- Speed of light in vacuum / air = 3×10^8 ms^{-1}
- **Ray of light :** A line drawn in the direction of propagation of light is called ray of light.
- **Beam of light :** A group of parallel rays light emitted by a source of light is called beam of light.
- **Reflection of light :** The phenomenon of returning of light in the same medium after striking a surface is called reflection of light.
- **Laws of reflection :** The reflection of light from a surface obeys certain laws called laws of reflection.
  - (i) incident angle is equal to reflected angle i.e. $\angle i = \angle r$.
  - (ii) Incident ray, reflected ray and normal to the reflecting surface at the point on incident lie in the same plane.
- **Concave mirror :** concave mirror is a part of a hollow sphere whose outer part is silvered and the inner part is reflecting surface.
- **Convex mirror :** convex mirror is a part of a hollow sphere whose outer part is reflecting surface and inner part is silvered.
- **Centre of curvature :** The centre of a hollow sphere of which the spherical mirror forms a part is called centre of curvature. It is denoted by C
- **Radius of curvature :** The radius of a hollow sphere of which the spherical mirror forms a part is called radius of curvature. It is denoted by R
- **Pole :** The mid point of a spherical mirror is called its pole. It is denoted by P
- **Aperture:** The part of spherical mirror exposed to the incident light is called the aperture of the mirror.
- **Principal Axis:** A line joining the centre of curvature (C) and pole (P) of a spherical mirror and extend on either side is called principal axis of the spherical mirror.
- **Principal Focus :** A point on the principal axis of a spherical mirror where the rays of light parallel to the principal axis meet or appears to meet after reflection from the spherical mirror is called principal focus. It is denoted by F.
- **Focal Plane :** A plane normal or perpendicular to the principal axis and passing through the principal focus (F) of the spherical mirror is called focal plane of the spherical mirror.
- **Focal length (f):** The distance between the pole (P) and the principal focus (F) of a spherical mirror is called the focal length of the spherical mirror.
- $f = \frac{R}{2}$, Where R is the radius of the curvature of the mirror.
- Focal length and radius of curvature of a concave mirror are **negative**.
- Focal length and radius of curvature of a convex mirror are **positive**.

- **Sign Conventions for reflection by spherical mirrors**

  (1) All distance are measured from the pole of a spherical mirror.

  (2) Distance measured in the direction of incident light are taken as positive. Distance measured in the direction opposite to that of the incident light are taken negative.

  (3) The upward distance perpendicular to the principal axis are taken as positive, while the downward distance perpendicular to the principal axis are taken as negative.

- Radius of curvature plane mirror = ∞ (infinite)
- Focal length of a plane mirror = ∞
- **Mirror Formula :** The relation between *u, v,* and focal length (*f*) of a spherical mirror is known as mirror formula.

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

- **Linear magnification :** Linear magnification produced by a mirror is defined as the ratio of the size (or height) of the image to the size of the object . It is denoted by m.

  That is $m=\frac{h'}{h}=\frac{-v}{u}$

- Power of mirror (P) = $\frac{-1}{f(\text{in m})}=\frac{-100}{f(\text{in cm})}$
- Linear magnification produced by a plane mirror = + 1.
- **Refraction of light:** The bending of light rays when they pass obsessively from one medium to the other medium is called refraction of light .
- A transparent medium through which light travels fast is known as optically rarer medium.
- A transparent medium through which light travels slow is known as optically denser medium.
- **Laws of refraction**

  (i) The incident ray, the refracted ray and the normal to the surface separating two media all lie in the same plane.

  (ii) The ratio of the sine of the incident angle ($\angle$i) to the sine of the refracted angle ($\angle$r) is constant

  i.e. $\frac{\sin i}{\sin r}=\text{constant}$

  This constant is known as the refractive index of second medium w.r.t the first medium.

- Absolute refractive index of a medium is defined as the ratio of the speed of light in vacuum (c) to the speed of light in the medium (v)

  i.e. $n=\frac{c}{v}$

- Relative refractive index of medium. 2 w.r.t. the medium 1 is defined as the ratio of the speed of light in medium 1 (v_1) to the speed of light in medium 2 (v_2).

  i.e. $n_{21}=\frac{v_1}{v_2}$

- $n_{21} = \frac{n_2}{n_1}$
- $n_{21} = \frac{1}{n_{12}}$
- A medium whose refractive index is large is known as optically denser medium.
- A medium whose refractive index is small is known as optically rarer medium.
- Lateral shift (displacement) . The perpendicular distance between the original part of the incident ray and the emergent ray coming out of the glass slab is called lateral shift.
- Lens is a transparent medium bounded by two spherical refracting surfaces one spherical and other plane refracting surface .
- Lens are of two types :
  - (i) Convex lens or converging lens: it is thick in the middle and thin at the edge.
  - (ii) Concave lens or diverging lens: it is thin in the middle and thick at the edge.
- Convex lens converges the rays of light falling on it and acts as a magnifying glass.
- Concave lens diverges the rays of light falling on it.
- Principal axis of a lens is a line joining the centres of curvature of two spherical surfaces forming a lens
- Optical centre of a lens is a point inside or outside a lens through which rays of light passes without deviation.
- Principal focus of a lens is a point on the principal axis where all the rays of light parallel to the principal axis meet or appear to meet after refracting through the lens.
- Focal length of a lens is the distance between the optical centre and the principal focus of the lens.
- Focal length of a convex lens is positive.
- Focal length of a concave length is negative.
- Lens formula: $-\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$
- Magnification produced by a lens: $m = \frac{\text{Size of image}}{\text{Size of object}} = \frac{h'}{h}$

  Also $m = \frac{v}{u}$
- Power of lens $P = \frac{1}{f(\text{in m})} = \frac{100}{f(\text{in cm})}$
- Unit of power is **diopter** (D).
- Power of a lens is 1 diopter if its focal length is 1 m or 100 cm.
- Power of a convex lens is **positive**.
- Power of concave lens is **negative**.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

TEACHER'S ADVICE

1. ***Always take value of u (object distance) –ve, in any of the problem either it is of Lens or Mirror directly.***
2. ***Take focal length of convex (either mirror or either lens) +ve, each problem directly.***
3. ***Take focal length of the concave (either mirror or lens) – ve, each problem directly.***

Q.1 Which one of the following materials cannot be used to make a lens?
(A) Water (B) Glass (C) Plastic (D) Clay

Ans. (D). This is because clay is opaque (i.e. light cannot pass through it).

Q.2 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.

Q.3 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.

Q.4 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 are concave.
(B) Both are convex.
(C) The mirror is concave and the lens is convex.
(D) The mirror is convex but the lens is concave.

Ans. (A) Both are concave

Q.5 No matter how far you stand from a mirror, your image appears erect. The mirror is likely to be
(A) Plane only. **(B) Concave only.**
(C) Convex only. **(D) Either plane or convex.**

Ans. (D) Either plane or convex

Q.6 Which of the following lenses would you prefer to use while reading small letters found in a dictionary?

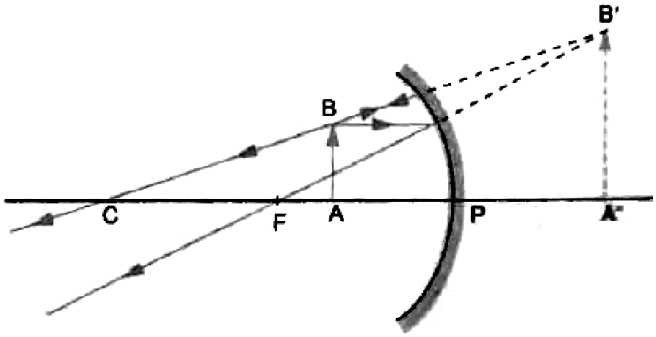
(A) A convex lens of focal length 50 cm. **(B) A concave lens of focal length 50 cm.**

(C) A convex lens of focal length 5 cm. **(D) A concave lens of focal length 5 cm.**

Ans. (D) A concave lens of focal length 5 cm

Q.7 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. A concave mirror produces an erect image if the object is placed between the pole and the focus of the concave mirror. Thus, object may be placed at any position whose distance is less than 15 cm from the concave mirror. The image is virtual and erect. The image is larger than the object.



Q.8 Name the type of mirror used in the following situation

(a) Head lights of a car **(b) Side rear view mirror of a vehicle** **(c) Solar furnace**

Support your answer with reason.

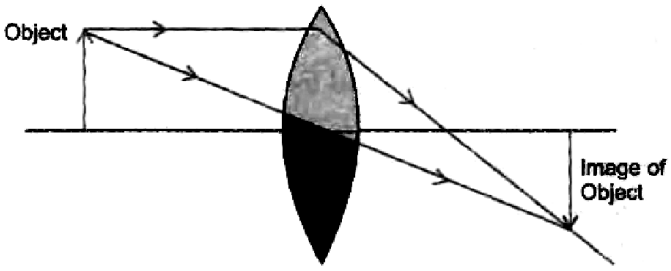
Ans. **(a)** **Concave mirror :** When a bulb is placed at the focus of a concave mirror, then the beam of light from the bulb after reflection from the concave mirror goes as a parallel beam which lights up the front road.

(b) **Convex mirror :** Image formed by a convex mirror is erect and small in size. The field of view behind the vehicle is large.

(c) **Concave mirror :** Concave mirror focuses rays of light coming from the sun at its focus. So, the temperature at the focus is raised.

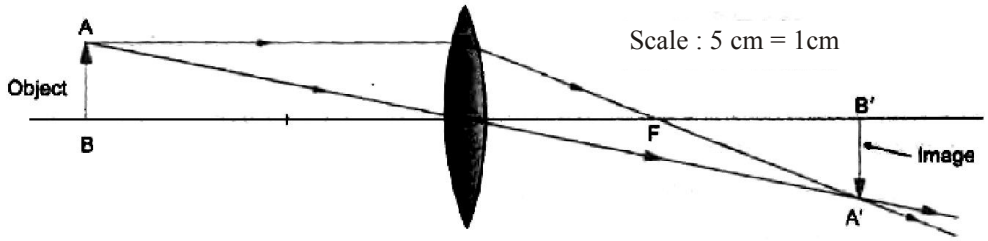
Q.9 One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object?

Ans. A complete image of the object is formed as shown in figure (but with less intensity).



Q.10 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.



Here, $u = -25$, $f = 10$ cm

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

$$\Rightarrow \quad \frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{10}-\frac{1}{25}=\frac{5-2}{50}=\frac{3}{50}$$

$$\therefore \quad v=\frac{50}{3}=16.67 \text{ cm (position of image)}$$

Size of Image :

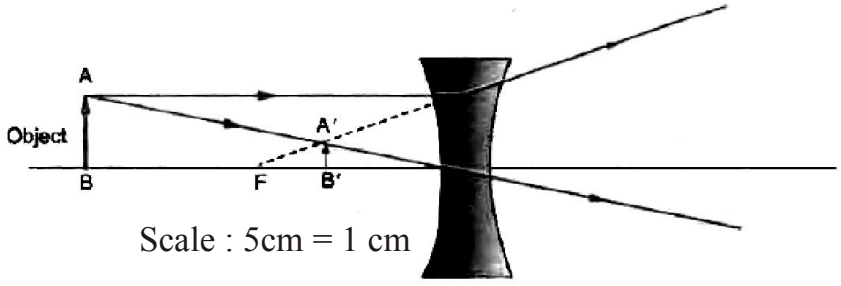
$$m=\frac{h'}{h}=\frac{v}{u}=+\frac{50}{3\times -25}=-\frac{2}{3}$$

or $$h'=-\frac{2}{3}\times h=-\frac{2}{3}\times 5=-\frac{10}{3}=-3.33 \text{ cm}$$

Image is real and inverted.

Q.11 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. Here, $f = -15$ cm, $v = -10$ cm, $u = ?$



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

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

$$\Rightarrow \frac{-1}{u}=\frac{1}{10}-\frac{1}{15}=\frac{1}{30}$$

$$\therefore \quad u=-30 \text{ cm.}$$

Q.12 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. Here, $u = -10$ cm, $f = +15$ cm, $v = ?$

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

we get, $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{15}+\frac{1}{10}=\frac{1}{6}$ $\therefore$ $v = 6$ cm.

Now, $m=\frac{-v}{u}=\frac{6}{10}=0.6$. Since, m is positive, so the orientation of both object and image is same.

Thus, image is erect and virtual.

Q.13 The magnification produced by a plane mirror is +1. What does this means?

Ans. $m=\frac{h'}{h}=1$ or $h' = h$

It means, size of the image formed by plane mirror is equal to the size of the object. Positive sign with m tells that both object and image are erect.

Q.14 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. $h = 5$ cm, $u = -20$ cm, $R = 30$ cm,

$\therefore$ $f=\frac{R}{2}=15$ cm

(i) Using, $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$, we get $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{15}+\frac{1}{20}=\frac{7}{60}$

$\therefore$ $v=\frac{60}{7}=8.57$ cm (Position of image)

(ii) $\frac{h'}{h}=-\frac{v}{u}=\frac{60}{7\times 20}=\frac{3}{7}$

or $h'=\frac{3}{7}\times 5=\frac{15}{7}=2.14$ cm

Since h' is positive, so image is erect and virtual.

Q.15 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. $h = +7.0$ cm, $u = -27$ cm, $f = -18$ cm

(i) Using, $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$,

we get $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=-\frac{1}{18}+\frac{1}{27}=-\frac{1}{54}$

$\therefore \quad v=-54$ cm

So the screen must be placed at distance of 54 cm in front of the concave mirror.

(ii) $\frac{h'}{h}=-\frac{v}{u}$ or $h'=-\frac{v}{u}\times h=\frac{54}{-27}\times 7=-14$ cm

Since h' is negative, so image is inverted & real.

Q.16 Find the focal length of a lens of power –2.0 D. What type of lens is this?

Ans. $P=\frac{1}{f(\text{in m})}$ $\therefore$ $f=\frac{1}{P}=\frac{1}{-2}=-0.5$ m $=-50$ cm

The lens is concave.

Q.17 A doctor has prescribed a corrective lens of power + 1.5 D. Find the focal length of the lens. Is the prescribed lens diverging of converging?

Ans. $f=\frac{1}{P}=\frac{1}{1.5}=+0.67$ m $=+67$ cm

Since focal length is positive, so the lens is converging.

Q.18 Define the principal focus of a concave mirror.

Ans. A point on the principal axis where the parallel rays of light after reflecting from a concave mirror meet.

Q.19 The radius of curvature of a spherical mirror is 20 cm. What is focal length?

Ans. Radius of curvature, R = 20 cm

$\therefore$ Focal length, $f=\frac{R}{2}=\frac{\pm 20}{2}=\pm 10$ cm

Note : '+' for covex mirror, '–' for concave mirror.

Q.20 Name a mirror that can give an erect and magnified image of an object.

Ans. A concave mirror

Q.21 Why do we prefer a convex mirror as a rear-view mirror in vehicles?

Ans. This because a convex mirror forms an erect and diminished (small in size) images of the objects behind the vehicle and hence the field of view behind the vehicle is also increased.

Q.22 Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Ans. R = + 32 cm. Therefore, f = R/2 = +32/2 = +16 cm

Thus, focal length of the convex mirror is 16 cm.

Q.23 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. m = –3,

But m = –v/u, so, v = 3u

u = –10 cm, v = 3 (–10 cm) = –30 cm

Thus, the image is located at a distance of 30 cm to the left side of the concave mirror.

Q.24 A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why?

Ans. The ray of light bends towards the normal because the speed of light decreases when it goes from air (rarer medium) into water (denser medium).

Q.25 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 in 3×10^8 ms^{-1}.

Ans. $n = \frac{c}{v}$ $\therefore$ $v = \frac{3\times10^8 \text{ms}^{-1}}{1.50} = 2 \times 10^8 \text{ ms}^{-1}$

Thus, speed of light in glass is 2×10^8 ms^{-1}.

Q.26 You are given kerosene, turpentine and water. In which of these does the light travel faster?

Ans. We know, $v = \frac{c}{n}$ Refractive index (n) of water is 1.333, whereas refractive index of kerosene is 1.44 and that of turpentine is 1.47. As refractive index of water is least, so speed of light in water is more than in kerosene and turpentine. Hence, light travels faster in water.

Q.27 The refractive index of diamond is 2.72. What is the meaning of this statement?

Ans. We know, $n = \frac{c}{v}$ or $v = \frac{c}{n} = \frac{1}{2.42} \times c$

Then, speed of light in diamond is $\frac{1}{2.42}$ times the speed a light in vacuum.

Q.28 Define 1 dioptre of power of a lens.

Ans. Power = 1/f (in m)

Power of a lens in 1 dioptre if focal length of the lens is 1 metre or 100 cm.

Q.29 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. (i) $v = 50$ cm

$m = \frac{h'}{h} = -1$ ($\because$ Image is real and inverted & of same size as that of object)

Also, $m = \frac{v}{u}$ or $u = -v = -50$ cm

Thus, needle is to be placed at 50 cm in front of the lens.

(ii) Using, $-\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, we get $\frac{1}{f} = \frac{1}{50} + \frac{1}{50} = \frac{2}{50} = \frac{1}{25}$ or $f = 25$ cm

$\therefore$ $P = \frac{100}{f(\text{in cm})} = \frac{100}{25} = +4.0$ D

Q.30 Find the power of a concave lens of focal length 2 m.

