Question 1:
Define the principal focus of a concave mirror.

Answer 1:
Light rays that are parallel to the principal axis of a concave mirror converge at a specific point on its principal axis after reflecting from the mirror. This point is known as the principal focus of the concave mirror.

Question 2:
The radius of curvature of a spherical mirror is 20 cm. What is its focal length?

Answer 2:
Radius of curvature, R = 20 cm
Radius of curvature of a spherical mirror = 2 × Focal length (f)
$R = 2f$

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

Hence, the focal length of the given spherical mirror is 10 cm.

Question 3:
Name the mirror that can give an erect and enlarged image of an object.

Answer 3:
When an object is placed between the pole and the principal focus of a **concave mirror**, the image formed is virtual, erect, and enlarged.

Question 4:
Why do we prefer a convex mirror as a rear-view mirror in vehicles?

Answer 4:
Convex mirrors give a virtual, erect, and diminished image of the objects placed in front of them. They are preferred as a rear-view mirror in vehicles because they give a wider field of view, which allows the driver to see most of the traffic behind him.

Question 1:
Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Answer 1:
Radius of curvature, R = 32 cm
Radius of curvature = 2 × Focal length (f)
$R = 2f$

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

Hence, the focal length of the given convex mirror is 16 cm.

Question 2:
A concave mirror produces three times magnified (enlarged) real image of object placed at 10 cm in front of it. Where is the image located?

Answer 2:
Magnification produced by a spherical mirror is given by the relation,

$$m = \frac{\text{Height of the image}}{\text{Height of the object}} = -\frac{\text{Image distance}}{\text{Object distance}}$$

$$m = \frac{h_1}{h_0} = -\frac{v}{u}$$

Let the height of the object, $h_o = h$
Then, height of the image, $h_I = -3h$ (Image formed is real)

$$\frac{-3h}{h} = \frac{-v}{u}$$

$$\frac{v}{u} = 3$$

Object distance, $u = -10$ cm $v = 3 \times (-10) = -30$ cm

Here, the negative sign indicates that an inverted image is formed at a distance of 30 cm in front of the given concave mirror.

Question 1:
A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why?

Answer 1:
The light ray bends towards the normal.

When a ray of light travels from an optically rarer medium to an optically denser medium, it gets bent towards the normal. Since water is optically denser than air, a ray of light travelling from air into the water will bend towards the normal.

Question 2:
Light enters from air to glass having refractive index 1.50. What is the speed of light in the glass? The speed of light in vacuum is 3×10^8 m s^{-1}.

Answer 2:
Refractive index of a medium n_m is given by,

$$n_m = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

Speed of light in vacuum, $c = 3 \times 10^8$ m s^{-1}

Refractive index of glass, $n_g = 1.50$

Speed of light in the glass, $v = \frac{c}{n_g} = \frac{3\times10^8}{1.50} = 2\times10^8 \text{ m s}^{-1}$

Question 3:

Find out, from Table 10.3, the medium having highest optical density. Also find the medium with lowest optical density.

Table 10.3 Absolute refractive index of some material media

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Canada Balsam	1.53
Ice	1.31		
Water	1.33	Rock salt	1.54
Alcohol	1.36		
Kerosene	1.44	Carbon disulphide	1.63
Fused quartz	1.46	Dense flint glass	1.65
Turpentine oil	1.47	Ruby	1.71
Benzene	1.50	Sapphire	1.77
Crown glass	1.52	Diamond	2.42

Answer 3:

Highest optical density = Diamond

Lowest optical density = Air

Optical density of a medium is directly related with the refractive index of that medium. A medium which has the highest refractive index will have the highest optical density and vice-versa.

It can be observed from table 10.3 that diamond and air respectively have the highest and lowest refractive index. Therefore, diamond has the highest optical density and air has the lowest optical density.

Question 4:
You are given kerosene, turpentine and water. In which of these does the light travel fastest? Use the information given in Table.

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Crown glass	1.52	Diamond	2.42

Answer 4:
Speed of light in a medium is given by the relation for refractive index (n_m). The relation is given as

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

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

$$v \propto \frac{1}{n_m}$$

It can be inferred from the relation that light will travel the slowest in the material which has the highest refractive index and travel the fastest in the material which has the lowest refractive index.
It can be observed from table 10.3 that the refractive indices of kerosene, turpentine, and water are 1.44, 1.47, and 1.33 respectively. Therefore, light travels the fastest in water.

Question 5:
The refractive index of diamond is 2.42. What is the meaning of this statement?

Answer 5:
Refractive index of a medium n_m is related to the speed of light in that medium v by the relation:

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

Where, c is the speed of light in vacuum/air

The refractive index of diamond is 2.42. This suggests that the speed of light in diamond will reduce by a factor 2.42 compared to its speed in air.

Question 1:
Define 1 dioptre of power of a lens.

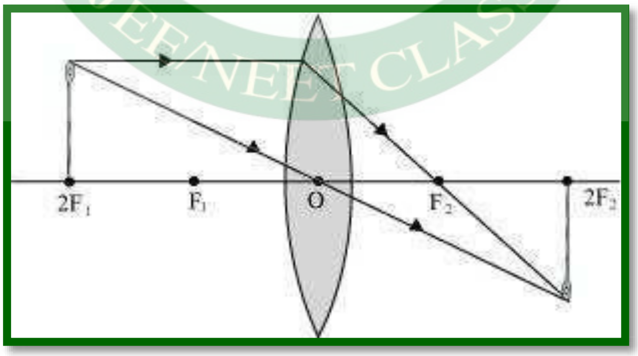
Answer 1:
Power of lens is defined as the reciprocal of its focal length. If *P* is the power of a lens of focal length *F* in metres, then

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

The S.I. unit of power of a lens is Dioptre. It is denoted by D.
1 dioptre is defined as the power of a lens of focal length 1 metre.
$\therefore$ 1 D = 1 m^{-1}

Question 2:
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.

Answer 2:
When an object is placed at the centre of curvature, $2F_1$, of a convex lens, its image is formed at the centre of curvature, $2F_2$, on the other side of the lens. The image formed is inverted and of the same size as the object, as shown in the given figure.



It is given that the image of the needle is formed at a distance of 50 cm from the convex lens. Hence, the needle is placed in front of the lens at a distance of 50 cm.

Object distance, *u* = −50 cm
Image distance, *v* = 50 cm
Focal length = *f*
According to the lens formula,

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

$$\frac{1}{f}=\frac{1}{50}-\frac{1}{(-50)}=\frac{1}{50}+\frac{1}{50}=\frac{1}{25}$$

$$f=25\,\text{cm}\ =0.25\ \text{m}$$

$$\text{Power of the lens, } P=\frac{1}{f\,(\text{in meters})}=\frac{1}{0.25}=+4\ \text{D}$$

Hence, the power of the given lens is +4 D.

Question 3:
Find the power of a concave lens of focal length 2 m.

Answer 3:
Focal length of concave lens, f = 2 m

$$\text{Power of a lens, } P=\frac{1}{f\,(\text{in meters})}=\frac{1}{(-50)}=-0.5\,\text{D}$$

Here, negative sign arises due to the divergent nature of concave lens.

Hence, the power of the given concave lens is −0.5 D.