O P JINDAL SCHOOL, SAVITRINAGAR

ASSIGNMENT

CLASS X PHYSICS

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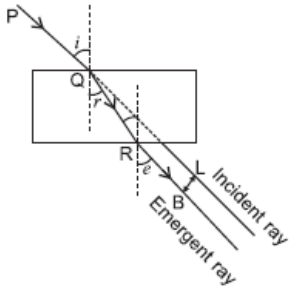
91 What is understood by lateral displacement of light? Illustrate it with the help of a diagram. List any two factors on which the lateral displacement of a particular substance depends. 3

ANS: Lateral displacement is the perpendicular distance between the incident ray produced and emergent ray. The lateral displacement in the given diagram is BL.
The lateral displacement depends on the thickness of the slab, the incident angle and the refractive index of the material.



92 (a) Draw a ray diagram to show the path of a light ray passes from one medium to another if the two media are optically exactly the same.
(b) Absolute refractive indices of medium 'A' and medium 'B' are 'n_a' and 'n_b' respectively. What is the refractive index of medium 'B' with respect to medium 'A'. 3
(c) How does the velocity of light vary with change in the optical density of the media?

ANS: (a) Since two media are optically exactly the same, no bending of the light rays occur when they pass from one medium to another as their refractive indices are equal.

(b) Refractive index of medium 'B' with respect to 'A' is $$n_{BA} = \frac{n_B}{n_A}$$

(c) Refractive index of the medium nm is given by

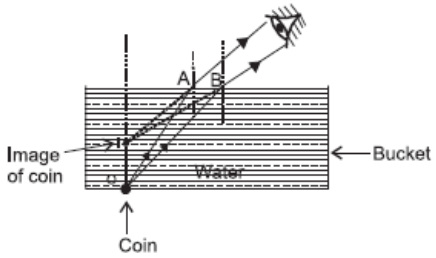
$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}} = \frac{c}{v}$$

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

It is obvious from the above relation, that the speed of light decreases with the increase in optical density, i.e. refractive indices of the media.

93 A coin is kept at the bottom of an empty bucket. A student standing near to it cannot see the coin. Another student pours some water into the bucket without disturbing the coin. Now, the first student is able to see the coin from the same position. Explain how it become possible to see the coin now? Draw a ray diagram to illustrate it. 3

ANS: When the coin is under water, then due to refraction of light, a virtual image of the coin is formed which is slightly above its actual position nearer to the water surface as shown in the figure. Thus, the coin becomes visible again on pouring some water into the bucket.



94 (a) Differentiate between reflection and refraction.
(b) A lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides. Explain why it so appears. 3

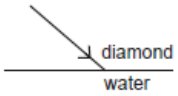
ANS: (a) Difference between reflection and refraction

Reflection	Refraction
1. It is the phenomenon of change in the path of light rays in a particular direction into the same medium again is called reflection. 2. The reflecting surfaces of all types, obey the laws of reflection.	1. When a ray of light enters from one medium into another obliquely, the direction of propagation of the light in the second medium changes. This is called the refraction of light. 2. The refracting surfaces obey the laws of refraction.

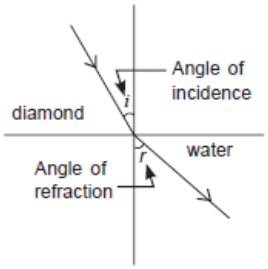
(b) As the ray of light comes into air from the different points on the surface of a lemon kept in water in a glass tumbler, it bends away from the normal, i.e. there is a change in the direction of propagation of light due to refraction. So, the ray of light appears to come from a point different from that of the actual point. Therefore, the lemon in water appears to be bigger than its actual size, when viewed from the sides of the glass tumbler.

95 A ray of light is incident on the interface separating diamond and water. Given that refractive indices of diamond and water with respect to air are 2.42 and 1.33 respectively, complete the diagram by showing a refracted ray and mark the angles of incidence and refraction.

3



ANS: Since the refractive index of diamond is more than that of water, so it is optically denser. Hence the light ray moves from a denser medium to a rarer medium and it will bend away from the normal in water as shown below.



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

ANS: Laws of refraction of light

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

(ii) The ratio of sine of angle of incidence, i.e. sin i to the sine of angle of refraction, i.e. sin r is always constant, for the light of a given colour and for the given pair of media.

Mathematically, $\frac{\sin i}{\sin r} = \text{constant} = n_{21}$

The constant n_{21} is called the refractive index of the second medium with respect to the first medium.