Ans. Here $f = -2$ m

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

CONCEPT APPLICATION LEVEL - II

SECTION - A

VERY SHORT ANSWER QUESTIONS

Q.1 What type of waves are light waves?

Ans. Light waves are electromagnetic waves.

Q.2 What is the radius of a plane mirror?

Ans. The radius of a plane mirror is infinity.

Q.3 What is the angle of reflection if a ray falls normally on a plane mirror?

Ans. The angle of reflection is 0°.

Q.4 Relate the focal length f and radius of curvature R.

Ans. Focal length = $\frac{\text{Radius of curvature}}{2}$ or f = R/2

Q.5 What is a real image?

Ans. If the rays of light after reflection or refraction actually meet at a point, the image is known as real image.

Q.6 What is a virtual image?

Ans. If the rays do not actually meet but appear to meet when produced backwards, then the image is known as virtual image.

Q.7 What type of image is formed:

(i) In a plane mirror (ii) On a cinema screen?

Ans. (i) Virtual image (ii) Real image

Q.8 Write the mirror formula.

Ans. $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ (u = object distance, v = image distance and f = focal length)

Q.9 Name the type of mirror which always forms a virtual and diminished image.

Ans. Convex mirror

Q.10 Which mirror convex or concave has more field of view?

Ans. Convex mirror

Q.11 For what position of an object, a concave mirror forms a real image equal in size to the object?

Ans. At C, centre of curvature.

Q.12 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?

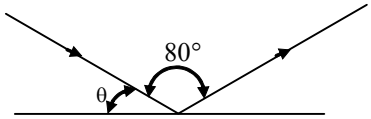
Ans. (i) Between pole P and focus F.
(ii) Between pole P and focus F.

Q.13 Differentiate between virtual image of a concave mirror and of a convex mirror.

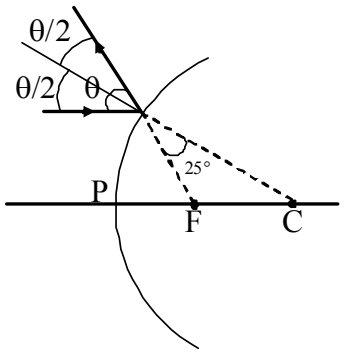
Ans. The virtual image of a concave mirror is always magnified whereas the virtual image of a convex mirror is diminished.

Q.14 The angle between an incident ray and the mirror is θ. The total angle turned by the ray of light is 80°. What is the value of θ?

Ans. Since angle of incidence is equal to angle of reflection, $\theta = 90° - 40° = 50°$.



Q.15 What is the value of θ in the following ray diagram?



Ans. 50°

Q.16 What is a rarer medium?

Ans. A medium, in which the speed of light is more, is known as optically rarer medium.

Q.17 What is the unit of refractive index?

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

Q.18 Name a point inside a lens through which the light passes undeviated.

Ans. Optical centre.

Q.19 Define the power of a lens. Give its SI unit. State whether the power of a converging lens is positive or negative.

Ans. Power of a lens is defined as the reciprocal of its focal length f (in metres)

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

The SI unit of a lens is dioptre. The power of a converging lens is positive.

Q.20 A spherical mirror and a lens both have focal length of –20 cm. What type of mirror and lens are these?

Ans. A concave mirror and concave lens have negative focal length.

Q.21 What is dioptre?

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

Q.22 What is the nature of light?

Ans. Light is an electromagnetic wave which does not require a material medium for propagation.

Q.23 What is a ray?

Ans. The path of light is called a ray.

Q.24 If the angle of incidence (i) for a light ray in air be 45° and the angle of refraction (r) in glass be 30°. Find the refractive index

Ans. Refractive index of glass, $n = \frac{\sin 45°}{\sin 30°} = \frac{1/\sqrt{2}}{1/2} = \sqrt{2}$

Q.25 A point object is 24 cm above the surface of water ($\mu = 4/3$) in a lake. A fish inside the water will observe the image to be at distance.

(A) 32 cm above the water surface **(B) 18 cm above the water surface**

(C) 6 cm above the water surface **(D) 6 cm below the water surface**

Ans. Apparent depth = $n_{dr} \times$ Real depth = $\frac{4}{3} \times 24 = 32$ cm

SECTION - B

CONCEPTUAL QUESTIONS

Q.1 State two effects caused by the refraction of light

Ans. Two effects caused by the refraction of light

(i) A stick partly immersed in water appears to be bent at the water surface.

(ii) A pool of water appears less deeper than it's actual position.

Q.2 Distinguish between real and virtual image.

Ans.

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

Q.3 If you are driving a car, what type of mirror would you prefer to use for observing traffic at your back and why?

Ans. Convex mirror, because it formes virtual, erect and diminished image of an object. Thus have larger field of view.

Q.4 Define Snell's law of Refraction.

Ans. The second law of refraction is called Snell's law of refraction. According to Snell's law "The ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for a pair of medium"

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

This constant is called refractive index.

Q.5 A convex lens of focal length 40 cm is in contact with a concave lens of focal length 25 cm. Find the power of the combination.

Ans. $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{0.4} + \frac{1}{-0.25} = \frac{1}{0.4} - \frac{1}{0.25} = \frac{0.25 - 0.4}{0.4 \times 0.25} = \frac{-0.15}{0.4 \times 0.25}$

or $\frac{1}{f} = \frac{-0.15}{0.4 \times 0.25} = -1.5 \text{ cm}$ or $P = \frac{1}{f} = -1.5$ Dioptre

Q.6 The speed of light in water 2.25×10^8 m/s. If the speed of light in vacuum be 3×10^8 m/s, calculate the refractive index of water.

Ans. Refractive index of water $= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in water}} = \frac{3 \times 10^8}{2.25 \times 10^8} = \frac{3 \times 100}{225} = 1.33$

Q.7 A person having a myopic eye uses a concave lens of focal length 50 cm. What is the power of the lens?

Ans. Focal length, f = –50 cm (concave lens)

Now, power, $P = \frac{1}{f(\text{in metre})} = \frac{1}{-50/100\ m} = -\frac{100}{50} = -2D$

Thus, the power of this concave lens is –2 dioptres.

Q.8 A glass slab placed over a page on which VIBGYOR is printed with each letter in its corresponding color.

(i) Will the image of all the letters be at same place

(ii) If not, give reason for your answer

Ans. (i) No, the image of letters of different. color will be raised by slightly different heights from each other.

(ii) Violet raised to maximum height because of refractive index of violet is maixmum. Its apparent depth will be minimum, hence maximum height.

SECTION C

NUMERICAL PROBLEMS

Q.1 An object is situated at a distance of f/2 from a convex lens of focal length f. Find the distance of the image.

Ans. For a spherical lens $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

For convex lens u = – f/2 and f is +ve

$\frac{1}{v}=\frac{1}{f}+\frac{1}{u}=+\frac{1}{f}-\frac{2}{f}=-\frac{1}{f}$ $\quad \therefore\ v=-f$

Therefore distance of image v = – f.

Q.2 An object of length 1 cm is placed at a distance of 15 cm from a concave mirror of focal length 10 cm. Find the nature and size of the image.

Ans. Given, u = – 15 cm f = –10 cm, O = 1 cm

By using mirror formula

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

$\therefore$ V = –30 cm

By magnification formula

$\frac{I}{O}=\frac{-v}{u}=-\frac{-30}{-15}=-2$

I = –2 × 1 = –2 cm

Image is real and inverted and placed on the same side of size 2 cm of mirror.

Q.3 A biconvex lens whose both the surfaces have same radii of curvature has a power of 5D. The refractive index of material of lens is 1.5. Find the radius of curvature of each surface.

Ans. $P=\frac{1}{f}$, $\quad \therefore \quad f=\frac{1}{p}=\frac{1}{5}m=20\ cm$

For an equiconvex lens

$\frac{1}{f}=\frac{2(\mu-1)}{R}$ $\quad \therefore \quad R=2(\mu-1)\ f=2\times 0.5\times 20=20\ cm$

Q.4 A lens placed at a distance of 20 cm from an object produces a virtual image 2/3 the size of the object. Find the position of the image, kind of lens and its focal lens

Ans. Virtual image means I is positive and it is given that I = (2/3)O. Thus m = + 2/3
Further because u = –20 cm (given), using

$$m = \frac{f}{f+u}$$

we get $\frac{2}{3} = \frac{f}{f+(-20)}$ or $f = -40$ cm

Thus f is negative, thus the lens is a concave lens. Again using m = v/u

we get $\frac{2}{3} = \frac{v}{-20}$ or $v = -\frac{40}{3} = -13.33$ cm

Thus virtual and erect image is formed on the same side of the object.

Q.5 The focal length of a concave mirror is 30 cm. Find the position of the object in front of the mirror, so that the image is three times the size of the object.

Ans. Here image can be real or virtual. If the image is real.

f = –30 cm, u = ?, m = –3

$$m = \frac{f}{f-u} \quad \Rightarrow \quad -3 = \frac{-30}{-30-u} \quad \Rightarrow \quad u = -40 \text{ cm}$$

If the image is virtual

$$m = \frac{f}{f-u} \quad \Rightarrow \quad 3 = \frac{-30}{-30-u} \quad \Rightarrow \quad u = -20 \text{ cm}$$

Q.6 A square ABCD of side 1 mm is kept at distance 15 cm infront of the concave mirror as shown in the figure. The focal length of the mirror is 10 cm. Find the length of the perimeter of its image.

Ans. Given that u = –15 cm, f = – 10 cm

By using mirror formula, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$\therefore \quad \frac{1}{v} = \frac{-3+2}{30}$

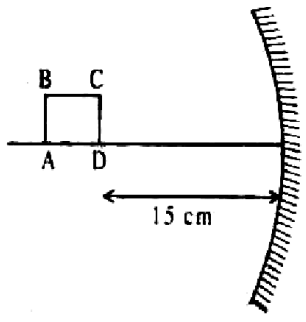
$\therefore \quad v = -30, m = -\frac{v}{u} = -2$

$\therefore \quad A'B' = C'D' = 2 \times 1 = 2$ mm

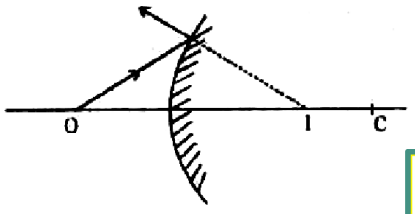
Now, $\frac{B'C'}{BC} = \frac{A'D'}{AD} = \frac{v^2}{u^2} = 4$ mm

$\Rightarrow \quad B'C' = A'D' = 4$ mm

$\therefore \quad$ Length = 2 + 2 + 4 + 4 = 12 mm



Q.7 A convex mirror has its radius of curvature 20 cm. Find the position of the image of object placed at a distance of 12 cm from the mirror.



Ans. The situation is shown in figure above.

Here, u = – 12 cm and R = + 20 cm. We have

$$\frac{1}{u}+\frac{1}{v}=\frac{2}{R} \text{ or } \frac{1}{v}=\frac{2}{R}-\frac{1}{u}$$

$$\Rightarrow \quad \frac{1}{v}=\frac{2}{20}-\frac{1}{-12}=\frac{11}{60}\text{ cm}$$

$$\Rightarrow \quad v=\frac{60}{11}\text{ cm}$$

Hence, distance of images 5.45 cm

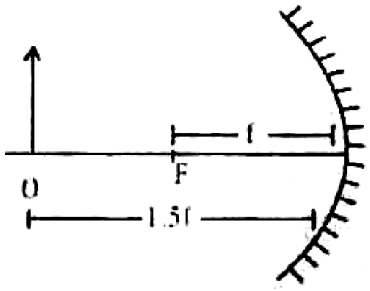
Q.8 An object of length 2.5 cm is placed at a distance of 1.5 f from a concave mirror where f is the magnitude of the focal length of the mirror. The length of the object is perpendicular to the principal axis. Find the length of the image. Is the image erect or inverted?

Ans. The given situation is shown in the figure

The focal length f = – f and u = –1.5 f , h_i = 2.5 cm

We know

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f} \quad \text{or} \quad \frac{-1}{1.5f}+\frac{1}{v}=-\frac{1}{f}$$



$$\text{or} \quad \frac{1}{v}=\frac{1}{1.5f}-\frac{1}{f}=\frac{-1}{3f} \quad \text{or} \quad v=-3f$$

Now $$m=-\frac{v}{u}=\frac{3f}{1.5f}=-2.$$

or $$\frac{h_2}{h_1}=-2.$$

or $$h_2=-2h_1=-5.0\text{ cm}$$

The image is 5.0 cm long. The minus sign shows that it is inverted.

Q.9 Sunlight is incident on a concave mirror, parallel to its principal axis. The image is formed at a distance of 12 cm from the pole. Find the radius of curvature of the mirror.

Ans. As the rays from the sun are parallel to the principal axis, they form the image at the focus. Thus, the focal length of the mirror is 12 cm. The radius of curvature will be twice the focal length, i.e. 24 cm

Q.10 An object is placed at a distance of 20 cm from a convex mirror of focal length 25 cm. Calculate the position of the image. Discuss its nature.

Ans. Here, u = 20 cm and f = 25 cm

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

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{25\,cm}-\frac{1}{-20\,cm}=\frac{9}{100\,cm}$$

$$v=\frac{100}{9}\ cm=11.11\ cm$$

The positive sign of v shows that the image is formed on the right i.e. behind the mirror. The image is virtual. Also,

$$m=-\frac{v}{u}=-\frac{11.11}{-20}=+0.55$$

Since the magnification, and hence, the height of the image is positive, the image is erect.

Q.11 A 2.0 cm high object is placed at a distance of 20 cm from a concave mirror. A real image is formed at 40 cm from the mirror. Calculate the focal length of the mirror and the size of the image.

Ans. As the image is real, it is formed on the same side as the reflected rays.

Here, u = – 20 cm and v = –40 cm

Thus, $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}=\frac{1}{-20\,cm}+\frac{1}{-40\,cm}$ or f = – 13.3 cm

The magnification is, $m=-\frac{v}{u}=-\frac{-40\ cm}{-20\,cm}=-2.0\ cm$

The height of the image is 4.0 cm, and the negative sign of $h_e = -2h_o = -2 \times 2.0\ cm = -4.0\ cm$

The height of the image is 4.0 cm, and the negative sign of h_e shows that the image is inverted.

Q.12 Find the position, size and the nature of the image formed by a spherical mirror from the following data

u = – 20 cm, f = –15 cm, h_o = 1.0 cm

Ans. We have $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

or $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-15}-\frac{1}{-20\,cm}=\frac{-1}{60cm}$

or v = –60 cm

The image is formed at 60 cm from the mirror. Since the sign of u and v are the same, the image is on the same side as the object (to the left of the mirror) and hence, is real. The magnification is

$$m=\frac{h_i}{h_o}=-\frac{v}{u}=-\frac{-60\,cm}{-20\,cm}=-3$$

So $h_i = -3h_0 = -3 \times 1.0\ cm = -3.0\ cm$

The minus sign shows that the image is inverted. Its size is 3.0 cm.

Q.13 A 2 cm high object is placed at a distance of 32 cm from a concave mirror. The image is real, inverted and 3 cm in size. Find the focal length of the mirror and the position of the image.

Ans. We have $m = -\frac{v}{u} = \frac{h_i}{h_o}$

From the question $h_e = -3$ cm and $h_o = 2$ cm

$$\therefore \quad m = \frac{h_i}{h_o} = \frac{-3\,cm}{2\,cm} = -1.5 \quad \text{or} \quad -\frac{v}{u} = -1.5$$

$$\text{or} \quad \frac{v}{-32\,cm} = 1.5 \quad \text{or} \quad v = -48 \text{ cm}$$

$$\text{We have } \frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{-32\,cm} + \frac{1}{-48\,cm} = \frac{-5}{96\,cm}$$

$$\text{or} \quad f = \frac{-96\,cm}{5} = -19.2 \text{ cm}$$

So the focal length of the concave mirror is 19.2 cm, and the image is formed 48 cm in front of it .

Q.14 A concave mirror forms an inverted image of an object placed at a distance of 12 cm from it. If the image is twice as large as the object, where is it formed.

Ans. From the question

$$\frac{h_i}{h_o} = -2 \text{ (inverted image)}$$

$$\text{But} \quad \frac{h_i}{h_o} = -\frac{v}{u}$$

$$\frac{v}{u} = 2$$

or $v = 2u = 2(-12 \text{ cm}) = -24$ cm

The image is formed 24 cm in front of the mirror.

Q.15 A concave mirror forms an erect image of an object placed at a distance of 10 cm from it. The size of the image is double that of the object. Where is the image formed ?

