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12. The speed of light in vacuum and in two different glasses is given in the table below:

Medium	Speed of light
Vacuum	$3.00 \times 10^8 \text{ m/s}$
Flint glass	$1.86 \times 10^8 \text{ m/s}$
Crown glass	$1.97 \times 10^8 \text{ m/s}$

(a) Calculate the absolute refractive indices of flint glass and crown glass.

Absolute refractive index of flint glass

$$\begin{aligned} &= \mu_{\text{vacuum fl. glass}} = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in flint glass}} \\ &= \frac{3.00 \times 10^8 \text{ m/s}}{1.86 \times 10^8 \text{ m/s}} = \frac{3 \times 10^8 \text{ m/s}}{1.86 \times 10^8 \text{ m/s}} \\ &= 1.61 \end{aligned}$$

Absolute refractive index of crown glass =  $\mu_{\text{vacuum crown glass}}$

$$\begin{aligned} &= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in crown glass}} \\ &= \frac{3 \times 10^8 \text{ m/s}}{1.97 \times 10^8 \text{ m/s}} = 1.52 \end{aligned}$$

(b) Calculate the relative refractive index for light going from crown glass to flint glass.

Relative refractive index for light going from crown glass to flint glass =  $m_1$  cr. glass  $m_2$  fl. glass

= ~~1.059~~ Refractive index of flint glass

$$= \frac{\text{Speed of light of crown glass}}{\text{Speed of light of flint glass}}$$

$$= \frac{1.97 \times 10^8 \text{ m/s}}{1.86 \times 10^8 \text{ m/s}} = 1.059$$

13. The speed of light in air is  $3 \times 10^8 \text{ m/s}$ . In medium X its speed is  $2 \times 10^8 \text{ m/s}$  and in medium Y the speed of light is  $2.5 \times 10^8 \text{ m/s}$ . Calculate:

(a)  $n_x = \frac{\text{Speed of light in air}}{\text{Speed of light in medium X}} = \frac{3 \times 10^8 \text{ m/s}}{2 \times 10^8 \text{ m/s}} = 1.5$

(b)  $n_y = \frac{\text{Speed of light in air}}{\text{Speed of light in medium Y}} = \frac{3 \times 10^8 \text{ m/s}}{2.5 \times 10^8 \text{ m/s}} = 1.2$

$$\begin{aligned}
 \mu_x \mu_y &= \frac{\text{Speed of light in medium X}}{\text{Speed of light in medium Y}} \\
 &= \frac{2 \times 10^8 \text{ m/s}}{2.5 \times 10^8 \text{ m/s}} \\
 &= 0.8
 \end{aligned}$$

14) What is speed of light in a medium of refractive index 6/5 if its speed in air is 300000 km/s?

Let the medium with refractive index 6/5 be  $n$  and the speed of light through it be  $x$ .

$$\mu_n = \frac{\text{Speed of light in air}}{\text{Speed of light in medium X}}$$

$$\Rightarrow \frac{300000 \text{ km/s}}{x} = \frac{6}{5}$$

$$\Rightarrow \frac{50000}{300000 \times 5} \text{ km/s} = x$$

$$\Rightarrow 250000 \text{ km/s}$$

15) The refractive index of glass is 1.5. Calculate the speed of light in glass. The speed of light in air is  $3.0 \times 10^8 \text{ m/s}$ .

Let the speed of light in glass be  $x$ .



Refractive index of the glass = 1.5

A/B

$$\mu_{\text{air glass}} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}} = 1.5$$

$$\Rightarrow \frac{3 \times 10^8 \text{ m/s}}{x} = 1.5$$

$$\Rightarrow \frac{2 \times 10^8 \text{ m/s}}{1.5} = x$$

$$\Rightarrow 2 \times 10^8 \text{ m/s}$$

16. The speed of light in water is  $2.25 \times 10^8 \text{ m/s}$ . If the speed of light in vacuum be  $3 \times 10^8 \text{ m/s}$ , calculate the refractive index of water.

$$\mu_{\text{water vacuum}} = \frac{3 \times 10^8 \text{ m/s}}{2.25 \times 10^8 \text{ m/s}} = 1.33$$

17. Light enters from air into diamond which has a refractive index of 2.42. Calculate the speed of light in diamond. The speed of light in air  $3 \times 10^8 \text{ m/s}$

$$\mu_{\text{air diamond}} = \frac{\text{Speed of light in air}}{\text{Speed of light in diamond}} = 2.42$$

$$\Rightarrow \frac{3 \times 10^8 \text{ m/s}}{2.42} = 2.42 \Rightarrow \frac{3 \times 10^8 \text{ m/s}}{2.42} = n$$

$$\Rightarrow 1.239 \times 10^8 \text{ m/s} = n$$

$$\Rightarrow 1.24 \times 10^8 \text{ m/s} = n.$$

## Multiple Choice Questions

19. The refractive indices of four substances P, Q, R and S are 1.50, 1.36, 1.77 and 1.31 respectively. The speed of light is maximum in the ~~substance~~ substances:

∴ The ~~more~~ <sup>lesser</sup> the refractive index of a medium, the more is the speed of light and vice-versa.

∴ ~~Medium~~ The speed of light in medium S is the maximum because it has ~~a~~ comparatively lesser refractive index.

