

Class10 CBSE Test paper Chapter: Reflection and Refraction of Light - 03

Question based on Refraction and Refractive index. Glass Slab, Lateral Shift.

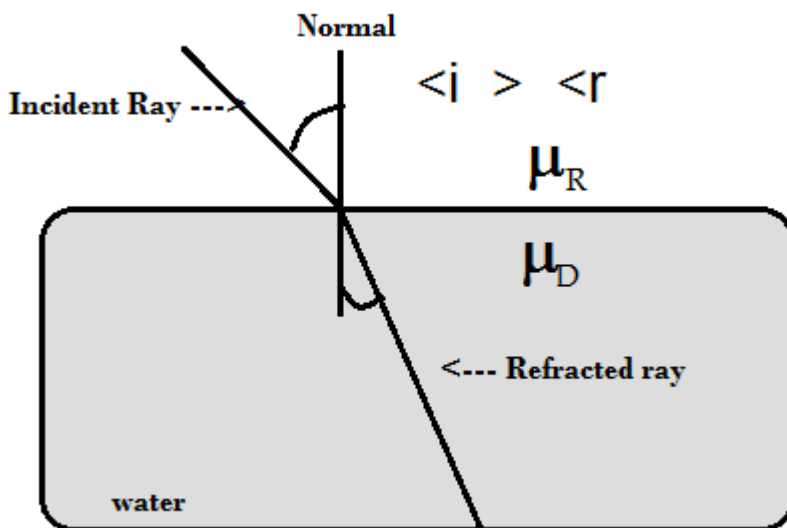
1. Q. What is refraction of light? What are the laws of refraction?

Ans: Deviation of ray of light from its original path when it travels from one transparent homogeneous medium to another transparent homogenous medium is called the refraction of light.

There are two laws of refraction:

(i) Incident ray, reflected ray and normal lie in the same plane.

(ii) The ratio of sine of angle of incidence and sine of angle of refraction is constant i.e. $\sin i / \sin r = n_{21}$. This is also called as Snell's law.



2. Q. Define Refractive Index:

Ans: It is the ratio of speed of light in vacuum to the speed of light in medium is called Refractive index.

3. Q. Give the ratio of velocities of two light waves travelling in vacuum and having wave lengths 4000\AA and 8000\AA .

Ans: In Vacuum, light of all the wave lengths travel with the same velocity i.e. 3×10^8 m/sec.

4. Q. For what angle of incidence, the lateral shift produced by parallel sided glass plate is zero?

Ans: For $i = 0^\circ$.

5. Q. What are the factors on which the lateral shift depends?

Ans: Thickness of the refracting medium, angle of incidence and its refractive index.

6. Q. Refractive index of media A, B, C and D are

A	B	C	D
1.54	1.33	1.46	1.62

In which of the four media is the speed of light (i) Minimum (ii) Maximum.

Ans: (i) Speed of light is minimum in medium D ($n = 1.62$). (ii) Speed of light is maximum in medium B ($n = 1.33$).

7. Q. What is the value of Relative refractive index of air?

Ans: One.

8. Q. If speed of light in vacuum = 3×10^8 m/sec and Refractive index of water = $4/3$, what is the speed of light in water?

Ans: Refractive index of water = Speed of light in vacuum / Speed of light in water;

$$\frac{4}{3} = \frac{3 \times 10^8 \text{ m/sec}}{\text{Speed of light in water}}$$

$$\text{Speed of light in water} = (3 \times 10^8 \text{ m/sec}) \times \frac{3}{4} = \frac{9}{4} \times 10^8 \text{ m/sec} = 2.25 \times 10^8 \text{ m/sec}.$$

9. Q. For the same angle of incidence in media P, Q and R, the angles of refraction are 35° , 25° , 15° respectively. In which medium will the velocity of light be minimum?

$$\text{Ans: According Snell's law } n = \frac{\sin i}{\sin r} = \frac{c}{v}$$

For given angle of incidence (i), v will be minimum, when angle of refraction r is minimum