Ans. From the question,

$$\frac{h_i}{h_o} = +2 \text{ (erect image)}$$

$$\text{or} \quad -\frac{v}{u} = 2 \quad \text{or} \quad v = -2u = -2(-10 \text{ cm}) = +20 \text{ cm}$$

Thus the image is formed 20 cm behind the mirror (from the positive sign of v)

Q.16 A concave lens of glass, refractive index 1.5 has both surfaces of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a

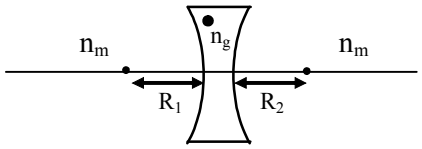
(A) convergent lens of focal length 3.5 R (B) convergent lens of focal length 3.0 R

(C) divergent lens of focal length 3.5 R (D) divergent lens of focal length 3.0 R

Ans. According to lens maker's formula

$$\frac{1}{f} = (n_{gm} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \text{Now, } n_{gm} = \frac{n_g}{n_m} = \frac{1.5}{1.75}$$

For concave lens as shown in figure in this case $R_1 = -R$ and $R_2 = R$



$$\therefore \frac{1}{f} = \left(\frac{1.5}{1.75} - 1\right)\left(-\frac{1}{R} - \frac{1}{R}\right) = +\frac{0.25 \times 2}{1.75R}$$

or $f = +3.5\ R$

The positive sign shows that the lens behaves as convergent lens.

Q.17 A ray of light travelling in air falls on the surface of a rectangular slab of a plastic material whose refractive index is 1.6. If the incident ray makes an angle of 53° with the normal, find the angle made by the refractive ray with the normal (sin 53° = 4/5).

Ans. The angle of incidence is 53° and the refractive index is n = 1.6.

We have, $\frac{\sin i}{\sin r} = n$ or $\sin r = \frac{\sin i}{n}$

or $\frac{\sin 53°}{1.6} = \frac{4}{5 \times 1.6} \Rightarrow \sin r = \frac{1}{2}$ or $r = 30°$

Q.18 Find the refractive index of glass with respect of water. The refractive indices of these with respect to air are 3/2 and 4/3 respectively.

Ans. We have $n_{21} = \frac{n_2}{n_1}$. Here, glass is the second medium

Here $n_2 = \frac{3}{2}, n_1 = \frac{4}{3},$ So, $n_{21} = \frac{9}{8}$

Q.19 A point object is placed at a distance of 12 cm from a convex lens on its principal axis. Its image is formed on the other side of the lens at a distance of 18 cm from the lens. Find the focal length of the lens.

Ans. According to convention, let the object be on the left of the lens. Therefore u is negative, i.e.u = –12 cm. Since the image is on the other side, it is formed on the right of the lens. Thus v is positive, i.e. v = +18 cm. (you can also say that since u is measured opposite to the direction of the incident ray, it is negative. And since v is measured along the direction of the incident rays, it is positive)

We have, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

or $\frac{1}{f} = \frac{1}{18\,cm} - \frac{1}{-12\,cm} = \frac{5}{36\,cm}$ or $f = \frac{36}{5}\ cm = 7.2\ cm$

Q.20 The image of an object formed by a convex lens is of the same size as the object. If the image is formed at a distance of 40 cm, find the focal length of the lens. Also find the power of the lens. At what distance from the lens is the object placed?

Ans. A same sized image is formed when an object is placed at a distance of 2f from the convex lens. The image is formed at a distance of 2f from the lens. Here this distance is given as 40 cm. So

$2f = 40\ cm$ or $f = 20\ cm$

Power $p = \frac{1}{f} = \frac{1}{0.2\,m} = 5\ D$

The object is placed at a distance of $2f = 40$ cm from the lens .

Q.21 An object is placed on the principal axis of a concave lens at a distance of 20 cm from it. If the focal length of the lens is also 20 cm, find the location of the image.

Ans. Given $u = -20$ cm, $f = -20$ cm

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

or $\frac{1}{v} - \frac{1}{-20\,cm} = \frac{1}{-20\,cm}$

or $\frac{1}{v} = \frac{1}{-20\,cm} + \frac{1}{-20\,cm} = \frac{-1}{10}$ or $v = -10$ cm.

Thus, the image is formed at a distance of 10 cm from the lens. As v has turned out to be negative, the image just be on the left of the lens.

Q.22 A beam of light travelling parallel to the principal axis of a concave lens appears to diverge from a point 20 cm behind the lens after passing through the lens. Find the power of the lens.

Ans. By definition, the point from where the beam appears to diverge is the focus of the lens. Thus the focal length is 20 cm. As it is a concave lens, f is negative

$f = -20\ cm = -0.2\ m$

The power is $P = \frac{1}{f} = \frac{1}{-0.2\,m} = -5\ D$

Q.23 A convex lens of power 4 D is placed at a distance of 40 cm from a wall. At what distance from the lens should a candle be placed so that its image is formed on the wall ?

Ans. Here, $f = \frac{1}{P} = \frac{1}{4\,D} = \frac{1}{4}m = 25\,cm$, and $v = +40$ cm

We have $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ or $\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{40} - \frac{1}{25} = -\frac{3}{200\,cm}$

So the candle should be placed $\frac{-200}{3}$ cm from the lens

Q.24 A pin which is 2 cm long is placed at a distance of 16 cm from a convex lens. Assuming it to be perpendicular to the principal axis, find the position, size and the nature of the image if the focal length of the lens is 12 cm.

Ans. Here u = –16 cm and f = + 12 cm

We have $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ or $\frac{1}{v}=\frac{1}{u}+\frac{1}{f}=\frac{1}{-16\,cm}+\frac{1}{12\,cm}=\frac{1}{48}$

or $v = + 48$ cm

The image is formed 48 cm from the lens on the side of the transmitted rays. The image is therefore real. The magnification is

$$m=\frac{v}{u}=\frac{48\,cm}{-16\,cm}=-3 \quad \text{or} \quad \frac{h_i}{h_o}=-3$$

or $h_i = –3h_o = –3 \times 2$ cm = –6 cm

The image is inverted and is 6 cm in size. So an inverted and real image of size 6 cm is formed 48 cm from the lens.

Q.25 A 4.0 cm high object is place at a distance of 60 cm from a concave lens of focal length 20 cm. Find the size of the image.

Ans. We have f = – 20 cm and u = –60 cm

For a lens $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

or $\frac{1}{v}=\frac{1}{u}+\frac{1}{f}=\frac{1}{-60\,cm}+\frac{1}{-20\,cm}=-\frac{1}{15\,cm}$

or $v = – 15$ cm

The magnification is

$$m=\frac{h_i}{h_o}=\frac{v}{u}=\frac{-15\,cm}{-60\,cm}=\frac{1}{4} \quad \text{or} \quad h_i=\frac{h_0}{4}\Rightarrow\frac{4.0\,cm}{4}=1.0\text{ cm}$$

So the image is 1.0 cm high. The positive sign shows that it is erect.

Q.26 A convex lens of focal length 20 cm is placed in contact with a concave lens of focal length 12.5 cm in such a way that they have the same principal axis. Find the power of combination.

Ans. $P = P_1 + P_2$

Here $P_1=+\frac{1}{20\,cm}=+\frac{1}{0.20\,m}=5D$

and $P_2=\frac{1}{125\,cm}=-\frac{1}{0.125\,m}=-8D$

So the power of the combination is $P_1 + P_2 = –3$ D.

Q.27 A plane mirror is approaching you at 10 cm/sec. You can see your image in it. At what speed will your image approach you.

Ans. Relative speed of image with respect to person/observer = 2 × Speed of object with respect to mirror
= 2 × 10 cm/sec = 20 cm/sec.

Q.28 Two mirrors are kept at 72° to each other and a body is placed at middle. Find the total number of images formed?

Ans. Here, $\frac{360}{\theta} = \frac{360}{72} = 5$

$\because \frac{360}{\theta}$ is odd integer and placement is symmetrical.

So, number of images = $\frac{360}{\theta} - 1 = 5 - 1 = 4$.

Q.29 An object is placed in front of a concave mirror of radius of curvature 40 cm at a distance of 10 cm. Find the position, nature and magnification of the image.

Ans. Here, R = –40 cm, u = –10 cm

Focal length of concave mirror,

$$f = \frac{R}{2} = -\frac{40}{2} = -20 \text{ cm}$$

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

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = -\frac{1}{20} - \frac{1}{(-10)} = -\frac{1}{20} + \frac{1}{10} = \frac{-1+2}{20} = \frac{1}{20}$$

$\therefore$ v = +20 cm

Thus position of the image is at 20 cm to the right side of the pole of the mirror.

Since v is positive, so virtual image is formed.

$$m = -\frac{v}{u} = \frac{-20}{(-10)} = 2 \quad \text{Since, } m = \frac{I}{O} = 2$$

$\therefore$ I = 2 × O

Therefore, size of image is double than the size of the object, Moreover image is erect.

Q.30 An object is situated at a distance of 15 cm from a convex lens of focal length 30 cm. Find the position of the image formed by it.

Ans. u = –15 cm, f = 30 cm, v = ?

$$\because \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{30} - \frac{1}{15} = \frac{1-2}{30}$$

or $\frac{1}{v} = -\frac{1}{30}$ or v = –30 cm

Q.31 Find the time taken by light in travelling a water column of length 1000 m if the refractive index of water is 4/3.

Ans. $n_{aw} = \frac{v_a}{v_w}$

$\therefore \quad v_w = \frac{v_a}{n_{aw}} = \frac{3\times10^8}{4/3}$ or $v_w = 2.25 \times 10^8$ m/s

or $t = \frac{d}{v_w} = \frac{1000}{2.25\times10^8}$ or $t = 4.4 \times 10^{-6}$ sec.

Q.32 A rectangular glass slab of thickness 8 cm is placed on a figure. Eye is kept exactly above this slab. If the refractive index of glass is 1.6, then the figure will appear to raised by
(A) 8 cm (B) 2.4 cm (C) 4.2 cm (D) 3 cm

Ans. Let the figure get raised by d cm on placing the slab, then its apparent depth will be (8–d) cm

$$n_{ag} = \frac{real\ depth}{apparent\ depth}$$

$$1.6 = \frac{8}{8-d}$$

or $1.6(8–d) = 8$ or $12.8 – 1.6\ d = 8$

or $d = \frac{4.8}{1.6} = 3$ cm

Q.33 The focal length of a convex lens is 10 cm and its refractive index is 1.5. If the radius of curvature of one surface is 7.5 cm. Find the radius of curvature of the second surface.

Ans. We know,

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

f = 10 cm, R_1 = 7.5 cm, n = 1.5

or $\frac{1}{10} = (1.5-1)\left(\frac{1}{7.5} - \frac{1}{R_2}\right)$

or $R_2 = –15$ cm

Q.34 Find the size, nature and position of image formed when an object of size 1 cm is placed at a distance of 15 cm from a concave mirror of focal length 10 cm.

Ans. Given that :
Object size = 1 cm
Object distance u = –15 cm
Focal length f = –10 cm

By using mirror formula, $\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{-1}{10}+\frac{1}{15}=\frac{-3+2}{30}=\frac{-1}{30}$

$\therefore$ v = –30 cm

Magnificatiion $m=\frac{-v}{u}=\frac{h_i}{n_0}$

$\Rightarrow \frac{-(-30)}{-15}=\frac{h_i}{h_0} \Rightarrow h_i=\frac{-30}{15}\times 1=-2$ cm

Image distance is at 30 cm in same side of mirror which is real and inverted. Image size is larger than object.

Q.35 A concave mirror of focal length 10 cm is placed at a distance of 25 cm from a wall. How far from the wall an object be placed so that its image formed by the mirror falls on the wall?

Ans. Given that focal length (f) = –10 cm
image distance (v) = –25 cm
object distance (u) = ?
by using mirror formula

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

$\Rightarrow \frac{1}{u}=-\frac{1}{10}-\left(-\frac{1}{25}\right)=\frac{1}{10}+\frac{1}{25}=\frac{-5+2}{50}$

$\therefore u=\frac{-50}{3}$ cm = – 16.66 cm

Object distance is 16.66 cm from the mirror.

Q.36 An object is placed at a distance of 15 cm from a convex mirror of focal length 30 cm. Find the position and the nature of the image.

Ans. Given that object distance u = – 15 cm
focal length f = +30 cm
By mirror formula,

$\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{v}-\frac{1}{15}=\frac{1}{30}$

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

$\therefore$ v = + 10 cm
Therefore image distance is 10 cm behind the mirror.

Q.37 A convex mirror used for rear-view on an automobile has a radius of curvature of 3 m. If a bus is located at 5 m from this mirror, find the position, nature and size of the image.

Ans. Given that radius of curvature (R) = 3 m

$\therefore$ Focal length = $\frac{R}{2} = \frac{3}{2} = 1.5$ m

object distance = – 5 cm

Position of image (v) = ?

By using mirror formula,

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

$$\Rightarrow \quad \frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{2}{3}-\left(\frac{-1}{5}\right)=\frac{2}{3}+\frac{1}{5}=\frac{10+3}{15}=\frac{13}{15}$$

$$\therefore \quad v=\frac{15}{13}=1.15 \text{ cm}$$

Thus, Image is placed at a distance of 1.15 cm behind the mirror which is virtual & erect

New magnification $m = -\frac{v}{u} = \frac{-1.15}{-5} = 0.23$

Then image size is a factor of 0.23 by the object size.

Q.38 An object 4 cm in size is placed at 25 cm in front of a concave mirror of focal length 15 cm. At what distance from the mirror should a screen by placed in order to obtain a sharp image? Find the nature and the size of this image.

Ans. Given that size of object $h_0 = 4$cm

object distance = –25 cm = u

focal length f = – 15 cm

By using mirror formula,

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

$$\Rightarrow \quad \frac{-1}{15}-\left(\frac{-1}{25}\right)=\frac{-1}{15}+\frac{1}{25}=\frac{-5+3}{75}=\frac{-2}{75}$$

$$\therefore \quad v=\frac{-75}{2}=-37.5 \text{ cm}$$

This image is formed at a distance of 37.5 cm from the mirror which is same side of object. It is real and inverted.

By using magnification

$$m=\frac{-v}{u}=\frac{h_i \text{ (height of image)}}{h_0 \text{(height of object)}} \qquad \Rightarrow \qquad \frac{h_i}{h_0}=\frac{-v}{u}$$

$$h_i=\frac{-v}{u}\times h_0=\frac{-(-37.5)}{-25}\times 4=6 \text{ cm}$$

Image size is larger than the object size.

Q.39 Light of wavelength 6000 Å in air enters a medium of refractive index 1.5. What will be the frequency in the medium?

Ans. Given that wavelength $\lambda = 6000Å$
refractive index $\mu = 1.5$
frequency = ?
By using formula,
$\because$ $C = f.\lambda$ where c is speed of light.

$$\therefore \quad f = \frac{c}{\lambda} = \frac{3\times10^{8}}{6\times10^{-7}} = 0.5 \times 10^{15}$$

Frequency (f) = 5×10^{14} Hz

Q.40 If the refractive index of water for light going from air to water be 1.33, what will be the refractive index for light going from water to air?

Ans. Refractive index of water with repect to air

$$\mu_w{}^a = 1.33 = \frac{4}{3}$$

$$\therefore \quad \mu_a{}^w = \frac{1}{\mu_w^a} = \frac{1}{\frac{4}{3}} = \frac{3}{4} = 0.75$$

Q.41 Refractive index of water is 4/3 and glass is 3/2 with regard to air. What is the refractive index of glass with respect to water?

Ans. Refractive Index of water $= \frac{4}{3} = \mu_g$

Refractive index of glass $= \frac{3}{2} = \mu_w$

$\therefore$ R.I of glass with respect to water $= \frac{\mu_w}{\mu_g} = \frac{3}{2}\Big/\frac{4}{3} = \frac{9}{8}$

Q.42 Light of wavelength of 500 nm in air, enters a glass plate of refractive index 1.5. Find (i) speed (ii) frequency and (iii) wavelength of light in glass. Assume that the frequency of light remains the same in both media.

Ans. Given that wavelength $(\lambda) = 500 \times 10^{-9}$ m
Refractive index of glass plate $(\mu) = 1.5$
To find speed, frequency & wavelength.

(i) $$\mu = \frac{c}{v} \quad \frac{\text{(speed of light in air / vaccum)}}{\text{(speed of light in medium)}}$$

$$1.5 = \frac{3\times10^{8}}{v} \qquad \Rightarrow \qquad v = \frac{3\times10^{8}}{1.5} = 2\times 10^{8} \text{ m/s.}$$

(ii) Since, velocity = frequency × wavelength

$$\Rightarrow \quad f = \frac{v}{\lambda} = \frac{2\times10^{8}}{500\times10^{-9}} = 0.4\times10^{15}\ \text{Hz}$$

(iii) Refractive index $(\mu) = \frac{f(\lambda_a)}{f(\lambda_g)}$

$$1.5 = \frac{500\times10^{-9}}{\lambda_g}$$

$$\Rightarrow \quad \lambda_g = \frac{500\times10^{-9}}{1.5} = 333.33\ \text{nm}$$

Q.43 A needle placed 45 cm from the lens forms an image on a screen placed 98 cm on the other side of the lens. Identify the type of the lens and determine its focal length.

Ans. Given that object (needle) distance (u) = – 45 cm

Screen placed or image formed at a

distance (v) = 98 cm

focal length (f) = ?

By using lens formula,

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

$$\frac{1}{f} = \frac{1}{98}+\frac{1}{45} = \frac{45+98}{98\times45}$$

$\therefore \quad f = +30.8$ cm

Focal length positive then lens is convex in nature.

Q.44 A concave lens has a focal length of 10 cm. An object 2.5 cm high is placed at 30 cm from the lens. Determine the position and size of the image.

