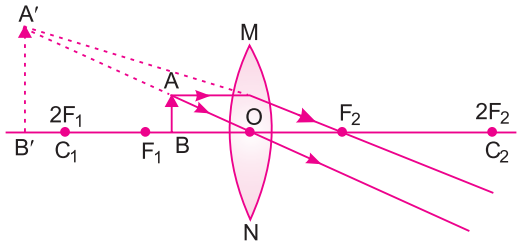
(c)



(d)



(e)



(f)

Q3. *Name the type of mirror used in the following situations:*

(i) Rear view mirror in vehicles

(ii) Solar furnace

(iii) Torch

(iv) Solar cooker

(v) To get the full length image of tall building.

Ans. (*i*) Rear view mirror in vehicles – convex mirror as it gives virtual image, diminished and cover the wider view.

(*ii*) Solar furnace – concave mirror to concentrate all parallel beam of light.

(*iii*) Torch – concave mirror is used.

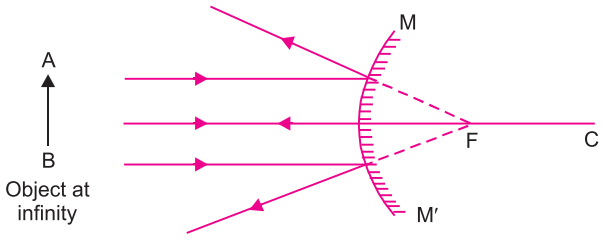
(*iv*) Solar cooker – concave mirror is used to concentrate the heat rays at a point.

(*v*) Convex mirror is used to view a full length tall building.

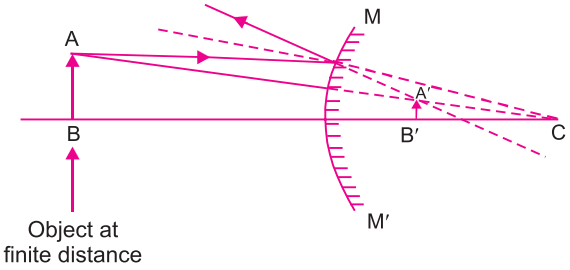
Q4. *Draw and explain the ray diagram formed by a convex mirror when*

(a) object is at infinity. *(b) object is at finite distance from the mirror.*

Ans. (*a*) When the object is at infinity, the image is formed at focus. 'F'.



(*b*) When the object is at finite distance the image is formed behind the mirror, it is virtual image and diminished in size.



Q5. *A convex lens has a focal length of 15 cm. At what distance from the lens should the object be placed so that is forms on its other side a real and inverted image 30 cm away from the lens? What would be the size of image formed if the object is 5 cm high? With the help of a ray diagram show the formation of the image by the lens in this case.*

Ans. $f = 15$ cm

$v = +30$ cm as image is real and inverted

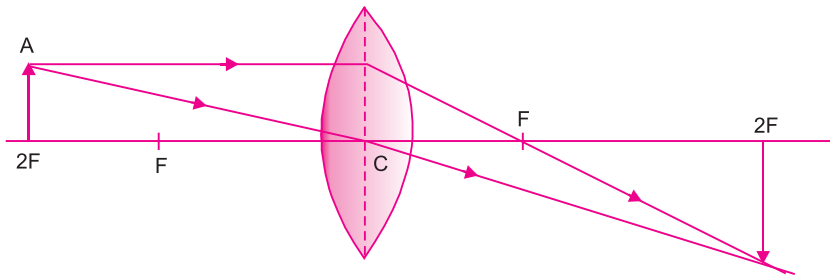
using $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get

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

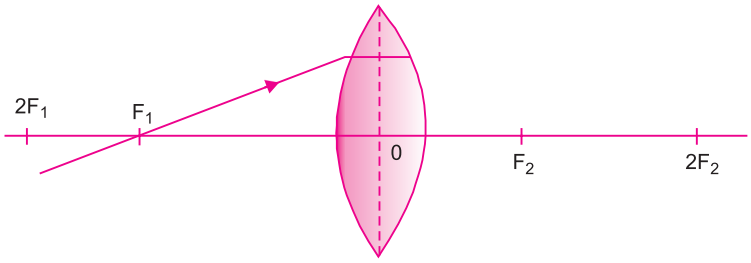
$$= \frac{1}{30} - \frac{1}{15} = \frac{1-2}{30} = -\frac{1}{30}$$