**(d) S.**

20. The refractive indices of four <sup>materials</sup> substances A, B, C and D are 1.33, 1.43, 1.71 and 1.52. When the light rays pass from air into these materials, they refract the maximum in:

∴ The ~~more~~ ~~the~~ larger the refractive index of the substance the more is the refraction & vice-versa.

∴ The light rays get refracted maximum in material C.

**(c) Material C**



21. The refractive index of glass for light going from air to glass is  $\frac{3}{2}$ . The refractive index for light going from glass to air will be:

$\mu_{\text{glass}}^{\text{air}} = \frac{\text{speed in air}}{\text{speed in glass}}$  Let speed of light be  $n$ .

$$\mu_{\text{glass}}^{\text{air}} = \frac{3 \times 10^8 \text{ m/s}}{n} = \frac{3}{2}$$

$$\Rightarrow \frac{3 \times 10^8 \text{ m/s} \times 2}{3} = n$$

$$\Rightarrow 2 \times 10^8 \text{ m/s} = n$$

$$\therefore \mu_{\text{glass}}^{\text{air}} = \frac{\text{speed of light in glass}}{\text{speed of light in air}} = \frac{2 \times 10^8 \text{ m/s}}{3 \times 10^8 \text{ m/s}} = 0.67 = \frac{2}{3}$$

**(c)  $\frac{2}{3}$**

22. The refractive indices of four media A, B, C and D are 1.44, 1.52, 1.65 and 1.36 respectively. When light travelling in air is incident on these media at equal angles, the angle of refraction will be the minimum:

$\therefore$  The ~~less~~ the smaller the refractive index of a medium, the lesser is the refraction and the angle of refraction.

$\therefore$  As the refractive index of medium D is comparatively smaller than others.

$\therefore$  Ans - **(d) in medium D**

23. The speed of light in substance X is  $1.25 \times 10^8$  m/s and that in air is  $3 \times 10^8$  m/s. The refractive index of this substance will be:

$$\begin{aligned} \mu_{\text{air}}^{\text{med-X}} &= \frac{\text{Speed of light in air}}{\text{Speed of light in medium X}} \\ &= \frac{3 \times 10^8 \text{ m/s}}{1.25 \times 10^8 \text{ m/s}} \\ &= 2.4 \end{aligned}$$

**(a) 2.4.**

24. The refractive indices of four substances P, Q, R and S are 1.77, 1.50, 2.42 and 1.81 respectively. When light travelling in air is incident on these substances at equal angles, the angle of refraction will be the maximum in:

∴ We know that, the larger/greater the refractive index of a substance the more is the angle of refraction.

∴ As the refractive index of substance R is the largest among others.

∴ The angle of refraction will be the maximum in substance R.

**(c) Substance R**



25. The refractive index of water is:

$$\mu_{\text{air water}} = \frac{3 \times 10^8 \text{ m/s}}{2.25 \times 10^8 \text{ m/s}}$$
$$= 1.33$$

**(a) 1.33**

26. The refractive index of water with respect to air is  $\frac{4}{3}$ . The refractive index of air with respect to water will be:

$$\mu_{\text{water air}} = \frac{\text{Speed of light in water}}{\text{Speed of light in air}} = \frac{2.25 \times 10^8 \text{ m/s}}{3 \times 10^8 \text{ m/s}}$$
$$= 0.75$$

**(c) 0.75**

27. Refractive indices of water, ~~with respect to air is~~ sulphuric acid, glass and carbon disulphide are 1.33, 1.43, 1.53 and 1.63 respectively. The light travels <sup>slowest</sup> in:

∴ We know that the smaller the refractive index, ~~the more~~ more is the speed of light in the substance & vice-versa.

∴ As the refractive index is ~~the~~ comparatively larger <sup>of Carbon disulphide</sup>

So, the speed of light is the least in it.

**(d) carbon disulphide**



26) The refractive index of glass with respect to air is  $3/2$  and the refractive index of water with respect to air is  $4/3$ . The refractive index of glass with respect to water will be:

Let speed of light in glass be  $n$ .

$$\mu_{\text{air to glass}} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}} = \frac{3}{2}$$

$$\Rightarrow \frac{3 \times 10^8 \text{ ms}^{-1}}{n} = \frac{3}{2}$$

$$\Rightarrow \frac{2 \times 3 \times 10^8 \text{ ms}^{-1}}{3} = n$$

$$\Rightarrow 2 \times 10^8 \text{ ms}^{-1} = n$$

Let the speed of light in water be  $y$ .

$$\mu_{\text{air to water}} = \frac{\text{Speed of light in air}}{\text{Speed of light in water}} = \frac{4}{3}$$

$$\Rightarrow \frac{3 \times 10^8 \text{ ms}^{-1}}{y} = \frac{4}{3}$$

$$\Rightarrow \frac{3 \times 3 \times 10^8 \text{ ms}^{-1}}{4} = y$$

$$\Rightarrow 2.25 \times 10^8 \text{ ms}^{-1} = y$$

$$\therefore \mu_{\text{water to glass}} = \frac{y}{n} = \frac{2.25 \times 10^8 \text{ ms}^{-1}}{2 \times 10^8 \text{ ms}^{-1}}$$

$$\text{Ans (d) } 1.125$$

$$= 1.125$$