Ans. Given that focal length (f) = – 10 cm

object height $(h_0) = 2.5$ cm

object distance u = –30 cm

by using lens formula

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

$$\Rightarrow \quad \frac{1}{v}=\frac{1}{f}+\frac{1}{u} = \frac{-1}{10}-\frac{1}{30} = \frac{-4}{30}$$

$$\therefore \quad v = \frac{-30}{4} = -7.5\ \text{cm}$$

$$\text{magnification (m)} = \frac{v}{u} = \frac{h_i\,(\text{image size})}{h_0\,(\text{ojbect size})}$$

$$\Rightarrow \quad \frac{-7.5}{-30} = \frac{h_i}{2.5} \qquad \Rightarrow \quad h_i = \frac{5}{8}\ \text{cm}$$

Q.45 A real image 4/5 size of the object is formed 18 cm from a lens. Calculate the focal length of the lens.

Ans. Given that image size = $\frac{4}{5}$ times of object size.

$$\Rightarrow \quad h_i = \frac{4}{5} h_0 \qquad \Rightarrow \quad \frac{h_i}{h_0} = \frac{4}{5}$$

$\because$ magnification (m) = $\frac{v}{u} = \frac{h_i}{h_0}$

$$\Rightarrow \quad \frac{4}{5} = \frac{18}{-u} \qquad \Rightarrow \quad u = \frac{-18 \times 5}{4} = -22.5 \text{ cm}$$

u is object disatnce

Now by using lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \qquad \Rightarrow \quad \frac{1}{18} - \left(\frac{-1}{22.5}\right) = \frac{1}{f} \qquad (\because \text{Image distance } v = 18 \text{ cm})$$

$$\Rightarrow \quad \frac{1}{f} = \frac{1}{18} + \frac{1}{22.5} = \frac{1}{10}$$

$\therefore$ focal length = 10 cm

Q.46 A 5 cm tall object is placed on the principal axis of a convex lens of focal length 50 cm at a distance of 40 cm from it. Find the nature, position and size of the image.

Ans. Given that : Object height $h_0 = 5$cm
Focal length f = 50 cm
Object distance v = –40 cm

By using lens formula, Image height = h_i = ?
Image distance = v ?

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

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

$$\Rightarrow \quad \frac{1}{50} + \left(\frac{-1}{40}\right) = \frac{1}{50} - \frac{1}{40} = \frac{4-5}{200} = \frac{-1}{200}$$

$\therefore$ v = –200 cm

Therefore image formed at a distance of 200 cm from the lens.

by magnification m = $\frac{v}{u} = \frac{h_i}{h_O}$

$$\Rightarrow \quad \frac{v}{u} = \frac{h_i}{h_O} = \frac{h_i}{5} \qquad \Rightarrow \quad h_i = 5 \times 5 = +25 \text{ cm}$$

Image is 25 cm tall which is virtual & erect.

Q.47 A 5 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 20 cm. The distance of the object from the lens is 30. Find the (i) position and (ii) nature of the image formed.

Ans. Given that Object height $h_0 = 5$cm
Focal length $f = 20$ cm
Object distance $u = -30$ cm

To find (i) Position of image $v = ?$
(ii) Nasture of image $= ?$

(i) By using lens formula,

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

$$\Rightarrow \quad \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{20} + \left(\frac{-1}{30}\right) = \frac{3-2}{60} = \frac{1}{60}$$

$$\frac{1}{v} = \frac{1}{60}$$

The image is situated 60 cm on the other side of the lens.

(ii) Image formed real and Inverted.

Q.48 A 2 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 10 cm. The distance of the object from the lens is 15 cm. Find the nature, position and size of the image. Also find its magnification.

Ans. Given that : Object height $h_0 = 2$ cm
(f) focal length $= +10$cm
(u) object distance $= -15$ cm

By using lens formula,

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

$$\Rightarrow \quad \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} - \frac{1}{15} = \frac{3-2}{30}$$

$$\Rightarrow \quad \frac{1}{v} = \frac{1}{30} \qquad \therefore v = 30 \text{ cm}$$

Image is formed at a distance of 30 cm behind the lens.

Now, magnification $= \frac{v}{u} = \frac{h_i}{h_0}$

$$\Rightarrow \quad \frac{30}{-15} = \frac{h_i}{2} \qquad \Rightarrow \quad h_i = -4 \text{ cm}$$

The image size is 4 cm which is real and inverted.

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

$$\Rightarrow \quad m = -2$$

Q.49 A convex lens has focal length of 20 cm. Calculate at what distance from the lens should the object be placed so that the image is formed at 40 cm on the other side of the lens? Also state the nature of the image formed.

Ans. Here, $f = 20$ cm, $v = 40$ cm, $u = ?$

Step 1: Using $-\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$,

we have $-\frac{1}{u}=\frac{1}{f}-\frac{1}{v}=\frac{1}{20}-\frac{1}{40}$ or $-\frac{1}{u}=\frac{1}{40}$ or $u=-40$ cm

Thus, the object should be placed at a distance of 40 cm in front of the convex lens.

Step 2: $m=\frac{v}{u}=\frac{40}{-40}=-1$

Negative sign shows that the image is real and inverted (Nature of image).

Q.50 An object 4 cm high is placed at a distance of 27 cm in front of a convex lens of focal length 18 cm. Find the position, nature and size of the image formed.

Ans. Here, $u = -27$ cm (sign convention), $f = 18$ cm, $h = 4$ cm

Step 1: Determination of 'v'

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

we get $\frac{1}{(-27)}+\frac{1}{v}=\frac{1}{18}$ or $\frac{1}{v}=\frac{1}{18}-\frac{1}{27}=\frac{1}{54}$

$\therefore$ $v = 54$ cm (Position of image)

Step 2 : Determination of h'

Using, $\frac{h'}{h}=\frac{v}{u}$

we get, $h'=\frac{v}{u}\times h=\frac{54}{-27}\times 4=-8.0$ cm

Thus, size of image is 8 cm. Negative sign shows that the image is **inverted**.

Q.51 A 4.0 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 20 cm. If the distance of the object is 30 cm from the lens, find the position, nature and size of the image. Also find its magnification.

Ans. Here, $h = 4.0$ cm, $f = 20$ cm; $u = -30$ cm, $h' = ?$, $v = ?$, $m = ?$

Step 1: Determination of v

Using lens formula $-\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

we have $-\frac{1}{(-30)}+\frac{1}{v}=\frac{1}{20}$

or $\frac{1}{v}=\frac{1}{20}-\frac{1}{30}$ or $\frac{1}{v}=\frac{1}{60}$ or $v = +60$ cm

Thus, the image is formed at 60 cm on other side (i.e. right side) of the lens.

Step 2: Determination of h'

Using, $\frac{h'}{h} = \frac{v}{u}$

We have $h' = \frac{v}{u}h = \frac{60}{-30} \times 4 = -8.0 \text{ cm}$

Thus, size of the image is 8.0 cm. Negative sign shows that the image is inverted.
So, a real and inverted image of large size is formed.

Step 3: Determination of Magnification

Using, $m = \frac{h'}{h}$

we get, $m = \frac{-8.0 \text{ cm}}{4.0 \text{ cm}} = -2$

Q.52 A concave lens of focal length 20 cm forms an image at a distance of 10 cm from the lens. What is the distance of the object from the lens? Also draw ray diagram.

Ans. Here, $f = -20$ cm (Sign convention), $v = -10$ cm ($\because$ image formed by concave lens is virtual)

Step 1: Using lens formula $-\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

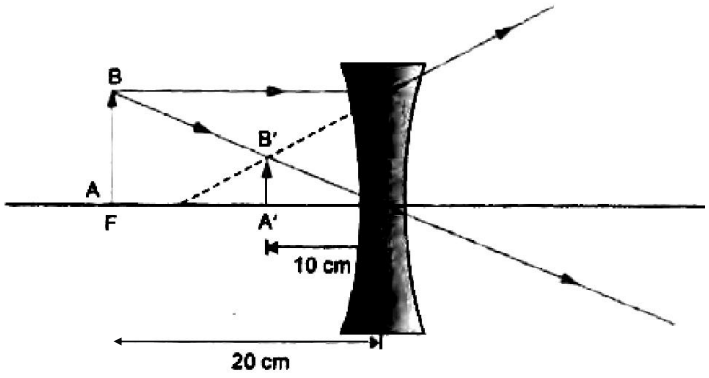
We have, $-\frac{1}{u} - \frac{1}{10} = -\frac{1}{20}$

$\Rightarrow -\frac{1}{u} = \frac{-1}{20} + \frac{1}{10}$

or $u = -20$ cm

Thus, the object is placed at 20 cm from the concave lens.

Step 2:



Q.53 What will be the focal length of a lens whose power is given as + 2.0 D?

Ans. Here, $P = 2.0$ D

Using $P = \frac{1}{f(\text{in m})}$ we get, $f = \frac{1}{P} = \frac{1}{2} = 0.5 \text{ m} = 50 \text{ cm}$

Q.54 What is the power of a convex lens of focal length 40 cm?

Ans. Here, $f = 40$ cm

Using $P = \dfrac{100}{f(\text{in cm})}$ we get, $f = \dfrac{100}{40} = +2.5$ D

Q.55 (a) Two lenses have power of (i) + 2D, (ii) –4D. What is the nature and focal length of each lens?

(b) An object is kept at a distance of 100 cm from each of above lenses. Calculate (i) image distance, (ii) magnification in each of the two cases.

Ans. (a) (i) $P = +2$D. Since power is positive, so the lens is convex lens.

Focal length, $f = \dfrac{1}{P} = \dfrac{1}{2} = 0.5$ m $= 50$ cm

(ii) $P = -4$D. Since power is negative. So the lens is concave lens.

Focal length, $f = \dfrac{1}{P} = \dfrac{1}{-4} = -0.25$ m $= -25$ cm

(b) (i) Here, $u = -100$ cm (sign convention)

1st case : $f = 50$ cm

Using $-\dfrac{1}{u} + \dfrac{1}{v} = \dfrac{1}{f}$

We get, $\dfrac{1}{v} = \dfrac{1}{f} + \dfrac{1}{u} = \dfrac{1}{50} - \dfrac{1}{100} = \dfrac{1}{100}$

or $v = 100$ cm

2nd case : $f = -25$ cm

Using $-\dfrac{1}{u} + \dfrac{1}{v} = \dfrac{1}{f}$

We get, $\dfrac{1}{v} = \dfrac{1}{f} + \dfrac{1}{u} = -\dfrac{1}{25} - \dfrac{1}{100} = \dfrac{-5}{100} = \dfrac{-1}{20}$

or $v = -20$ cm

(ii) $m = \dfrac{v}{u}$

1st case : $u = -100$ cm, $v = 100$ cm

$\therefore$ $m = \dfrac{100 \text{ cm}}{-100 \text{ cm}} = -1$

2nd case : $u = -100$ cm, $v = -20$ cm

$\therefore$ $m = \dfrac{-20 \text{ cm}}{-100 \text{ cm}} = \dfrac{1}{5} = 0.2$

Q.56 An object of size 5 cm is kept at a distance 25 cm from the optical centre of a converging lens of focal length 10 cm. Calculate the distance of the image from the lens and size of the image.

Ans. Here, size of object, h = 5 cm, u = –25 cm (sign convention), f = 10 cm (sign convention)

Step 1: Using $-\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

We get, $\frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{10}-\frac{1}{25}=\frac{3}{50}$

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

Thus, image distance = 16.67 cm

Step 2: $m=\frac{h'}{h}=\frac{v}{u}$

$h'=\frac{v}{u}\times h=\frac{50}{3\times(-25)}\times 5=-\frac{10}{3}=-3.33 \text{ cm}$

Thus, size of image = 3.33 cm. Negative sign show that image is inverted.

Q.57 A concave lens has focal length of 20 cm. At what distance from the lens, a 5 cm tall object be placed so that it formed an image at 15 cm from the lens? Also calculate the size of the image formed.

Ans. Here, f = –20 cm (sign convention), h = 5 cm, v = – 15 cm (sign convention), u = ?, h' = ?

Step 1: Using $-\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

We get, $-\frac{1}{u}-\frac{1}{15}=-\frac{1}{20}=\frac{1}{u}=\frac{1}{20}-\frac{1}{15}=\frac{3-4}{60}$

or $\frac{1}{u}=-\frac{1}{60} \qquad \therefore \qquad -u=60 \text{ cm}$

Thus, object should be placed at a distance of 60 cm from the lens to the left side.

Step 2: Using $m=\frac{h'}{h}=\frac{v}{u}$

$h'=\frac{v}{u}\times h=\frac{-15}{-60}\times 5 \text{ cm}=1.25 \text{ cm}$

$\therefore$ Size of image = 1.25 cm

Q.58 An object 50 cm tall is placed on the principal axis of a convex lens. A 20 cm tall image is formed on the screen placed at a distance of 10 cm from the lens. Calculate the focal length of the lens.

Ans. Here, h = 50 cm, h' = –20 cm (sign convention), v = 10 cm, f = ?

Step 1: Using $\frac{h'}{h} = \frac{v}{u}$

we get $\frac{-20}{50} \times \frac{10}{u}$ or $u = -\frac{10 \times 50}{20} = -25$ cm

Step 2: Using $-\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

we get, $\frac{1}{25} + \frac{1}{10} = \frac{1}{f}$

or $\frac{1}{f} = \frac{2+5}{50} = \frac{7}{50}$ or $f = \frac{50}{7} = 7.14$ cm

Thus, focal length of the convex lens = 7.14 cm

SECTION D

PREVIOUS YEAR VERY SHORT ANSWER QUESTION (1 Mark)

Q.1 To find the focal length of a concave mirror, Sita should choose which one of the following set-ups? **[CBSE - 2011]**

(A) A mirror holder and a screen holder.
(B) A screen holder and a scale.
(C) A mirror holder, a screen holder and a scale.
(D) A screen, a mirror, holders for them and a scale.

Q.2 By using a convex lens, a student obtained a sharp image of his class-room window grill on a screen. In which direction should he move the lens to focus a distant tree instead of the grill? **[CBSE - 2007,11]**

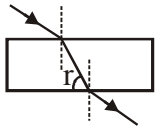
(A) Towards the screen (B) Away from the screen
(C) Very for away from the screen (D) Behind the screen

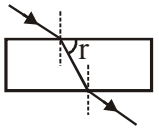
Q.3 To determine the focal length of a convex lens by obtaining a sharp image of a distant object, the following steps were suggested which are given in proper sequence: **[CBSE - 2007, 11]**

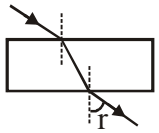
(I) Hold the lens between the object and the screen.
(II) Adjust the position of the lens to form a sharp image.
(III) Select a suitable distant object.
(IV) Measure the distance between the lens and the screen.
The correct sequence of steps to determine the focal length of the lens is

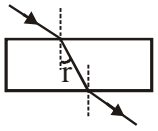
(A) III, I, II, IV (B) III, I, IV, II (C) III, IV, II, I (D) I, II, III, IV

Q.4 In these diagrams, the angle of refraction r has been correctly marked? **[CBSE - 2007, 11]**

(I) 

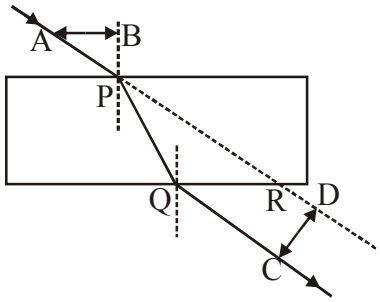
(II) 

(III) 

(IV) 

(A) I (B) II (C) III (D) IV

Q.5 For a ray of light passing through a glass slab **[CBSE - 2011]**



the lateral displacement was correctly measured as

(A) AB (B) PQ (C) CD (D) PR

Q.6 The steps involved in observing a slide under a microscope are given below. They are not in proper sequence. **[CBSE - 2011]**

(I) Focus the object under high power of the microscope.
(II) Place the slide on the stage of the microscope.
(III) Arrange the mirror to reflect maximum light to the slide.
(IV) Focus the object under low power of the microscope.

The proper sequence of steps is

(A) II, III, IV, I (B) I, II, III, IV (C) IV, III, II, I (D) III, I, II, IV

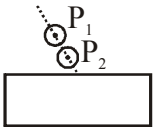
Q.7 A student has to determine the focal length of a concave mirror by obtaining the image of a distant object on screen. For getting best result he should focus **[CBSE - 2012]**

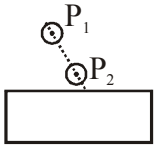
(A) A distant tree or an electric pole
(B) A well-illuminated distant building
(C) Well-lit grills of the nearest window
(D) A burning candle placed at the distant edge of the laboratory table

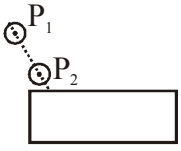
Q.8 If you have to determine the focal length of a convex lens, you should have **[CBSE - 2012]**

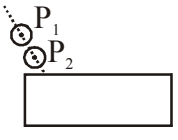
(A) A convex lens and a screen
(B) A convex lens and a lens holder
(C) A lens holder, a screen holder and a scale
(D) A convex lens, a screen, holders for them and a scale

Q.9 While performing the experiment on tracing the path of a ray of light through a rectangular glass slab, in which of the following experimental set-ups is a student likely to get best results? P_1 and P_2 are the positions of pins fixed by him. **[CBSE - 2007,11,13,14]**

(I) 

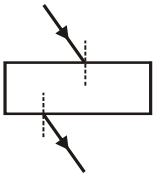
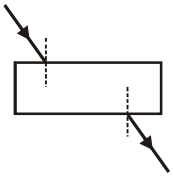
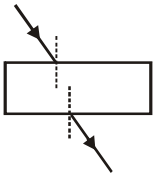
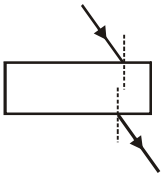
(II) 

(III) 

(IV) 

(A) I (B) II (C) III (D) IV

Q.10 Four students showed the following traces of the path of a ray of light passing through a rectangular glass slab. **[CBSE - 2007,11,12]**

(I)  (II)  (III)  (IV) 

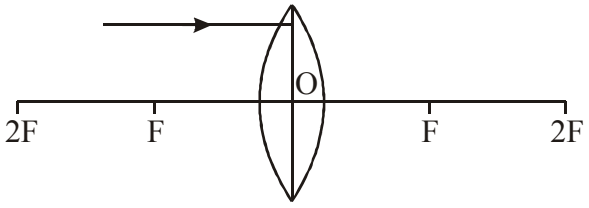
The trace most likely to be correct is that of student.