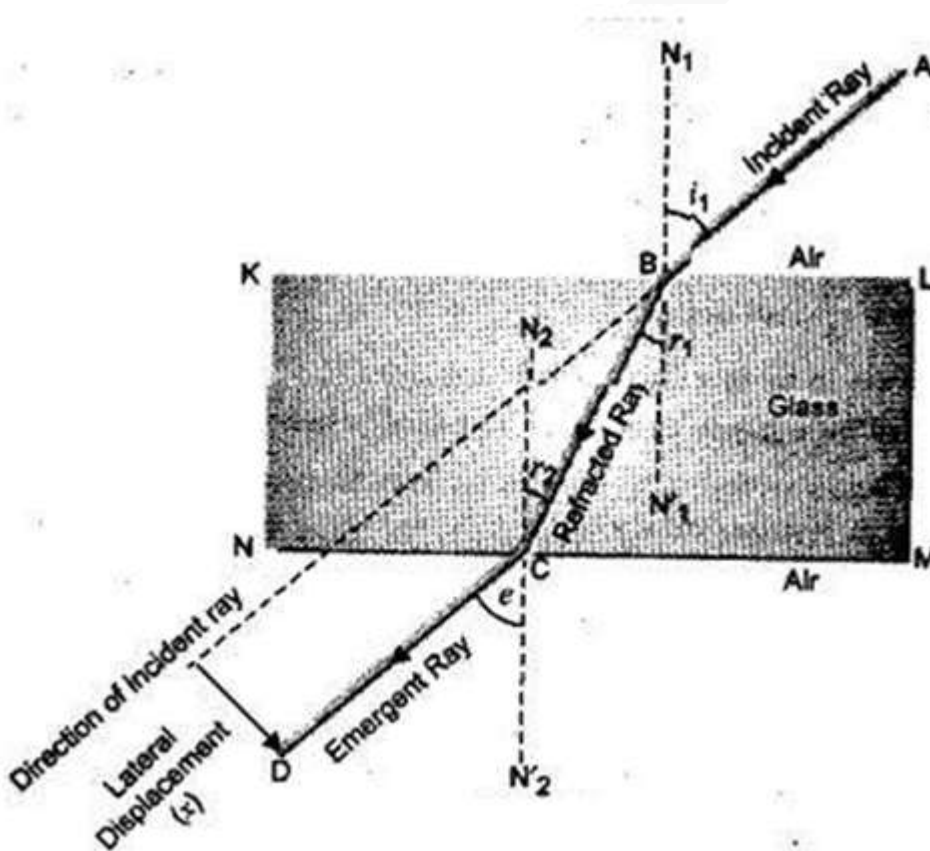
In given data it is for medium R.

10. Q. A coin in a glass beaker appears to rise as the beaker is slowly filled with water. Why?

Ans: It happens on account of refraction of light. A ray of light starting from the coin goes from water to air and bends away from normal. Therefore, bottom of the beaker on which the coin lies appears to be raised.

11. Q. When a ray of light passes through a parallel sided glass slab of transparent medium then show that angle of incidence is equals to angle of emergence.

Solution:



Applying Snell's Law at B,

$$\frac{\sin i_1}{\sin r_1} = \frac{n_g}{n_a} \text{ -----(i)}$$

Applying Snell's Law at C,

$$\frac{\sin r_2}{\sin e} = \frac{n_a}{n_g} \Rightarrow \frac{\sin e}{\sin r_2} = \frac{n_g}{n_a} \text{ -----(ii)}$$

From (i) & (ii)

$$\frac{\sin i_1}{\sin r_1} = \frac{\sin e}{\sin r_2} \text{ ----- (iv)}$$

Now, $KL \parallel MN$ and $N_1 \perp KL$ and $N_2 \perp MN$

$\Rightarrow N_1 \parallel N_2$ and BC is transversal,

$$\angle r_2 = \angle r_1$$

$$\Rightarrow \sin r_2 = \sin r_1 \text{ ----- (v)}$$

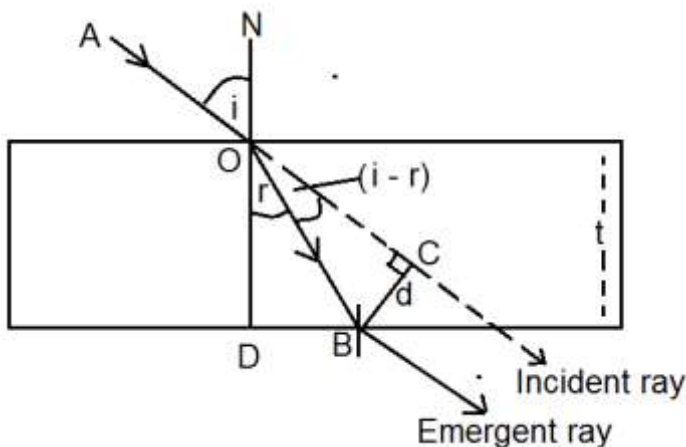
From (iv) & (v)

$$\sin i_1 = \sin e$$

Angle of emergent at second boundary MN of glass slab is equal to angle of incidence at the first boundary KL of glass slab. Hence, $CD \parallel AB$