$u = -30$ cm $(= 2f)$

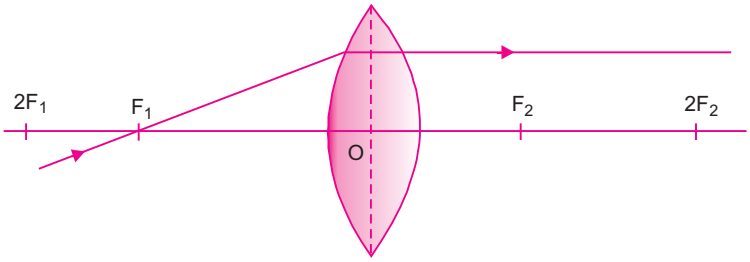
So, image should be of the same size as the object. Height of image = 5 cm.



Q6. *Redraw the given diagram and show the path of retracted ray.*



Ans.



Q7. *A convex lens has a focal length of 12 cm. At what distance from the lens should an object of height 6 cm be placed so that on the other side of the lens its real and inverted image is formed 24 cm away from the lens? What would be the size of the image formed? Draw a ray diagram to show the image formed in this case.*

Ans. $f = +12$ cm

Real and inverted image so $v = +24$ cm

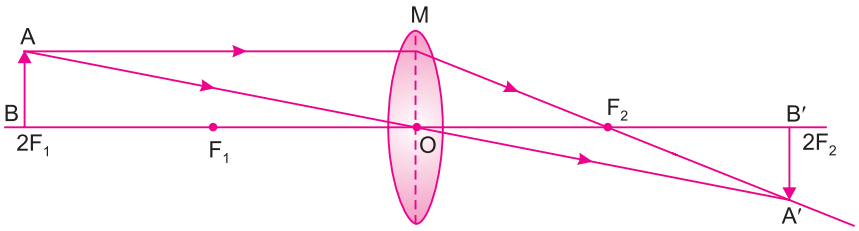
Using $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get

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

$$= \frac{1}{24} - \frac{1}{12} = \frac{1-2}{24} = -\frac{1}{24}$$

$u = -24$ cm $(= 2f)$

So image will be of the same size as the object. Height of image = 6 cm.



V. QUESTIONS ON HIGH ORDER THINKING SKILLS (HOTS)

Q1. *Amit visited a fair and saw a mirror in which he got a very funny image. The above part of his body was big in size, middle part was of normal size and the lower part of the body showed very small size. What kind of mirror is this?*

Ans. Upper part – Concave mirror; Middle part : Plane mirror; Lower part : Convex mirror.

Q2. *Nidhi wanted the image of her pencil to be double the size of its original size. Name the mirror used for getting such image.*

Ans. Concave mirror.

Q3. *Give the mirror image of "AMBULANCE"*

Ans. ƎƆИAJUBMA

Q4. *An incident ray makes an angle of 60° with the mirror. What is the angle of reflection?*

Ans. 60°.

Q5. *Define the following.*

(*a*) *What is ray?*

(*b*) *What is beam?*

(*c*) *What is reflection of light?*

(*d*) *What is reflector?*

(*e*) *What is focal length?*

(*f*) *What is principal focus?*

(*g*) *What is refraction?*

(*h*) *What is optically rare medium?*

(*i*) *What is optically denser medium?*

(*j*) *What is power?*

(*k*) *What is 1 dioptre?*

Ans. (*a*) It is the path of light.

(*b*) Group of parallel light rays emitted by the source of light.

(*c*) Bouncing back of light after striking any surface.

(*d*) The surface which reflects the light.

(*e*) The distance between the pole and the principal focus of the spherical mirror.