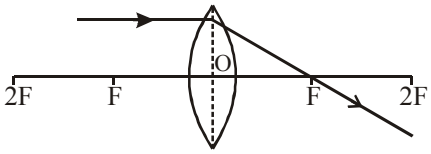
(A) I (B) II (C) III (D) IV

Q.11 Why does a ray of light bend when it travels from one medium to another medium? **[CBSE 2009]**

Sol. When a ray of light travels from one medium into another medium, its speed (wavelength) changes so it bends.

Q.12 Draw the given diagram in your answer book and complete it for the path of ray of light beyond the lens. **[CBSE- 2009]**



Sol. 

Q.13 Explain why a ray of light passing through the centre of curvature of a concave mirror gets reflected along the same path. **[CBSE - 2010]**

Sol. The normal of concave mirror at any point passes through centre, so incident angle ($\angle$i) is equal to zero.

Q.14 What is the nature of the image formed by a concave mirror if the magnification produced by the mirror is +3? **[CBSE- 2010]**

Sol. Magnification = + 3

so that nature of image virtual, erect and magnified.

Q.15 State one function of iris in human eye. **[CBSE - 2012]**

Sol. Functions of iris :

To control the amount of light entering the eye.

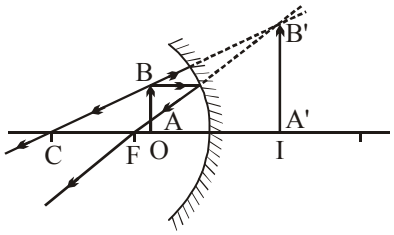
SECTION - E

PREVIOUS YEAR SHORT ANSWER QUESTIONS (2 & 3 Marks)

Q.1 What is the minimum number of rays required for location of the image formed by a concave mirror of an object. Draw a ray diagram to show the formation of a virtual image by a concave mirror.

[CBSE - 2009]

Ans. Two (minimum)



Q.2 At what distance should an object be placed from a convex lens of focal length 18 cm to obtain an image at 24 cm from it on the other side. What will be the magnification produced in this case?

[CBSE - 2010]

Ans. Given : $f = 18$ cm; $v = 24$ cm; $u = ?$; $m = ?$

By using len's formula,

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

$$\Rightarrow \quad \frac{1}{24} - \frac{1}{u} = \frac{1}{18} \qquad \Rightarrow \quad \frac{1}{u} = \frac{1}{24} - \frac{1}{18}$$

$$\Rightarrow \quad \frac{1}{u} = \frac{3-4}{72} \qquad \Rightarrow \quad \frac{1}{u} = -\frac{1}{72}$$

$$\Rightarrow \quad u = -72 \text{ cm}$$

Object distance is 72 cm infront of mirror.

Magnification :

$$m = \frac{v}{u} = \frac{24}{-72} = -\frac{1}{3}$$

Hence, final image is 3 times smaller than the object.

Negative sign shows image is real & inverted.

Q.3 State any four characteristics of the image of an object formed by a plane mirror. **[CBSE - 2010]**

Sol. (i) Distance of object from mirror is equal to distance of image from mirror.

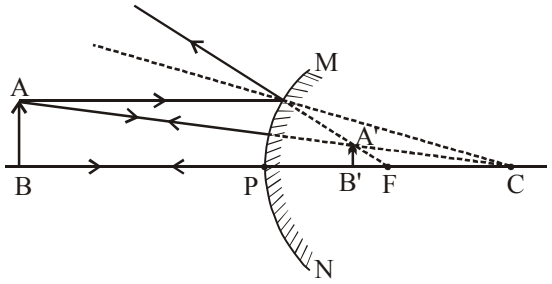
(ii) The image is laterally inverted.

(iii) The line joining the object point with its image is normal to the reflecting surface.

(iv) The size of the image is same as that of the object.

Q.4 An object is placed between infinity and the pole of a convex mirror. Draw a ray diagram and also state the position, the relative size and the nature of the image formed. **[CBSE - 2010]**

Sol.



Position of the image – Between P and F, behind the mirror.
Size of the image – Diminished.
Nature of the image - Virtual and erect.

Q.5 What is the principal of reversibility of light? Show that the incident ray of light is parallel to the emergent ray of light when light falls obliquely on a side of a rectangular glass slab. **[CBSE - 2010]**

OR

"A ray of light incident on a rectangular glass slab immersed in any medium emerges parallel to itself." Draw labelled ray diagram to justify the statement. **[CBSE - 2010]**

Sol. Path of ray of light is reversible.

or

Light traces back it's path while travelling in reverse direction.

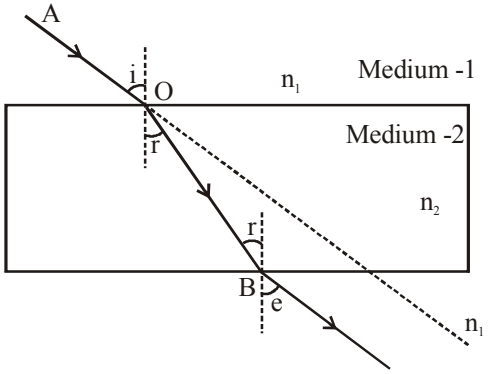
$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} \quad .... (1)$$

$$\frac{\sin r}{\sin e} = \frac{n_1}{n_2} \quad .... (2)$$

on multiplying eq. (1) and (2)

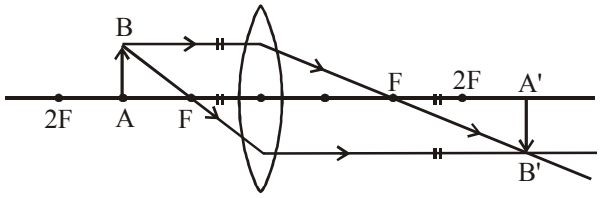
$$\frac{\sin i}{\sin r} \times \frac{\sin r}{\sin e} = \frac{n_2}{n_1} \times \frac{n_1}{n_2}$$

$$\Rightarrow \frac{\sin i}{\sin e} = 1 \Rightarrow \angle i = \angle e$$



Q.6 To construct ray diagram we use two light rays which are so chosen that it is easy to know their directions after refractions from the lens. List these two rays and state the path of these rays after refraction. Use these rays to locate the image of an object placed between centre of curvature and focus of a convex lens. **[CBSE - 2010]**

Sol. (i) Any ray parallel to the principal axis after reflection will pass through the focus.
(ii) Any ray passing through the focus after refraction will go parallel to the principle axis.



Q.7 A 4 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 24 cm. The distance of the object from the lens is 16 cm. Find the position, size & nature of the image formed by using lens formula. **[CBSE - 2012]**

Sol. A 4 cm tall object is given

So object height $h_0 = 4$ cm

focal length $f = +24$ cm

object distance $u = -16$ cm

To find : image height $h_i = ?$

image distance $v = ?$

using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\Rightarrow \quad \frac{1}{f} + \frac{1}{u} = \frac{1}{v} \qquad \ldots (1)$$

put the value of u and f in equation (1)

$$\frac{1}{v} = \frac{1}{24} - \frac{1}{16} = \frac{2-3}{48} = -\frac{1}{48}$$

$\therefore \quad v = -48$ cm

(–ve) sign shows that the image formed is same side of the object.

Now, magmification

$$m = \frac{h_i}{h_0} = \frac{v}{u}$$

$$\frac{h_i}{4} = \frac{-48}{-16} \Rightarrow h_i = 3 \times 4 = 12 \text{ cm}$$

Hence, image is formed at a distance of 48 cm infront of lens which is virtual and erect. Height of image is 12 cm.

Q.8 Draw a diagram and only these conventions for calculating the focal length and nature of a spherical mirror which forms a $\frac{1}{3}$ times magnified virtual image of an object placed 18 cm in front of it.

[CBSE - 2012]

Sol. Given that $u = -18$ cm

If object size is h_0 and image size is h_i,

then $h_i = \frac{1}{3} h_0 \quad \Rightarrow \quad \frac{h_i}{h_0} = \frac{1}{3}$

magnification $m = \frac{h_i}{h_0} = \frac{1}{3}$

$$\therefore \quad \frac{h_i}{h_0} = \frac{1}{3} \quad \Rightarrow \quad -\frac{v}{u} = \frac{1}{3}$$

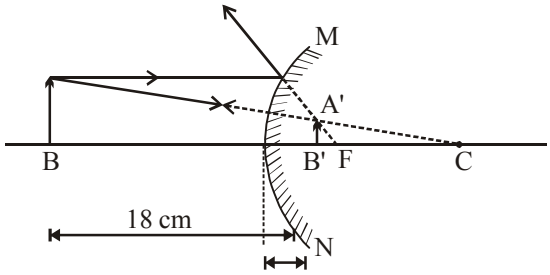
$$\Rightarrow \quad v = \frac{-u}{3} = -\left(\frac{-18}{3}\right) = \frac{+18}{3} = +6\text{cm}$$

By using mirror formula

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

$$\Rightarrow \quad \frac{1}{6}-\frac{1}{18}=\frac{1}{f} \qquad \Rightarrow \quad \frac{1}{f}=\frac{3-1}{18}=\frac{2}{18}$$

$$\Rightarrow \quad \frac{1}{f}=\frac{1}{9} \qquad \Rightarrow \quad f=9 \text{ cm}$$



Hence, focal length is 9 cm behind the mirror and mirror is convex in nature. Image is virtual & erect and size of image is smaller than object.

Q.9 An object of height 6 cm is placed perpendicular to the principal axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size of nature of the image if the distance of the object from the lens is 10 cm. **[CBSE - 2013]**

Sol. Given that $h_0 = 6$ cm

$f = -5$ cm

$u = -10$ cm

by using lens formula,

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

$$\Rightarrow \quad \frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{-5}+\frac{1}{-10}=\frac{-2-1}{10}=\frac{-3}{10}$$

$$v=\frac{-10}{3} \text{ cm} = -3.33 \text{ cm}$$

Distance of image from the lens is 3.33 cm.

Now magnification $m=\frac{h_i}{h_0}=\frac{v}{u}$

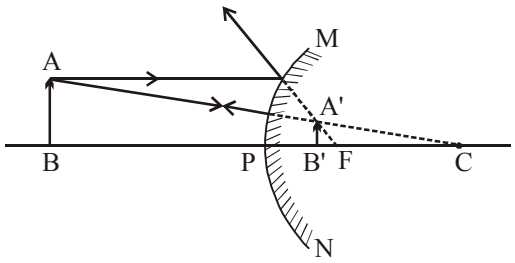
$$\Rightarrow \quad \frac{h_i}{h_0}=\frac{v}{u} \Rightarrow \frac{h_i}{6}=\frac{-10/3}{-10}=\frac{1}{3}$$

$$h_i = 2 \text{ cm}$$

Hence, image formed at a distnace of 3.33 cm infront of lens which is virtual & erect size of image is larger than the object i.e. image size is 3 times less than object size.

Q.10 If the image formed by the mirror for all positions of the object placed infront of it is always erect and diminished, what type of mirror it is? Draw a ray diagram to justify your answer. Where and why do we generally use this type of mirror. **[CBSE - 2015]**

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 virtual, erect and diminished image is formed behind the mirror between the pole and focus as shown in figure.As a convex mirror gives a wide field of view, it is used as a rear view mirror in vehicles. It enables the driver to view a much larger area of the traffic behind, it is also used as shop security cameras.

Q.11 An object of height 5 cm is placed perpendicular to the principle axis of a concave lens of focal length 10 cm. If the distance of the object from the optical centre of the lens is 20 cm, determine the position, nature & size of the image formed using the lens formula. **[CBSE - 2015]**

Sol. Given:

Height of object = 5cm

Focal length of concave lens = – 10 cm

Object distance u = – 20 cm

Using lens formula,

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

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-10} - \frac{1}{20} = \frac{-2-1}{20} = \frac{-3}{20}$$

$\therefore$ v = – 6.67 cm

Hence image is formed 6.67 infront of the lens on the same side as the object because v is negative, we can say that the image is virtual.

Now, magnification $m = \frac{h_i}{h_o} = \frac{v}{u}$

$$h_i = \frac{v}{u} \times h_o = -\frac{6.67 \times 5}{-20} = 1.67 \text{ cm}$$

Hence, the size of the image is $h_i = 1.67$ cm

Because the height of the image is positive and smaller than the height of the object, the image is erect and diminised.So, we can conclude that image is virtual, erect and diminished.

Q.12 The image of a candle flame placed at a distance of 45 cm from a spherical lens is formed on a screen placed at a distance of 90 cm from the lens. Identify the type of lens and calculate its focal length. If the height of the flame is 2 cm, find the height of its image. **[CBSE - 2016]**

Ans. Given that object distance $u = -45$ cm

Image distance $v = 90$ cm

The image of a candle flame is formed on the screen, so a convex lens is used.

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

$$\Rightarrow \quad \frac{1}{f} = \frac{1}{90} - \left(\frac{1}{-45}\right) = \frac{1}{90} + \frac{1}{45} = \frac{1+2}{90} = \frac{3}{90} = \frac{1}{30}$$

$$\Rightarrow \quad f = +30 \text{ cm}$$

Hence, it is convex lens of focal length 30 cm

Now, height of image $h_i = ?$

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

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

$$\therefore \quad h_i = \frac{2 \times 90}{-45} = -4 \text{ cm}$$

Height of image $h_i = -4$ cm

Thus, height is 4 cm which is image minus (–1) sign indicates that the image is formed below the principal axis. So image is real & inverted.

Q.13 The image formed by a spherical mirror is real, inverted and is of magnification-2. If the image is at a distance of 30cm from the mirror, where the object placed? Find the focal length of the mirror. List two characteristic of the image formed if the object is moved 10 cm towards the mirror. **[CBSE - 2016]**

Sol. Given that $m = -2$

Distance of the image, $v = -30$ cm

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

$$u = \frac{-v}{m} = -\frac{(-30)}{(-2)} = -15\text{cm}$$

Now using mirror formula

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

$$= \frac{1}{(-30)} + \frac{1}{(-15)} = \frac{-1}{30} - \frac{1}{15} = \frac{-1-2}{30} = \frac{-3}{30}$$

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

When object is moved 10 cm towards the mirror the new position of the object is

$$u' = -(15 - 10) = -5 \text{ cm}$$

Again, using $\frac{1}{f}=\frac{1}{v'}+\frac{1}{u'}$

$$\frac{1}{v'}=\frac{1}{f}-\frac{1}{u'}=\frac{1}{-10}-\left(\frac{1}{-5}\right)=\frac{-1}{10}+\frac{1}{5}$$

$$\frac{1}{v'}=\frac{1}{10} \quad \Rightarrow \quad v'=10\text{cm}$$

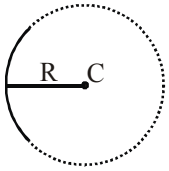
Thus, the image formed 10 cm behind the mirror.

magnification $m'=\frac{v'}{u'}=-\frac{10}{(-5)}=2$

Since, magnification is positive the image is erect and virtual.
Thus, the image is erect, virtual and magnified in nature.

Q.14 Define the radius of curvature of spherical mirror. Find the nature and focal length of a spherical mirror whose radius of curvature is + 24 cm. **[CBSE - 2017]**

Ans. Radius of curvature : Radius of sphere from which a mirror is cut. It is denoted by R.



The radius of curvature of a spherical mirror is the radius of the sphere of which the reflecting surface of the spherical mirror is a part and it represented by 'R'.

Given that R = 24 cm

$\therefore$ focal length $f=\frac{R}{2}=12\text{cm}$

SECTION - F

PREVIOUS YEAR LONGANSWER QUESTIONS (5 Marks)

Q.1 (a) What is meant by 'Power of a lens'? **[CBSE - 2010]**

(b) State and define the S.I. unit of power of a lens.

(c) A convex lens of focal length 25 cm and a concave lens of focal length 10cm are placed in close contact with each other. Calculate the lens power of this combination.

Sol. (a) It is the ability of lens to converge or diverge the incident light rays.
Power of a lens is the reciprocal of the focal length of a lens.

$$P=\frac{1}{f(\text{in m})}=\frac{100}{f(\text{in cm})}$$

(b) S.I. unit of power of a lens is dioptre (D)
Power of a lens in 1 dioptre if focal length of the lens is 1 metre or 100 cm.