12. Q. What is lateral shift? Explain with the help of a diagram.

Ans: When a ray of light travels through a glass slab from air, it bends towards the normal and when it comes out of the other side of the glass slab it bends away from the normal. It is found that the incident ray and the emergent ray are not along the same straight line, but the emergent ray seems to be displaced with respect to the incident ray. This shift in the emergent ray with respect to the incident ray is called lateral shift or lateral displacement. The incident and the emergent rays, however, remain parallel.



Lateral Shift

The perpendicular distance between incident and emergent ray is known as lateral shift.
Lateral Shift

$d = BC$ and $t =$ thickness of slab

$$\text{In } \Delta BOC, \sin(i - r) = \frac{BC}{OB} = \frac{d}{OB} \Rightarrow d = OB \sin(i - r) \text{ ----- (i)}$$

$$\text{In } \Delta OBD, \cos r = \frac{OD}{OB} = \frac{t}{OB} \Rightarrow OB = \frac{t}{\cos r} \text{ ----- (ii)}$$

From (i) and (ii)

$$d = \frac{t}{\cos r} \sin(i - r)$$

13. Q. An object under water appears to be at lesser depth than in reality. Explain why?

Ans: This is due to refraction of light. We know

$$\frac{\text{Real depth}}{\text{Apparent depth}} = n \Rightarrow \text{Apparent depth} = \frac{\text{Realdepth}}{n}$$

Since $n > 1$, so apparent depth $<$ real depth.

14. Q. When does Snell's law fail?

Ans: Snell's law fails when light is incident normally on surface of a refracting medium.

15. Q. Light of wavelength λ in air enters a medium of refractive index n . What will be its wavelength, velocity and frequency in the medium?

Answer: We know, $n = c / v$, where $c = 3 \times 10^8 \text{ ms}^{-1}$

Therefore, $v = c/n$, which is the velocity of light in the medium.

Also $c = v\lambda$ and $v = v\lambda'$

Therefore, $c / v = \lambda / \lambda'$

Or $\lambda' = \lambda / (c / v) = \lambda / n$, which is wavelength of light in the medium.

Frequency of light in air, $v = c / \lambda$

Frequency of light in medium, $v' = v / \lambda' = (v / \lambda) n = (v / \lambda)(c / v) = c / \lambda$.

Hence $v' = v$.

So frequency of light in the medium is same as that in air.

16. Q. With respect to air the refractive index of ice and rock salt benzene are 1.31 and 1.54 respectively. Calculate the refractive index of rock salt with respect to ice.

Ans: We know that,

With respect to air the refractive index of ice = 1.31 and rock salt benzene 1.54

$$n = 1.54 / 1.31 = 1.17$$

17. Q. When light goes from one medium to another, the characteristics that remain unaffected is (a) Speed (b) Direction (c) Wave length (d) Frequency

Ans: (d) Frequency

18. Q. Bending of a ray of light due to change in velocity with medium is called

(a) Reflection (b) Refraction (c) Diffraction (d) Dispersion

Ans: (b) Refraction

19. Q. For no bending of a ray of light through a glass slab, angle of incidence must be

(a) 0° (b) 30° (c) 60° (d) 90°

Ans: (a) 0°

20. Q. Under what condition will a glass lens placed in a transparent liquid become invisible? Describe and illustrate with a diagram, how we should arrange two converging lenses so that a parallel beam of light entering one lens emerges as a parallel beam after passing through the second lens.

Ans:

(a) When the refractive index of glass and liquid are same, the glass lens will become invisible in the liquid.

(b) When both the converging lenses are placed at a distance of $f_1 + f_2$ where f_1 is the focal length of lens 1 and f_2 is the focal length of lens 2.