Absolute refractive index of the medium is given by

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

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

Given: $c = 3 \times 10^8$ m/s, $v = 1.4 \times 10^8$ m/s

$$n_m = \frac{c}{v} = \frac{3 \times 10^8}{1.4 \times 10^8} = \frac{3}{1.4} = 2.14$$

97 An object of height 6 cm is placed perpendicular to the principal axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size and nature of the image if the distance of the object from the lens is 10 cm. 3

ANS: Given: $h_o = 6$ cm, $f = -5$ cm, $u = -10$ cm

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$. $\frac{1}{-5} = \frac{1}{v} - \frac{1}{-10}$

$\frac{1}{v} = \frac{-3}{10}$

or $\frac{1}{v} = \frac{1}{-5} - \frac{1}{10} = \frac{-2-1}{10}$ $v = -\frac{10}{3}$ cm Thus, the image is formed on the same side of the object at a distance of $-\frac{10}{3}$ cm from the optical centre of the lens. The negative sign indicates that the image is virtual.

Using the formula, $m = \frac{h_i}{h_o} = \frac{v}{u}$ — $h_i = \frac{v}{u} \times h_o = \frac{-10}{3 \times (-10)} \times 6 = +2$ cm

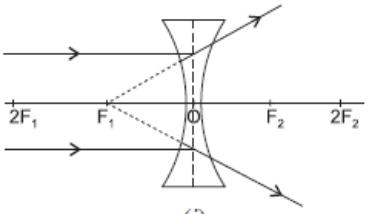
The positive sign indicates that the image is erect.

98 If the image formed by a lens for all positions of the object placed in front of it is always virtual, erect and diminished, state the type of the lens. Draw a ray diagram in support of your answer. If the numerical value of focal length of such a lens is 20 cm, find its power in new cartesian sign conventions. 3

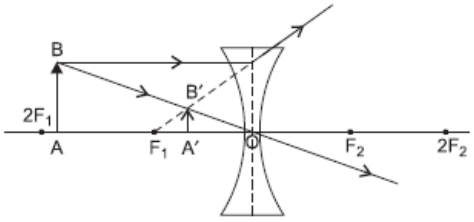
ANS: Concave lens.

(i) When an object is placed at infinity.

(ii) When an object is placed between F_1 and $2F_1$.



(*i*)



(*ii*)

Thus, from the above figures, it is clear that whatever be the position of the object in front of a concave lens, the image formed is always virtual, erect and diminished.

The power of the given lens is calculated as $P = \frac{1}{f(\text{m})} = \frac{100\text{ cm}}{-20\text{ cm}} = -5$ — $P = -5D$

99 An object of height 5 cm is placed perpendicular to the principal 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 and size of the image. 3

ANS: Given: $h_o = +5$ cm, $f = -10$ cm, $u = -20$ cm, $v = ?$, $h_i = ?$

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get $\frac{1}{-10} = \frac{1}{v} - \frac{1}{-20} = \frac{1}{v} + \frac{1}{20}$

— $\frac{1}{v} = -\frac{1}{10} - \frac{1}{20} = \frac{-2-1}{20} = -\frac{3}{20}$. $v = -\frac{20}{3} = -6.67$ cm

So, the image is formed on the same side of the object at a distance of 6.67 cm. The negative sign indicates that the image is virtual.

Also $|v| < |u|$, so the image is diminished. • $m = \frac{v}{u} = \frac{h_i}{h_o}$ or $\frac{-20/3}{-20} = \frac{h_i}{5}$

or $h_i = \frac{5}{3} = 1.66$ cm

So, the image is virtual, erect, diminished and of size 1.66 cm.

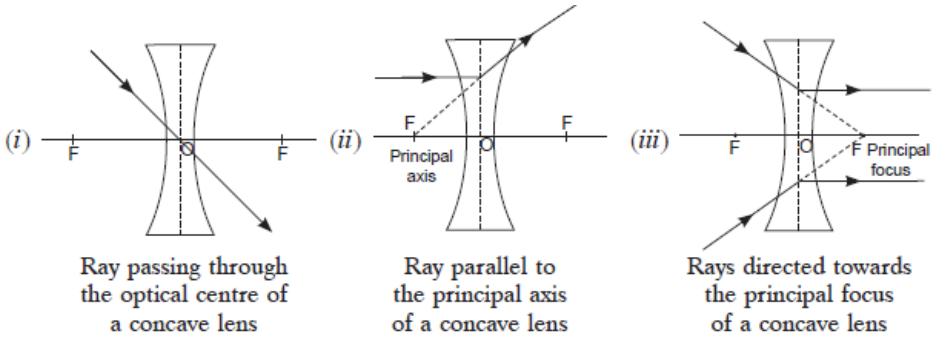
100 Draw a ray diagram to show the path of the refracted ray in each of the following cases: A ray of light incident on a concave lens is

(i) passing through its optical centre. 3

(ii) parallel to its principal axis.

(iii) directed towards its principal focus.

ANS:



Ray passing through the optical centre of a concave lens

Ray parallel to the principal axis of a concave lens

Rays directed towards the principal focus of a concave lens