(c) Given $f_1=25$ cm; $f_2=-10$ cm; $p_1=\frac{100}{25}=4\text{D}$; $p_2=\frac{100}{-10}=-10\text{D}$

$p=p_1+p_2=(4-10)\text{ D}=-6\text{ D}$

Q.2 (a) Draw a ray diagram to show the formation of image of object placed between infinity and the optical centre of a concave lens.

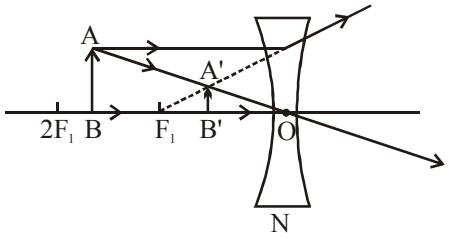
(b) A concave lens of focal length 15 cm forms an image 10 cm from the lens.
Calculate :

(i) The distance of the object from the lens.

(ii) The magnification for the image formed.

(iii) The nature of the image formed. **[CBSE - 2010]**

Sol. (a)



(b) f = – 15 cm

v = – 10 cm

(i) $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \quad \Rightarrow \quad \frac{1}{-10}-\frac{1}{u}=\frac{1}{-15}$

$\frac{1}{u}=\frac{1}{-10}+\frac{1}{15} \quad \Rightarrow \quad u = -30 \text{ cm}$

Object distance is 30 cm from lens.

(ii) $m=\frac{v}{u}=\frac{-10}{-30}=\frac{1}{3}$

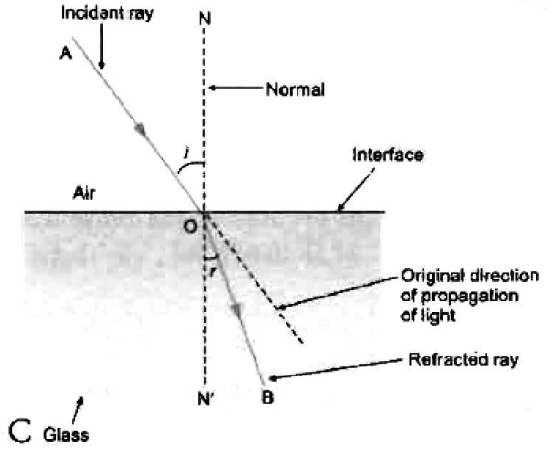
Hence magnification is 1/3

(iii) Nature of image – virtual and erect.

Q.3 With the help of ray diagram, state what is meant by refraction of light. State snell's law of refraction of light and also express it mathematically. The refractive index of air with respect to glass is 2/3 and the refractive index of water with respect to air is 4/3. If the speed of light in glass is 2×10^8 m/s. Find the speed of light in (a) air (b) water. **[CBSE - 2012]**

Sol. Refraction of light :

The bending of light rays when they pass obliquely from one medium to another medium is called refraction of light.



Snell's law :

The ratio of the sine of the incident angle ($\angle i$) to the sine of the refracted angle ($\angle r$) is constant for a pair of two media

$$\text{i.e. } \frac{\sin i}{\sin r} = \text{constant}$$

This constant is known as the refractive index of the medium in which refracted ray travels with respect to the medium in which incident ray travels.

Given that ${}^{a}\mu_{g} = \frac{2}{3} \Rightarrow {}^{g}\mu_{a} = \frac{3}{2}$ and ${}^{w}\mu_{a} = \frac{4}{3}$

Let velocity of light in glassis v_g & water is v_w then $v_g = 2 \times 10^8$ m/s

To find : $v_a = ?\ v_w = ?$

$$\text{Refractive index} = (\mu) = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

(a) $${}^{g}\mu_{a} = \frac{\text{speed of light in glass}}{\text{speed of light in air}}$$

$$\Rightarrow \frac{2}{3} = \frac{2\times10^8}{V_a} \Rightarrow V_a = 3 \times 10^8 \text{ m/s}$$

Hence, speed of light in air is 3×10^8 m/s.

(b) $${}^{a}\mu_{w} = \frac{\text{speed of light is air}}{\text{speed of light in water}}$$

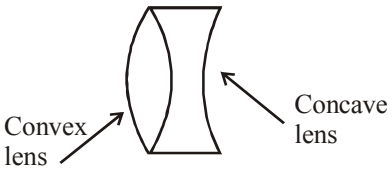
$$\frac{4}{3} = \frac{3\times10^8}{V_w} \quad (\because \text{Speed of light is air} = 3 \times 10^8 \text{ m/s})$$

$$\Rightarrow V_w = \frac{4}{9}\times10^8 = 2.25 \times 10^8 \text{ m/s}$$

Q.4 A convex lens of focal length 25 cm and a concave lens of focal length 10 cm are placed in close contact with each other. Calculate the lens power of this combination. **[CBSE - 2012]**

Sol. Focal length of convex lens $f_1 = 25$ cm

Focal length of concave lens $f_2 = -10$ cm



$$\because \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{25} - \frac{1}{10} = \frac{2-5}{50} = \frac{-3}{50}$$

$$\therefore f = -\frac{50}{3} = -16.66 \text{ cm}$$

Focal length of combination of lens is $\frac{-50}{3}$ cm

$$\therefore \text{Power} = \frac{100}{f}, \text{ where f is in cm}$$

$$= \frac{-100\times3}{50} = -6 \text{ D}$$

Q.5 A concave lens of focal length 15 cm forms an image 10 cm from the lens. Calculate

(i) The distance of the object from the lens.

(ii) The magnification for the image formed.

(iii) The nature of the image formed. **[CBSE - 2012]**

Sol. Given that $f = -15\text{cm}, v = -10\text{ cm}$,

To find, $u = ?,\ m = ?$

(i) By using lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$-\frac{1}{u} = \frac{1}{f} - \frac{1}{v} = -\frac{1}{15} + \frac{1}{10} = \frac{-2+3}{30} = \frac{1}{30} \quad \Rightarrow \quad u = -30\text{ cm}$$

(ii) Magnification, $m = \frac{v}{u} = \frac{-10}{-30} = \frac{1}{3}$

(iii) $m = \frac{1}{3}$, and $m = \frac{h_i}{h_0} = \frac{\text{image size}}{\text{object size}}$

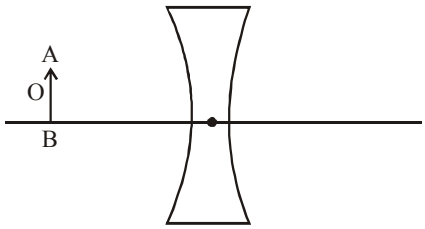
$$\therefore \quad \frac{h_i}{h_0} = \frac{1}{3}$$

$$h_i = \frac{1}{3} h_0$$

Hence image size is $\frac{1}{3}$ times of the object size. Image formed at the same side of object which is virtual and erect.

Q.6 (a) An object of size 7.6 cm is placed at 24 cm infront of a concave mirror of focal length 16 cm. At what distance from the mirror should a screen be placed, so that a sharp focused image can be obtained? Find the size and nature of the image.

(b) The diagram given below shows an object O. Copy the diagram and draw a suitable ray to locate the image. Name the type of lens used in this case. **[CBSE - 2013]**



Sol. (a) Given that object height $h_0 = 7.6\text{ cm} = -24\text{ cm};\ f = -16\text{ cm};\ v = ?$

By using mirror formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = -\frac{1}{16} - \left(-\frac{1}{24}\right)$$

$$\frac{-1}{16} + \frac{1}{24} = \frac{-3+2}{48} = \frac{-1}{48}$$

$$v = 48\text{ cm}$$

Image distance with (-ve) sign shows that image formed at the same side of the object and screen also placed at that point.

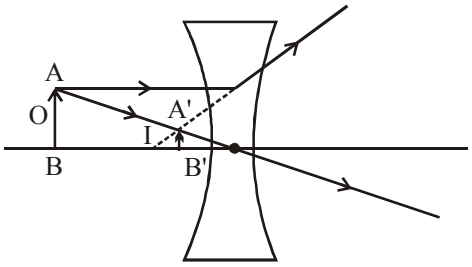
Now, $m = \frac{h_i}{h_0} = \frac{-v}{u} \quad \Rightarrow \quad \frac{h_i}{h_0} = \frac{-v}{u}$

$\Rightarrow \quad \frac{h_i}{7.6} = \frac{-(-48)}{-24} = 2$

$h_i = 2 \times 7.6 = 15.2$ cm

Image size is 15.2 cm which is lager than the oject. Image I real and inverted.

(b)



AB = object

A'B' = Image

Lens used here is concave.

Q.7 (a) Name the lens which can be used as a magnifying glass. For which position of the object a convex lens forms:

(i) A real & inverted image of the same size as that of the object.

(ii) A virtual & erect image.

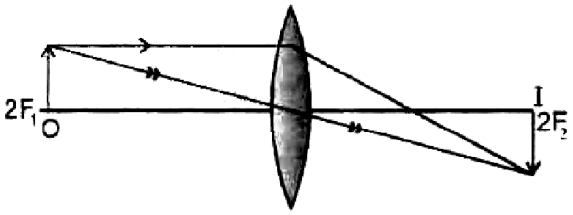
Draw the ray diagram to justify your answer in each case.

(b) One half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object?

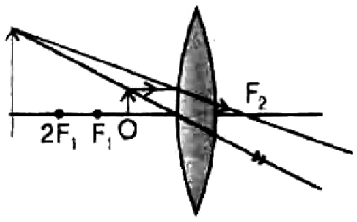
Draw ray diagrm to justify your answer. **[CBSE - 2016]**

Ans. (a) Convex lens is used as a magnifying glass.

(i)

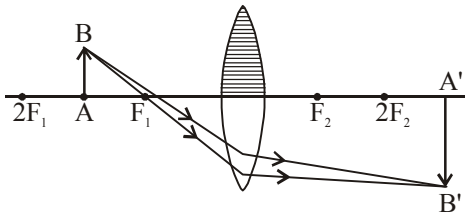


(ii)



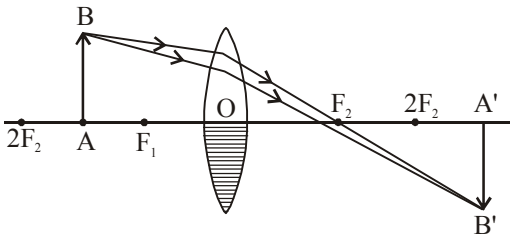
(b) The convex lens will form a complete image of an object, even if its one-half is covered with black paper. It can be understood by the following two cases :

Case I - When upper half of lens is covered



In this case, the ray of light coming from the object will be refracted by lower half of the lens. These rays meet at the other side of the lens to form the image of the given object.

Case-II - When the lower half of the lens is covered.



In this case, a ray of light coming from the object is refracted by the upper half of the lens. These rays meet at the other side of the lens to form the image of the given object, as shown in figure given above.

Note : The only difference between these two images will be that they will have less intensity.

Q.8 An object 4 cm in length is placed at a distance of 20 cm infront of a convex mirror of radius of curvature 20 cm. The mirror formula to find the position, nature and size of image. Also draw a ray diagram for the above situation and mark the position of pole, focus and centre of curvature on it.

[CBSE - 2016]

Sol. Given that :

Object distance $u = -20$ cm

Object height $h_0 = 4$ cm

Radius of curvature $R = 20$ cm

$$\therefore \quad f = \frac{R}{2}$$

$$\therefore \quad \text{Focal length } f = \frac{20}{2} = 10 \text{ cm}$$

According to mirror formula,

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

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

$$\frac{1}{v} = \frac{1}{10} - \left(\frac{1}{-20}\right) = \frac{1}{10} + \frac{1}{20} = \frac{2+1}{20} = \frac{3}{20}$$

$$\therefore \quad v = \frac{20}{3} = 6.67 \text{ cm}$$

The positive value of v indicates that the image is formed behind the mirror. So,it is virtual in nature

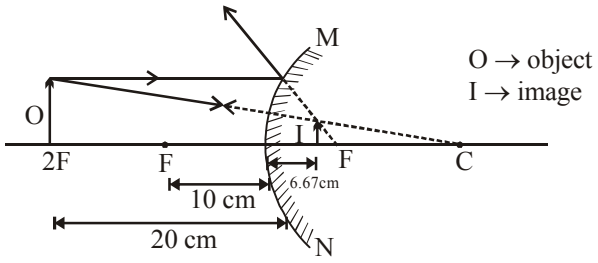
magnification $m = -\frac{v}{u}$

$$m = -\frac{v}{u} = -\frac{6.67}{-20} = 0.33$$

and $$m = \frac{h_i}{h_0} \Rightarrow h_i = m \times h_0$$

$$= 0.33 \times 4 = 1.32 \text{ cm}$$

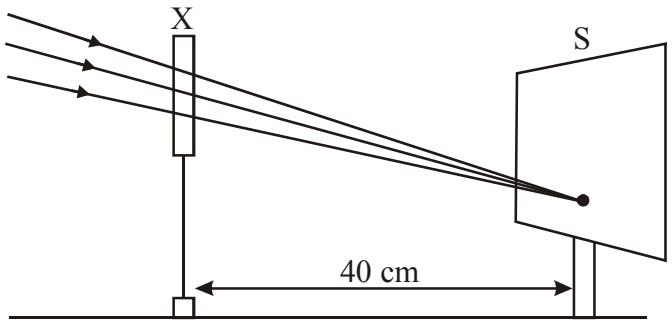
The positive value of the image height indicates that the image formed is erect.



SECTION - G

PRACTICAL BASED QUESTIONS

Q.1 A student focused the image of a distant object using a device 'X' on a white screen 'S' as shown in the figure. If the distance of the screen from the device is 40 cm, select the correct statement about the device.



(A) The device X is a convex lens of focal length 20 cm.
(B) The device X is a concave mirror of focal length 40 cm.
(C) The device X is concave mirror of radius of curvature 40 cm.
(D) The device X is a convex lens of focal length 40 cm.

Q.2 A student obtained a sharp image of a burning candle, placed at the farther end of a laboratory table, on a screen using a concave mirror. For getting better value of focal length of the mirror, the subject teacher suggested him for focussing a well illuminated distant object. What should the student do?
(A) He should move the mirror away from the screen.
(B) He should move the mirror slightly towards the screen.
(C) He should move the mirror as well as the screen towards the newly selected object.
(D) He should move only the screen towards the newly selected object.

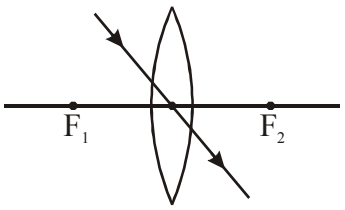
Q.3 After tracing the path of rays of light through a glass slab for three different angles of incidence, a student measured the corresponding values angle of refraction (r) and angle of emergence (e) and recorded them in the table given below:

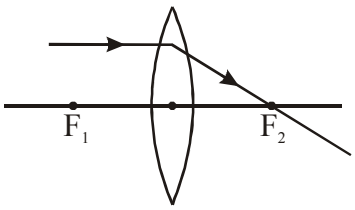
S.No.	∠i	∠r	∠e
I	30°	20°	31°
II	40°	25°	40°
III	50°	31°	49°

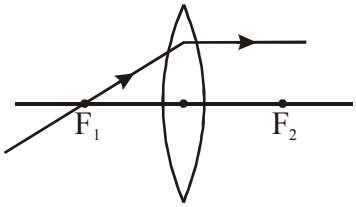
correct observations are :

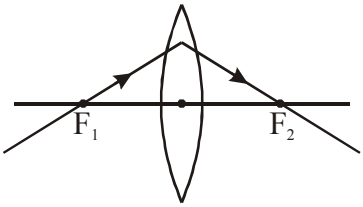
(A) only I (B) only II (C) I and III (D) I, II and III

Q.4 Study the following ray diagrams:

(I) 

(II) 

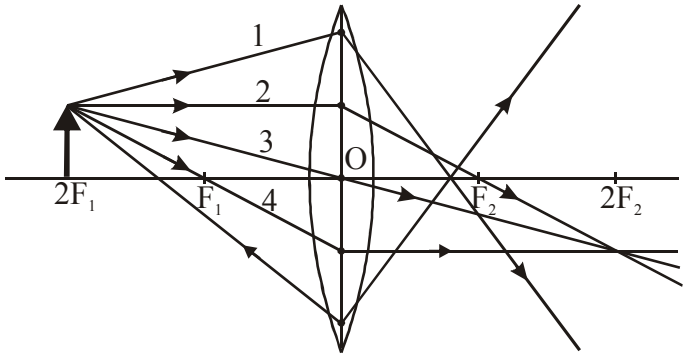
(III) 

(IV) 

The diagrams showing the correct path of the ray after passing through the lens are

(A) II and III only (B) I and II only (C) I, II and III (D) I, II and IV

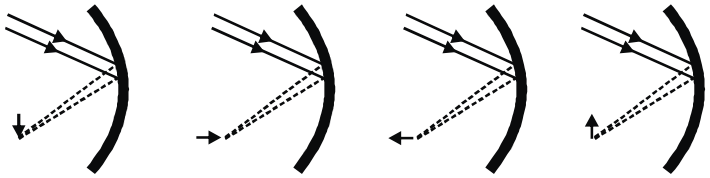
Q.5 Out of the five incident rays shown in the figure find the three rays that are obeying the laws of refraction and may be used for locating the position of image formed by a convex lens.



