QB365 Question Bank Software

12th Physics Case study Questions Ray Optics and Optical Instruments For - 2024

12th Standard

Physics

SECTION -A 2 x 4 = 8

1) The lens maker's formula relates the focal length of a lens to the refractive index of the lens material and the radii of curvature of its two surfaces. This formula is called so because it is used by manufacturers to design lenses of
required focal length from a glass of given refractive index. If the object is placed at infinity, the image will be formed at focus for both double convex lens and double concave lens

Therefore, lens maker's formula is $\frac{1}{f} = \left[\frac{\mu_2 - \mu_1}{\mu_1}\right]\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

When lens is placed in air, $\mu_1 = 1$ and $\mu_2 = \mu$. The lens maker formula takes the form

$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

(i) The radius of curvature of each face of biconcave lens with refractive index 1.5 is 30 cm. The focal length of the lens in air is

(a) 12 cm **(b) 10 cm** **(c) 20 cm** **(d) 30 cm**

(ii) The radii of curvature of the faces of a double convex lens are 10 cm and 1.5 cm. If focal length is 12 cm, then refractive index of glass is

(a) 1.5 **(b) 1.78** **(c) 2.0** **(d) 2.52**

(iii) An under-water swimmer cannot see very clearly even in absolutely clear water because of

(a) absorption oflight in water **(b) scattering of light in water**

(c) reduction of speed of light in water **(d) change in the focal length of eye-lens**

(iv) A thin lens of glass (μ = 1.5) offocallength 10 cm is immersed in water (μ = 1.33). The new focal length is

(a) 20 cm **(b) 40 cm** **(c) 48 cm** **(d) 12 cm**

(v) An object is immersed in a fluid. In order that the object becomes invisible, it should

(a) behave as a perfect reflector
(b) absorb all light falling on it
(c) have refractive index one
(d) have refractive index exactly matching with that of the surrounding fluid.

Answer : **(i) (d):** Here, $\mu = 1.5; R_1 = 30 \text{ cm}$

R_2 = -30 cm

$$\text{As } \frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$= (1.5 - 1)\left[\frac{1}{30} - \frac{1}{-30}\right] = -0.5 \times \frac{2}{30} - \frac{-1}{30}$$

$$f = -30 \text{ cm}$$

(ii) (a): Here, f= 12 cm ; R_1 = 10 cm

R_2 = -15 cm

$$\text{As } \frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\frac{1}{12} = (\mu - 1)\left[\frac{1}{10} + \frac{1}{15}\right]$$

$$\mu = 1.5$$

(iii) (d): The eye-lens is surrounded by a different medium than air. This will change the focal length of the eye-lens. The eye cannot accommodate all images as it would do in air.

(iv) (b): $\frac{1}{f} = (1.5 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

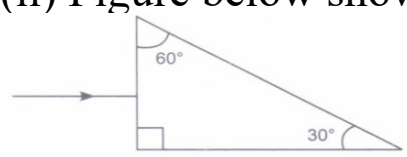
$$\text{and } \frac{1}{f_w} = \left(\frac{1.5}{1.33} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{f_w}{f} = \frac{0.5 \times 1.33}{0.17} = 4$$

$$f_w = 4f = 4 \times 10 = 40 \text{ cm}$$

(v) (d): If the refractive index of two media are same,the surface of separation does not produce refraction or reflection which helps in visibility.

2) (i) Explain what is meant by (a) total internal reflection (b) critical angle.
(ii) Figure below shows a ray of light, travelling in air, incident on a glass prism.

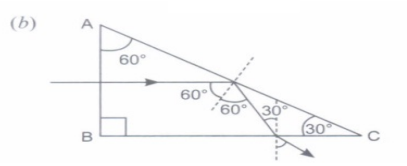


(a) The speed of light in air is 3.0 x 10^8 m/s. Its speed in the glass is 2.0 x 10^8 m/s. Calculate toe refractive index of the glass.
(b) On figure, draw carefully, without calculation, the continuation of the ray through the prism and into the air.
(c) Show that the critical angle for the glassair boundary is 42°.

Answer : (i) (a) Important Terms and Concepts,
Total Internal Reflection
When the angle of incidence is increased then for some angle of incidence ie called the critical angle, the angle of refraction will be 90°. If the angle of incidence is increased beyond ie., the incident ray is reflected back in the denser medium and obeys the laws of reflection. This is known as total internal reflection. The following are the necessary conditions for total internal reflection to take place.
(b) Critical angle: It is the angle of incidence in denser medium for which angle of refraction in rarer medium is 90°

(ii) (a) $\because$ $\text{R.I. of glass } = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}}$

$$= \frac{3 \times 10^8}{2 \times 10^8} = 1.5$$



$\because$ i = 60° is greater than critical angle = 42°