Reflection, Refraction & Dispersion of Light

Previous Years Examination Questions

1.A biconvex lens made of a transparent material of refractive index 1.25 is immersed in a water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Give reason. [All India 2014]

Ans. When a lens is placed in a liquid, where refractive index is more than that of the material of lens, then the nature of the lens changes. So, when a biconvex lens of refractive index 1.25 is immersed in water (refractive index 1.33), i.e. in the liquid of higher refractive index, its nature will change. So, biconvex lens will act as biconcave lens or diverging lens.

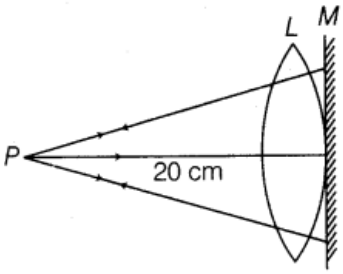
2.A biconvex lens made of a transparent material of refractive index 1.5 is immersed in a water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Give reason. [Ail India 2014]

Ans. A biconvex lens acts as a converging lens in air because the refractive index of air is less than that of the material of the lens. The refractive index of water is less than the refractive

index of the material of the lens (1.5). So, its nature will not change, it behaves as a converging lens.

3.A convex lens is placed in contact with a plane mirror. A point object at a distance of 20 cm on the axis of this combination has its image coinciding with itself. What is the focal length of the lens? [All India 2014]

Ans. The adjacent figure shows a convex lens L in contact with a plane mirror P is the point object kept in the front of this combination at a distance of 20 cm from it.



Since, the image is coinciding with the object itself, the rays from the object after refraction from the lens fall normally on the mirror M and form an image coinciding with the object itself. So, the image is formed at the focus of the lens. So, focal length of the lens is 20 cm.

4.Write the relationship between angle of incidence i, angle of prism A and angle of minimum deviations from a triangular prism. [Delhi 2013]

Ans. The relation between the angle of incidence /', angle of prism, A and the angle of minimum deviation, A_m for a triangular prism is given by

$$i = \frac{A + \Delta_m}{2}.$$

5.How does focal length of a lens change when red light incident on it is replaced by violet light? Give reason for your answer. [Foreign 2012]

Ans.The refractive index of the material of a lens increases with the decrease in wavelength of the incident light. So, focal length will decrease with decrease in wavelength according to the formula.

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

Thus, when we replace red light with violet light then due to increase in wavelength the focal length of the lens will decrease

6.Name the physical quantity which remains same for microwaves of wavelength 1 mm and UV-radiation of 1600 A in vacuum. [Delhi 2012]

Ans. Both microwave and UV-rays are a part of the electromagnetic spectrum. Thus, the physical quantity that remains for both types of radiation will be their speeds equal to
c. $c=3\times10^8 m/s$

7.Under what condition, does a biconvex lens of glass having a certain refractive index act as a plane glass sheet when immersed in a liquid? [Delhi 2012]

Ans. When refractive index of lens is equal to the refractive index of liquid.

8.For the same value of angle of incidence, the angles of refraction in three media A, B and C are 15°, 25° and 35° respectively. In which medium, would the velocity of light be minimum? [All India 2012]

From Snell's law, $\mu = \frac{\sin i}{\sin r} = \frac{c}{v}$

$\Rightarrow$ $v \propto \sin r$ for given value of i

$\Rightarrow$ Smaller angle of refraction, smaller the velocity of light in medium.

Velocity of light is minimum in medium, A as angle of refraction is minimum, i.e. 15°. **(1)**

9.When monochromatic light travels from one medium to another, its wavelength changes but frequency remains the same. Explain. [Delhi 2011]

Ans.Because refractive index for a given pair of media depends on the ratio of wavelengths and velocity of light in two medium and not on frequency

10.The refractive index of diamond is much greater than that of glass. How does a diamond cutter make use of this fact? [HOTS; All India 2011C]

Ans. The refractive index of diamond is much higher than that of glass. Due to high refractive index, the critical angle for diamond air interface is low. The diamond is cut suitably so that the light entering the diamond from any face suffers multiple total internal reflections at the various surfaces.

11.If a ray of light propagates from a rarer to a denser medium, how does its frequency change? [All India 2011c]

Ans. Frequency remains unchanged when light travels from one transparent medium to another transparent medium.

12.State the criteria for the phenomenon of total internal reflection of light to take place. [Delhi 2011,2010, 2008C]

Ans. Following are the criteria for total internal reflection

(i) Light must pass from a denser to a rarer medium.