(A) 1, 2 and 3 (B) 2, 3 and 4 (C) 3, 4 and 5 (D) 1, 2 and 4

Q.6 What does the relationship $\angle i = \angle e$ mean ?

Q.7 Four students A, B, C and D carried out focal length of concave mirror as shown in four diagram :



(I) (II) (III) (IV)

Correct diagram is :

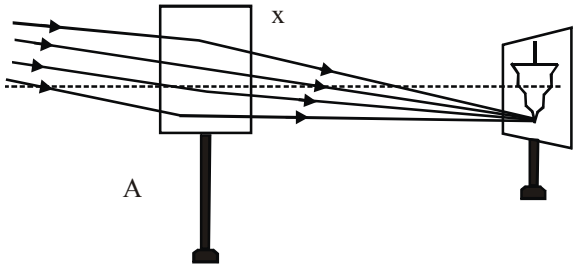
(A) II (B) I (C) III (D) IV

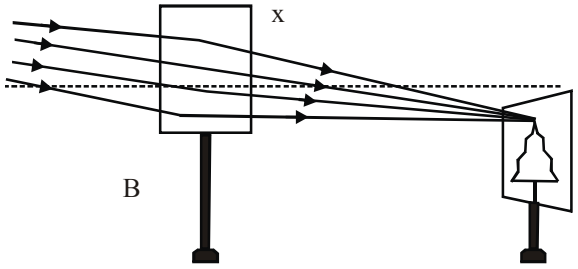
Q.8 A student obtained a sharp image of the grill of a window on a screen, using a convex lens. For getting better results, the teacher suggested focusing of a distant tree instead of the grill. In which direction should the lens be moved for this purpose ?

(A) away from the screen (B) very far away from the screen

(C) behind the screen (D) towards the screen

Q.9 Parallel rays, from a distant tree, incident on the device X, forms its distinct image on a screen as shown. The diagram correctly showing the image of the tree on the screen, is diagram :





(A) A and the device X is convex lens (B) A and the device X is a concave mirror

(C) B and A the device X is convex lens (D) B and the device X is a concave mirror

Q.10 Three students measured the focal length of a convex lens using parallel rays from a distant object. All of them measured the distance between the lens and the inverted image on the screen.

Student A saw a sharp image on the screen and labelled the distance of f_1.

Student B saw a slightly larger blurred image on the screen and labelled the distance as f_2.

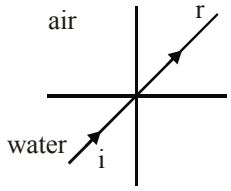
Student C saw a slightly smaller blurred image on the screen and labelled the distance as f_3.

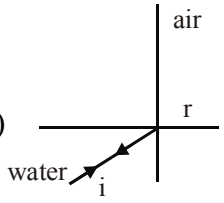
The relation between the three measurements would most likely be :

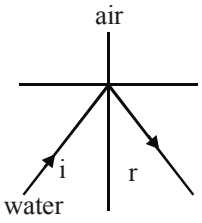
(A) $f_1 = f_2 = f_3$ (B) $f_1 < f_2$ and f_3 (C) $f_3 < f_1 < f_2$ (D) $f_1 < f_2$ and $f_1 = f_3$

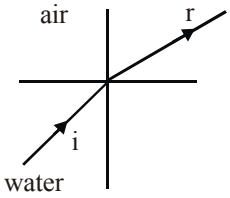
Q.11 In an experiment to determine the focal length of a convex lens, a student obtained a sharp inverted image of a distant tree on the behind the lens. She then removed the screen and looked through the lens in the direction of the object. She will see :
(A) An inverted image of the tree at the focus of the lens
(B) No image as the screen has been removed
(C) A blurred image on the wall of the laboratory
(D) An erect image of the tree on the lens

Q.12 A ray of light is travelling from water to air, which figure shows correct refraction ?

(A) 

(B) 

(C) 

(D) 

Q.13 Which characteristic of light remains unchanged on refraction ?
(A) velocity (B) frequency (C) refractive index (D) wavelength

Q.14 When ray of light enters glass from air, its wavelength :
(A) decreases (B) Increases (C) remains same (D) all of them

*****

CONCEPT APPLICATION LEVEL - III

SECTION-A

- **Fill in the blanks**

Q.1 A light wave of frequency 5×10^{14} Hz enters a medium of refractive index 1.5. In the medium the velocity of light wave is _____ and its wavelength is _____.

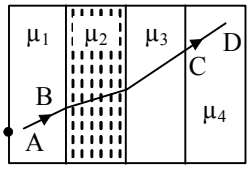
SECTION-B

- **Multiple choice question with one correct answers**

Q.1 When a ray of light enters a glass slab from air.
(A) Its wavelength decreases.
(B) Its wavelength increases.
(C) Its frequency decreases.
(D) Neither its wavelength nor its frequency changes.

Q.2 An eye specialist prescribe spectacles having combination of convex lens of focal length 40 cm in contact with a concave lens of focal length 25 cm. The power of this lens combination in diopters is
(A) +1.5 (B) –1.5 (C) +6.67 (D) –6.67

Q.3 A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have

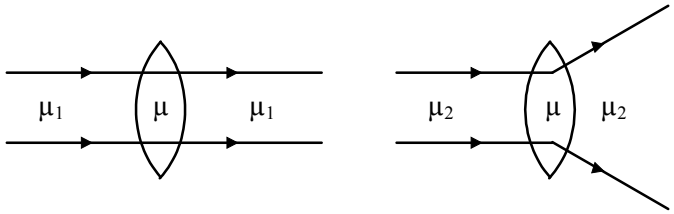


(A) $\mu_1 = \mu_2$ (B) $\mu_2 = \mu_3$ (C) $\mu_3 = \mu_4$ (D) $\mu_4 = \mu_1$

Q.4 A hollow double concave lens is made of very thin transparent material. It can be filled with air or either of two liquids L_1 or L_2 having refractive indices μ_1 and μ_2 respectively ($\mu_2 > \mu_1 > 1$). The lens will diverge a parallel beam of light if it is filled with
(A) Air and placed in air (B) Air and immersed in L_1
(C) L_1 and immersed in L_2 (D) L_2 and immersed in L_1

Q.5 A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of virtual image from the surface is
(A) 6 cm (B) 4 cm (C) 12 cm (D) 9 cm

Q.6 What is the relation between the refractive indices μ_1 and μ_2, if the behaviour of light ray is as shown in the figure.



(A) $\mu_1 > \mu_2$ (B) $\mu_1 < \mu_2$ (C) $\mu_1 = \mu_2$ (D) None of these

Q.7 Which of the following lens can form image of an object on screen.
(A) Concave (B) Convex
(C) Both convex and concave (D) none of these

Q.8 To obtain a diminished image of an object, formed by a convex lens, where should the object must be placed?
(A) between F and 2F (B) At F
(C) between infinity and 2F (D) at 2F

Q.9. If object is placed between infinity and 2F of a convex lens, then image will form
(A) at F (B) between F and 2F (C) at 2 F (D) at infinity

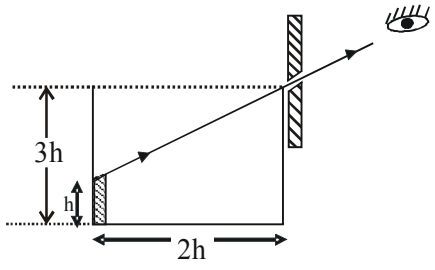
Q.10 A convex lens A of focal length 20 cm and a concave lens B of focal length 5 cm are kept along the same axis with a distance 'd' between them. If a parallel beam of light falling on A leaves B as a parallel beam, then d is equal to
(A) 25 cm (B) 20 cm (C) 15 cm (D) 10 cm

Q.11 A thin rod of length f/3 is placed along the principal axis of a concave mirror of focal length f such that its image which is real and elongated, just touches the rod. The magnification is
(A) 2/3 (B) 3/2 (C) 3/5 (D) 5/3

Q.12 Two thin lenses, when in contact, produce a combination of power +10 diopters. When they are 0.25 m apart, the power reduces to +6 diopters. The focal length of the lenses are
(A) 0.125 m. 0.5 m (B) 0.25 m, 0.5 m (C) 0.25 m, 0.75 m (D) none of these

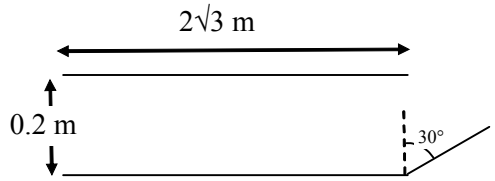
Q.13 A diminished image of an object is to be obtained on a screen 1.0 m from it. This can be achieved by appropriately placing.
(A) A convex lens of focal length more than 0.25 m.
(B) A convex mirror of suitable focal length.
(C) A convex lens of focal length less than 0.25 m.
(D) A concave lens of suitable focal length.

Q.14 An observer can see through a pin-hole the top end of a thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can see the lower end of the rod. Then the refractive index of the liquid is



(A) $\frac{5}{2}$ (B) $\sqrt{\frac{5}{2}}$ (C) $\sqrt{\frac{3}{2}}$ (D) $\frac{3}{2}$

Q.15 Two plane mirrors A and B are aligned parallel to each other as shown in the figure. A light ray is incident at an angle 30° at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is



(A) 28 (B) 30 (C) 31 (D) 34

Q.16 The size of the image of an object, which is at infinity, as formed by a convex lens of focal length 30 cm is 2 cm. If a concave lens of focal length 20 cm is placed between the convex lens and the image at a distance of 26 cm from the convex lens, calculate the new size of the image.
(A) 1.25 cm (B) 1.67 cm (C) 1.05 cm (D) 2 cm

Q.17 A convex lens is in contact with concave lens. The magnitude of the ratio of their focal length is 2/3. Their equivalent focal length is 30 cm. What are their individual focal lengths?
(A) –15, 10 (B) –10, 15 (C) 75, 50 (D) –75, 50

Q.18 A short linear object of length 'b' lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to

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

Q.19 A concave mirror is placed on a horizontal table, with its axis directed vertically upwards. Let O be the pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image also located at C. If the mirror is now filled with water, the image will be
(A) real, and will remain at C
(B) real, and located at a point between C and ∞.
(C) virtual, and located at a point between C and O
(D) real, and located at a point between C and O.

SECTION-C

- **Multiple choice question with one or more than one correct answers**

Q.1 A converging lens is used to form an image on a screen. When the upper half of the lens is covered by an opaque screen.
(A) half the image will disappear (B) complete image will be formed
(C) intensity of the image will increase (D) intensity of the image will decrease

Q.2 Which of the following forms a virtual and erect image for all positions of the object?
(A) convex lens (B) concave lens (C) convex mirror (D) concave mirror

SECTION-D

- **Assertion & Reason**

Instructions: In the following questions as Assertion (A) is given followed by a Reason (R). Mark your responses from the following options.

(A) Both Assertion and Reason are true and Reason is the correct explanation of 'Assertion'

(B) Both Assertion and Reason are true and Reason is not the correct explanation of 'Assertion'

(C) Assertion is true but Reason is false

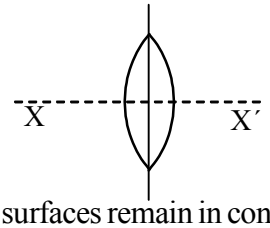
(D) Assertion is false but Reason is true

Q.1 **Assertion:** A ray of light entering from glass to air suffers from change in frequency.
Reason: Velocity of light in glass is less than that in air.

Q.2 **Assertion:** A plane mirror has unity magnification.
Reason: In the case of plane mirror the distance of image is equal to the distance of object.

Q.3 **Assertion:** Convex mirror is used as a driver's mirror.
Reason: Field view of a convex mirror is large.

Q.4 **Assertion:** Focal length of a lens remain same if it is cut across the axis along XX′.



Reason: Both the refracting surfaces remain in contact if the lens is cut along X – X′ plane.

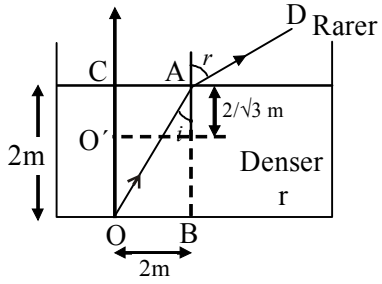
Q.5 **Assertion:** Power of a lens is indirectly proportional to its focal length.
Reason: Units of focal length and power of a lens are same.

SECTION-E

- **Comprehension**

An object O is placed in denser medium. A light ray OA travels from denser to rarer medium. Refracted ray AD appears to come from O′. O′ is image of the object O.

Given that: OC = 2m, O′C = $\frac{2}{\sqrt{3}}$ m and OB = 2m.



Q.1 Value of angle *i* is

(A) 60° (B) 45° (C) 30° (D) None of these

Q.2 Value of angle *r* is
(A) 60° (B) 45° (C) 30° (D) None of these

Q.3 Refractive index of denser medium w.r.t. rarer medium is
(A) $\frac{\sin i}{\sin r}$ (B) $\frac{\sin r}{\sin i}$ (C) $\frac{\sin (i-r)}{\sin r}$ (D) None of these

SECTION-F

- **Match the following (one to one)**

Column-I and **column-II** contains **four** entries each. Entries of column-I are to be matched with some entries of column-II. Only One entries of column-I may have the matching with the same entries of column-II and one entry of column-II Only one matching with entries of column-I

Q.1

	Column I		**Column II**
(A)	Law of reflection	(P)	1/focal length
(B)	Law of refraction	(Q)	$\angle i = \angle r$
(C)	Power of lens	(R)	$\frac{\sin i}{\sin r} = \text{constant}$
(D)	Absolute refractive index of glass	(S)	$\frac{\text{Speed of light in air}}{\text{Speed of light in glass}}$

SECTION-G

- **Match the following (one to many)**

Column-I and **column-II** contains **four** entries each. Entries of column-I are to be matched with some entries of column-II. One or more than one entries of column-I may have the matching with the same entries of column-II and one entry of column-II may have one or more than one matching with entries of column-I

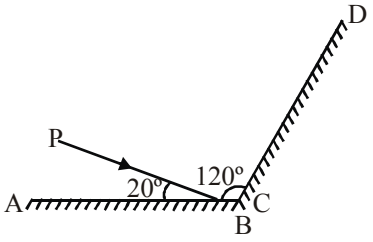
Q.1

	Column I		**Column II**
(A)	Straight line which is normal to the mirror at its pole (P)	(P)	Will passes through principal focus (F)
(B)	A ray, parallel to the principal axis of concave mirror after reflection	(Q)	Focal length (f)
(C)	The distance between the pole and the principal focus of a mirror	(R)	Principal axis
(D)	A straight line passing through the pole (P) and the centre of curvature (c)	(S)	Half of radius of curvature (R)

SECTION-H

Q.1 Optical density of a medium depends on _____ **[NSO 2010]**
(A) Density of the medium (B) thickness of the medium
(C) Velocity of light in that medium (D) None of these

Q.2 Figure shows a ray of light P striking a mirror AB. The mirror AB and the mirror CD make an angle of 120º with each other. The angle of reflection of ray P at CD is _____ **[NSO 2010]**

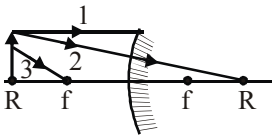


(A) 20º (B) 30º (C) 50º (D) 70º

Q.3 Two plane mirrors are placed parallel to each other at distance L apart. A point object O is placed betweeen them, at a distance $\frac{L}{3}$ from one mirror. Both mirrors form multiple images. The distance between any two images cannot be_____. **[NSO 2010]**

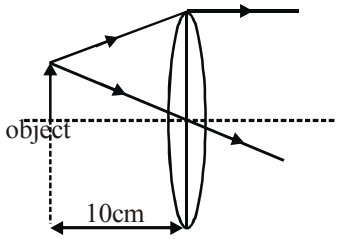
(A) $\frac{3L}{2}$ (B) $\frac{2L}{3}$ (C) 2L (D) None of these

Q.4 Which pairs of rays from the object in the drawing are used to construct the image location produced by the convex spherical mirror of focal length f and radius R? **[NSO 2010]**



(A) 1 and 3 (B) 1 and 2 (C) 2 and 3 (D) any pair of rays of shown will work

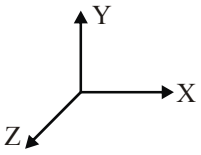
Q.5 The diagram shows the paths of two rays of light from an object. The object is 10 cm in front of a lens as shown in the diagram. **[NSO 2010]**

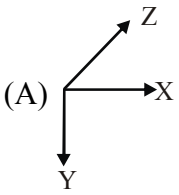


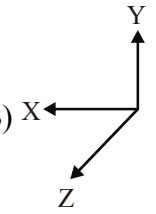
Which of the following statements is true about the given diagram ?
(A) The lens is converging and focal length of lens is greater than 10 cm.
(B) The lens is converging and focal length of lens is less than 10 cm.
(C) The lens is diverging and focal length of lens is greater than 10 cm.
(D) The lens is diverging and focal length of lens is less than 10 cm

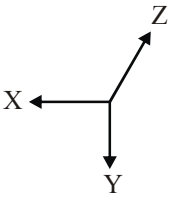
Q.6 A fisherman is standing on the bank of a lake. To a fish under water, viewing obliquely the man looks
(A) Taller than what he actually is (B) Shorter than what he actually is **[NSO 2015]**
(C) The same height as he actually is (D) Depends on the obliquity

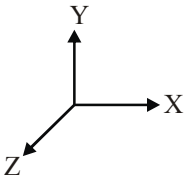
Q.7 A coordinate axis as shown in figure is kept in front of a converging lens at a distance 2f from it, where f is the focal length of the lens. Which of the following shows the approximate shape of the image ? Assume that X-axis is the principal axis of the lens. **[NSO 2015]**



(A) 

(B) 

(C) 

(D) 

Q.8 Read the given statements and select the correct option. **[NSO 2015]**

Statement 1 : A concave mirror and a convex lens both have the same focal length in air. When they are submerged in water, they will still have the same focal length.