(*f*) A point of the principal axis where the rays of light parallel to principal axis meet.

(*g*) Bending of light ray when it travels from one medium to another.

(*h*) When the speed of light is more as compared to other medium.

(*i*) When the speed of light is less as compared to another medium.

(*j*) The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power

(*k*) It is the power of lens whose focal length is 1 m.

Q6. *What are the two types of reflection?*

Ans. (*i*) Regular (*ii*) Irregular

Q7. *Write the laws of reflection.*

Ans. (*a*) The angle of incidence is equal to angle of reflection.

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

Q8. *Give characteristics of image formed by plane mirror*

Ans.
- Image is virtual and erect.
- Size is same as of the object.
- It is formed at same distance.

Q9. *Give uses of plane mirror.*

Ans.
- Looking glass
- Used in submarines

- Solar cooker
- Kaleidoscope

Q10. *Name two types of spherical mirror.*

Ans.
- Concave mirror
- Convex mirror

Q11. *Give uses of concave mirror.*

Ans.
- Used as reflectors in car headlights, searchlights, etc.
- Used as shaving mirror.
- Used in solar cooker to focus the sunlight on one point.

Q12. *Give uses of convex mirror.*

Ans.
- It is used as the rear view mirror in cars.
- It is used in street lights as it diverge the light over larger area.

Q13. *What are the two types of refractive index?*

Ans.
- Relative refractive index– It is the ratio of speed of light in one medium to the speed of light in another medium
- Absolute refractive index– It is the ratio of light in vacuum to the speed of light in another medium

Q14. *Why do we prefer a convex mirror as a rear view mirror in vehicles?*

Ans. Convex mirrors are used as rear view mirror in cars because it produces erect and diminished image of the traffic behind the vehicle. It also gives a wider view.

Q15. *Name the type of mirror used in the following situations.*

(*a*) *Headlights of a car.*

(*b*) *Side/rear-view mirror of a vehicle.*

(*c*) *Solar furnace.*

Ans. (*a*) Concave mirror

(*b*) Convex mirror

(*c*) Concave mirror

Q16. *The magnification produced by a plane mirror is +1. What does this mean?*

Ans. This means that the size of the image is equal to the size of the object.

Q17. *Find the focal length of a lens of power –2.0 D. What type of lens is this?*

Ans. Given, Power = –2.0

The given lens is concave (power of concave lens is –ve)

$$P = \frac{1}{f} \text{ (in metre)}$$

$$-2.0 = \frac{1}{f}$$

$$f = \frac{1}{-2}\,\text{m}$$

$$f = -50\ \text{cm}$$

$\therefore$ The focal length is – 50 cm.

VI. VALUE-BASED QUESTION

Q1. *In a small town fair Akshay took his friend and showed him a mirror in which his image showed upper half body very fat and lower body very thin. Akshay's friend got upset but Akshay explained him by showing his similar image in the mirror.*

(*a*) *Name two mirrors used in this fair shop.*

(*b*) *Name the mirror in which the size of image is small.*

(*c*) *What value of Akshay is reflected?*

Ans. (*a*) Concave and convex mirror.

(*b*) Convex mirror gives small size image.

(*c*) Akshay showed compassion and empathy.

TEST YOUR SKILLS

Q1. *The power of a lens is – 40, what is its focal length?*

Q2. *State laws of reflection.*

Q3. *What are the properties of image formed by a plane mirror?*

Q4. *Give two uses of convex mirror.*

Q5. *What is refractive index?*

Q6. *Draw a ray diagram to show the image formed by a concave lens for the object placed at infinity.*

Q7. *Draw a ray diagram to show the path of light when it travels through glass slab.*

Q8. *State the lens formula and mirror formula.*

Q9. *The refractive index of water is 1.33 and kerosene is 1.44 calculate the refractive index of kerosene with respect to water.*

Q10. *Draw and explain the ray diagram formed by a convex mirror when:*

(*a*) *object is at infinity.*

(*b*) *object is at finite distance from the mirror.*

Q11. *Differentiate between concave lens and convex lens.*

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