(ii) Angle of incidence must be greater than critical angle

13.A lens behaves as a converging lens in air and a diverging lens in water (g = 4/3). What will be the condition on the value of refractive index (g) of the material of the lens? [Delhi 2011c]

Ans. Refractive index of the material **of** lens is less than the refractive index **of** water.

14.A converging lens axially in contact with a diverging lens; both the lenses being of equal focal lengths. What is the focal length of the combination? [All India 2010]

Combined focal length of a lens combination

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$ (For two thin lenses in contact)

As, $f_2 = -f_1$

(focal lengths are equal, one is convex and other is concave)

$$\Rightarrow \quad \frac{1}{f} = 0 \quad \Rightarrow \quad f = \infty.$$ **(1)**

15.A glass lens of refractive index 1.45 disappears when immersed in a liquid What is the . value of refractive index of the liquid? [Delhi 2010]

When a lens immersed in a liquid disappears then, $\mu_{liquid} = \mu_g = 1.45$ **(1)**

16.Calculate the speed of light in a medium whose critical angle is 30°. [Delhi 2010]

> Critical angle is the angle of incidence for which angle of refraction becomes 90°. Here, in this case refractive index, $\mu = \frac{1}{\sin i_C}$

$\because$ Refractive index, $\mu = \frac{c}{v} = \frac{1}{\sin i_C}$

$$\Rightarrow \quad v = c \sin i_C = 3 \times 10^8 \times \sin 30°$$

$$= 3 \times 10^8 \times \frac{1}{2} = 1.5 \times 10^8 \text{ m/s}$$ **(1)**

17.Why does the sky appear blue? [Foreign 2010]

Due to large scattering of visible light of smaller wavelength (blue colour) as intensity of scattered light $\propto \frac{1}{\lambda^4}$. **(1)**

18.Under what condition does the formation of rainbow occur? [All India 2010C]

Ans. Availability of rain drops causes refraction, dispersion and total internal reflection of sun light results in the form of rainbow and the back of the observer should be towards the sun.

19.Two thin lenses of power + 6 D and -2D are in contact. What is the focal length of the combination? [All India 2010]

Resultant power of the combination,

$$P = P_1 + P_2 = 6 - 2 = 4\text{D}$$

$$\therefore \quad \frac{1}{f} = 4 \quad \Rightarrow \quad f = \frac{1}{4} \text{m} = 25 \text{ cm}$$

20.Two thin lenses of power + 4 D and -2D are in contact. What is the focal length of the combination? [All India 2010]

Refer to ans. 19, (f = 50 cm).

21.Two thin lenses of power + 5D and -2.5D are in contact. What is the focal length of the combination? [All India 2010]

Refer to ans. 19, (f = 40 cm).

22.Why are convex mirrors used as side view mirrors in cars? [Delhi 2009c]

Ans. Because convex mirror forms virtual, erect and smaller image of object irrespective of relative position of object from mirror and therefore, its field of view is very wide.

23.A converging lens of refractive index 1.5 is kept in a liquid medium having same refractive index. What would be the focal length of the lens in this medium? [hots; Delhi 2008]

As the lens is placed in same medium as that of the lens, the ray will pass without any deviation.

In liquid, $\frac{1}{f} = \left(\frac{\mu_g}{\mu_s} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Given, $\mu_g = \mu_s$

$\therefore \quad \frac{1}{f} = \left(\frac{\mu_g}{\mu_g} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0 \quad \text{or} \quad f = \infty$ **(1)**

24.How does the power of convex lens vary if the incident red light is replaced by violet light? [Delhi 2008]

From lens maker's formula, $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

We can write

$$P = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

For same lens when only medium is changed

$\Rightarrow \quad P \propto (\mu - 1)$

Also, $\mu \propto \frac{1}{\lambda\,(\text{wavelength})}$

$\therefore \quad P \propto \frac{1}{\lambda}$

Due to decrease of wavelength (red to violet), the refractive index of glass increases and hence power of lens increases. **(1)**

25.Explain giving reason why the sun looks reddish at sunrise or sunset? [Foreign 2008]

Intensity of scattered light $\propto \frac{1}{\lambda^4}$ (Rayleigh criteria).

Red light have got highest wavelength in visible spectrum, therefore scatters least and hence, red light from sun able to reach on the earth at the time of sunrise and sunset. Therefore, the sun appears reddish at the time of sunrise and sunset. **(1)**