Statement 2 : The refractive index of water is greater than the refractive index of air.

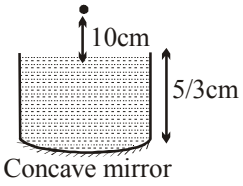
(A) Both statements 1 and 2 are true and statement 2 is the correct explanantion of statement 1.

(B) Both statements 1 and 2 are true but statement 2 is not the correct explanation of statement 1.

(C) Statement 1 is true but statement 2 is false.

(D) Statement 1 is false but statement 2 is true.

Q.9 A concave mirror of focal length 10 cm is dipped in water as shown in the given figure.



Given that the refractive index of water is $\frac{4}{3}$ and object S is placed on the principal axis of the concave mirror. The final image formed by the system is at **[NSO 2015]**

(A) $\frac{85}{4}$ cm from water surface

(B) $\frac{85}{4}$ cm from mirror surface

(C) $\frac{94}{3}$ cm from water surface

(D) $\frac{94}{3}$ cm from mirror suface.

SECTION-I

Q.1 The image formed by a concave mirror is observed to be real, inverted and larger than the object. Where should be the position of the object? **[NTSE 2016 Stage 1]**

(A) At the centre of curvature

(B) Between the principal focus and centre of curvature

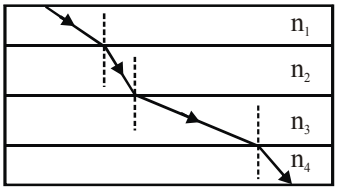
(C) Beyond the centre of curvature

(D) Between the pole of the mirror and its principal focus.

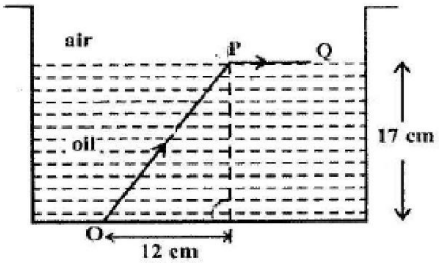
Q.2 The path of ray of light in different media of refractive indices n_1, n_2, n_3 and n_4 is shown in figure. The velocity of light will be maximum in the medium whose refractive index is

[NTSE 2016 Stage 1]

(A) n_1
(B) n_2
(C) n_3
(D) n_4



Q.3 A vessel is filled with oil as shown in the diagram. A ray of light from point O at the bottom of vessel is incident on the oil - air interface at point P and grazes the surface along PQ. The refractive index of the oil is close to – **[NTSE Stage II 2017]**

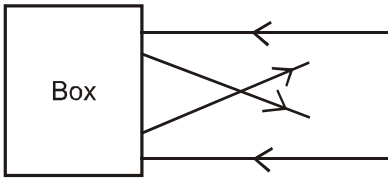


(A) 1.41 (B) 1.50 (C) 1.63 (D) 1.73

Q.4 The intensities of two interfering waves are I_1 and I_2. The best contrast in the interference pattern will be, when - **(Raj./ NTSE Stage-I/2005)**

(A) $I_1 = I_2$ (B) $I_1 >> I_2$ (C) $I_1 > I_2$ (D) I_1 or $I_2 = 0$

Q.5 In the given diagram the reflecting surface inside the box will be - **(Raj./ NTSE Stage-I/2005)**



(A) Plane mirror (B) Concave mirror
(C) Convex mirror (D) Two inclined plane mirrors.

Q.6 On immersing a glass lens in water its focal length **(Raj./ NTSE Stage-I/2005)**

(A) will become zero (B) will decrease (C) will increase (D) will become infinite

Q.7 A point object is placed in the middle of two concave mirrors. The focal lengtth of each mirror is 10 cm. to obtain single image of point object, the distance between two mirrors in cm will be:

(Raj./ NTSE Stage-I/2006)

(A) 10 (B) 20 (C) 30 (D) 50

Q.8 If a ray of light is incident normally on the glass slab, then angle of refraction will be : **(Raj./ NTSE Stage-I/2006)**

(A) 0º (B) 45º (C) 60º (D) 90º

Q.9 While obtaining the image of a candle by a convex lens, if lower half portion of the lens is blackened to make it opaque completely, then the intensity of the image will be: **(Raj./ NTSE Stage-I/2007)**

(A) constant (B) decreased (C) increased (D) zero

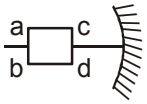
Q.10 When a light wave of frequency 5×10^{14} Hz is passed through a medium of refractive index 1.5 then its wavelength will become: **(Raj./ NTSE Stage-I/2007)**

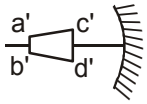
(A) 4000 Å (B) 4500Å (C) 6000Å (D) 9000Å

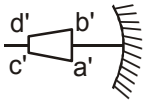
Q.11 The Lens used in the Camera is – **(Raj./ NTSE Stage-I/2007)**

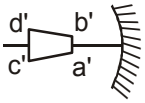
(A) Convex Lens (B) Concave Lens (C) Biconvex Lens (D) Biconcave Lens

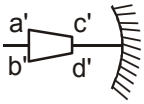
Q.12 An object in placed in front of a concave mirror of local length 'f' as shown in figure. Choose the correct shape of image. **(Haryana/ NTSE Stage-I/2013)**



(A) 

(B) 

(C) 

(D) 

Q.13 Match the following **(Haryana/ NTSE Stage-I/2013)**

Column I	**Column II**
(i) Convex mirror, real object	p. Real image
(ii) Concave mirror, real object	q. Virtual image
(iii) Concave lens real object	r. Magnified image
(iv) Convex lens, real object	s. Diminished image

(A) (i)-q,s (ii) p,q,s (iii) q,r (iv)-p,q,r, s (B) (i)-q (ii) p,q,s (iii) q,r (iv)-p,q,r

(C) (i)-s (ii) p,q,s (iii) q,s (iv)-p,q,r,s (D) (i) q,s (ii) p,q,r,s (iii) q,s (iv)-p,q,r,s

Q.14 The minimum distance between an object and its real image in a convex lens is (f = focal length of the lens) **(West Bengal/ NTSE Stage-I/2013)**

(A) 2.5 f (B) 2f (C) 4f (D) f

Q.15 The frequency of light of wave length 5000 Å is **(West Bengal/ NTSE Stage-I/2013)**

(A) 1.5×10^5 Hz (B) 6×10 Hz (C) 6×10^{14} Hz (D) 7.5×10^{15} Hz

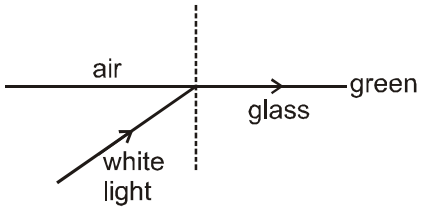
Q.16 The relation among u, v and f for a mirror is : **(Mizoram/ NTSE Stage-I/2013)**

(A) $f = uv/(u + v)$ (B) $v = fu(u + f)$ (C) $u = fv(f + v)$ (D) all of these

Q.17 The correct relation between u, v and r for a mirror will be : (symbols represent traditional meaning)
(Raj./ NTSE Stage-I/2014)

(A) $r = \frac{2uv}{u+v}$ (B) $r = \frac{uv}{2(u-v)}$ (C) $r = \frac{1}{u+v}$ (D) $\frac{1}{r} = \frac{1}{u} + \frac{1}{v}$

Q.18 White light is incident on the interface of glass and air as shown in the figure. If green light is just totally internally reflected then the emerging ray in air contains : **(Haryana./ NTSE Stage-I/2014)**

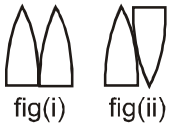


(A) Yellow, orange , red (B) Violet, indigo, blue
(C) All colours except green (D) All colours

Q.19 A concave mirror is placed in a horizontal table with its axis directed vertically upwards. Let O be pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image, also located at C. If the mirror is now filled with water, the image will be : **(Raj./ NTSE Stage-I/2014)**
(A) Real and located at a point between C and O.
(B) Real and will remain at C.
(C) Real and located at point between C and ∞ (infinity).
(D) Virtual and located at a point between C and O.

Q.20 If a lens of focal length 'f' is cut in two equal parts shown as :

are put in contact as shown in figure (i) and (ii)



the resulting focal length of fig (i) and (ii) will be- **(Haryana/ NTSE Stage-I/2014)**
(A) f/2,0 (B) 0, f/2 (C) f,f (D) f/2, (infinity)

Q.21 The mirror used by a dentist to examine the teeth of a person is - **(M.P/ NTSE Stage-I/2014)**
(A) Convex (B) Concave (C) Plane (D) Plano convex

Q.22 For magnification in spherical mirrors object height is: **(MAHARASHTRA/ NTSE Stage-I/2014)**
(A) Negative (B) Positive
(C) For real images positive (D) For virtural image negative

Q.23 After refraction of light through a glass slab, incident ray and refracted are :
(MAHARASHTRA/ NTSE Stage-I/2014)
(A) Perpendicular (B) Parallel (C) In a straight line (D) (A) and (C)

Q.24 If sum of velocities of light in two media is 3.25×10^8 m/s and their difference is 0.75×10^8 m/s, find the refractive index of the second medium with respect to one : **(MAHARASHTRA/ NTSE Stage-I/2014)**

(A) 1.25 (B) 1.6 (C) 1.5 (D) 1.3

Q.25 The ability of a lens to converge or diverge light rays depends on : **(MAHARASHTRA/ NTSE Stage-I/2014)**

(A) Principal axis (B) Focal length (C) Object distance (D) Image distance

Q.26 The focal length of a concave mirror in air is f. If it is immersed in water $\left(n=\frac{4}{3}\right)$, then the focal length will be : **(Raj./ NTSE Stage-I/2015)**

(A) f (B) $\frac{4}{3}$f (C) $\frac{3}{4}$f (D) 4f.

Q.27 A student was asked to draw a ray diagram for formation of image by a convex lens for the following positions of the object : **(Raj./ NTSE Stage-I/2015)**

(1) Between F and 2F (2) At F

(3) At 2F (4) Between F and optical centre

The position for which virtual image can be formed among these is

(A) 2 (B) 1 (C) 3 (D) 4

Q.28 Amount of light entering into the camera depends upon: **(Delhi/ NTSE Stage-I/2014)**

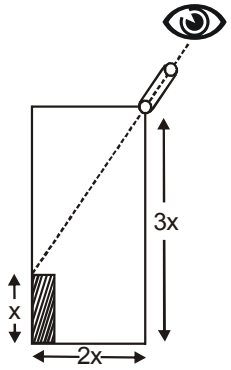
(A) Focal length of objective lens (B) Product of focal length & diameter of objective lens.

(C) Distance of objective from camera. (D) Aperture setting of the camera.

Q.29 The resultant focal length of the lenses as shown in the figure is : **(Delhi/ NTSE Stage-I/2014)**

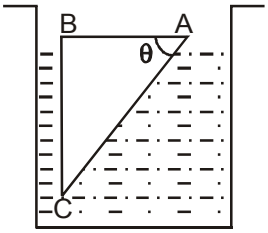
(A) 2t (B) $\frac{f}{2}$ (C) $\frac{f}{4}$ (D) f

Q.30 A man can see through a hole, the top end of a thin rod of height x, the height of beaker is 3x, If the beaker is filled with a liquid of refractive index μ upto height 2x, he can now see the lower end of rod. The value of μ is: **(Haryana/ NTSE Stage-I/2014)**



(A) $\frac{5}{2}$ (B) $\sqrt{\left(\frac{5}{2}\right)}$ (C) $\sqrt{\frac{3}{2}}$ (D) $\frac{3}{2}$

Q.31 A glass prism of refractive index 3/2 is immersed in water of refractive index 4/3. A light beam incident normally on the face AB is totally reflected to reach the face BC if : **(Haryana/ NTSE Stage-I/2014)**



(A) $\sin\theta > \frac{8}{9}$ (B) $\frac{2}{3} < \sin\theta < \frac{8}{9}$ (C) $\sin\theta < \frac{2}{3}$ (D) $\sin\theta > \frac{3}{2}$

Q.32 If a part of a convex lens is covered, its focal length will : **(West Bengal/ NTSE Stage-I/2014)**

(A) Remain unchanged (B) Become twice
(C) Become half (D) Depend on the covered area

Q.33 The minimum distance between an object and its real image in a convex lens is : **(West Bengal/ NTSE Stage-I/2014)**

(A) 2.5 times its focal length (B) 2 times its focal length
(C) 4 times its focal length (D) Equal to its focal length

Q.34 A convex lens forms a real image of a point object placed on its principal axis. If the upper half of the lens is cut **(Bihar/ NTSE Stage-I/2014)**

(A) The image will be shifted downwards (B) The image will be shifted upward
(C) The intensity of the image will decrease (D) None of the above

Q.35 A screen is placed at a distance 40 cm away from an illuminated object. A converging lens it placed between the source and screen and attempt is made to form an image on screen. If no position could be found. The focal length of the lens : **(Bihar/ NTSE Stage-I/2014)**

(A) Must be less than 10 cm (B) Must be greater than 20 cm
(C) Must not be greater than 20 cm (D) Must not be less than 10 cm

Q.36 Find the wrong statement related to convex lens: **(Maharashtra/ NTSE Stage-I/2015)**

(A) Two spherical surfaces bulging outward (B) Converging lens
(C) Positive focal length (D) Image is always virtual and diminished

Q.37 Velocity of light travelling from rarer medium to denser medium decreases by 30%. Find the refractive index of the denser medium with respect to rarer medium ? **(Maharashtra/ NTSE Stage-I/2015)**

(A) 1.35 (B) 1.5 (C) 1.4 (D) 1.428

Q.38 Object when placed at ..... in front of concave mirror magnification of –1 is obtained. **(Maharashtra/ NTSE Stage-I/2015)**

(A) Infinity (B) Centre of curvature
(C) Between focus and centre of curvature (D) Principal focus

ANSWERS

Try Yourself

1. (C)
2. (i) 7/9 m (ii) 2/9 (iii) Virtual, erect and diminished
3. $n_g = 3/2$
4. 1.32
5. 5/8
6. (i) $h_i = 5$ cm (ii) $v = -10$ cm (iii) virtual, erect & diminished (iv) –5 D
7. f = 25 cm, P = 4D

CONCEPT APPLICATION LEVEL - II

SECTION D

Q.1 D Q.2 A Q.3 D Q.4 D Q.5 C Q.6 A Q.7 D
Q.8 D Q.9 B Q.10 C

SECTION G

Q.1 D Q.2 B Q.3 B Q.4 C Q.5 B
Q.6 It means that the incident ray and emergent ray are parallel to each other. Q.7 B
Q.8 D Q.9 A Q.10 A Q.11 A Q.12 D Q.13 B Q.14 A

CONCEPT APPLICATION LEVEL - III

SECTION-A

Q.1 2×10^8 m/s, 0.4×10^{-6} m

SECTION-B

Q.1 A Q.2 B Q.3 D Q.4 C Q.5 B Q.6 B Q.7 B
Q.8 C Q.9. B Q.10 A Q.11 B Q.12 A Q.13 C Q.14 B
Q.15 C Q.16 B Q.17 A Q.18 D Q.19 D

SECTION-C

Q.1 BD Q.2 BC

SECTION-D

Q.1 D Q.2 A Q.3 A Q.4 A Q.5 C

SECTION-E

Q.1 B Q.2 A Q.3 B

SECTION-F

Q.1 (A)-(Q), (B)-(R), (C)-(P), (D)-(S)

SECTION-G

Q.1 (A)-(R), (B)-(P), (C)-(Q,S), (D)-(P,R)

SECTION-H

Q.1	C	Q.2	C	Q.3	A	Q.4	B	Q.5	A	Q.6	A	Q.7	A
Q.8	D	Q.9	A										

SECTION-I

Q.1	B	Q.2	C	Q.3	D	Q.4	A	Q.5	B	Q.6	C	Q.7	B
Q.8	A	Q.9	B	Q.10	A	Q.11	A	Q.12	C	Q.13	D	Q.14	C
Q.15	C	Q.16	A	Q.17	A	Q.18	A	Q.19	A	Q.20	D	Q.21	B
Q.22	B	Q.23	B	Q.24	B	Q.25	B	Q.26	A	Q.27	D	Q.28	D
Q.29	B	Q.30	B	Q.31	A	Q.32	A	Q.33	C	Q.34	C	Q.35	D
Q.36	D	Q.37	D	Q.38	B								