# 6. Refraction of Light
# Extra Questions

1. Give the co – relation

Dispersion of light : colour bands : : Refraction of light : ……

Ans – Twinkling of stars

2. Scattering of light : particles of atmosphere : :Rainbow : ……

Ans – Water droplets

3. State true or false

The refractive index of a medium ( such as glass) does not depend on the wavelength of light

Ans – False

4. When the sunlight passes through a canopy of dense forest, scattering of light can be observed

Ans – True

5. The path of light ray is irreversible

Ans – False

6. Find odd one out

Reflection, Neutralization, Refraction, Dispersion

Ans – Neutralization

7. What is meant by refraction of light?

Ans – Refraction is the change in the direction of a wave passing from one medium to another.

8. What is prism?

Ans – Prism is a homogeneous, transparent, refracting material

(such as glass) enclosed by two inclined plane refracting surface at some fixed angle.

9. Why does refraction occur?

Ans – Refraction occurs because light travels in different media with different speed.

10. What is dispersion?

Ans – Dispersion is the separation of white light into colours or of any radiation according to wavelength.

11. What is reflection of light?

Ans – When a ray of light approaches a smooth polished surface & the light ray bounces back it is called the reflection of light.

12. Give scientific reason

star twinkle at night

Ans – Star are self luminous & can be seen at night in the absence of sunlight.

When starlight enters the earth’s atmosphere, it undergoes refraction continuously in the medium with gradually varying refractive index.

So it apparent position of star is slightly higher than actual position.

Due to motion refractive index of air keeps changing continuously.

When more light is refracted towards us the star appears bright. when less light is refracted towards us, star is seen dim

Thus due to change in refractive index, star twinkle at night.

13. Plants do not twinkle.

Ans – Plants are much closer to us as compared to stars. Hence a planet behaves as an extended source of light. They do not appear as a collection of point source.

On an average there is an increase in intensity of light from some point source while decrease in intensity of light coming from equal number of other point sources.

Thus the average intensity coming from a planet remains the same. Hence planet does not twinkle.

14. The sun appears reddish early in the morning.

Ans – During sunrise the light rays coming from the sun have to travel a greater distance in the earth’s atmosphere before reaching our eyes.

In this journey, the shorter wavelengths of lights are scattered out & only longer eave lengths are able to reach our eyes. Since blue colour has a shorter wavelength & red colour has a longer wavelength, the red colour is able to reach our eyes after the atmospheric scattering of light. Therefore, the sun appears reddish early in the morning.

15. It is possible to enjoy a rainbow at fountain in any season

Ans – We can observe & enjoy the rainbow by standing in front of water fountain in the evening facing the east.

We can also enjoy in the morning under the same conditions just by facing the west because formation of rainbow depends on the water droplet & the sunlight so, its is possible to enjoy rainbow at fountains in any season.

16. What is meant by reflection of light?

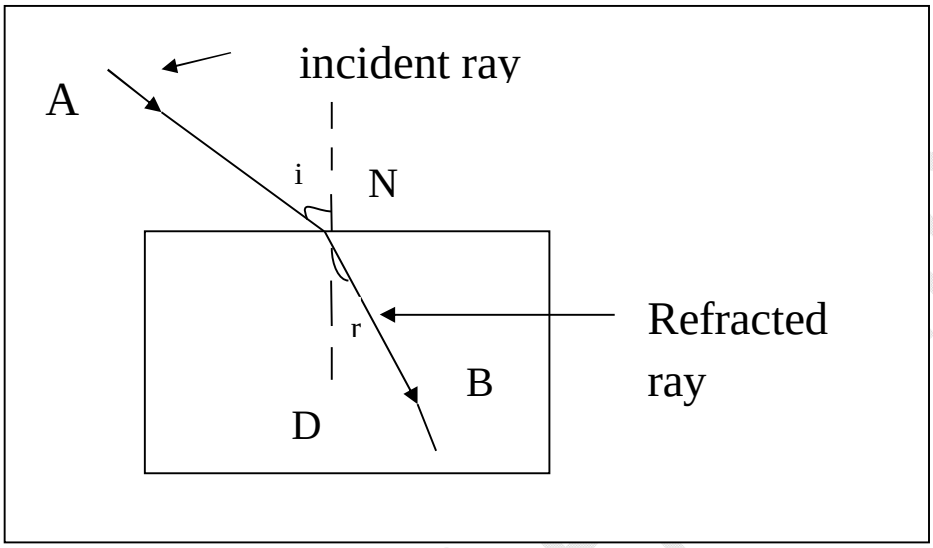
Ans – Reflection is the change in direction of wave media so that the wave front returns into the medium from which it originated.

Reflection of light is either secular or diffuse depending on the nature of the interface.

In secular reflection the phase of reflected waves depends on the choice of origin of co – ordinates but the relative phase between s & p polarization is fixed by the properties of the media & interface between them.

17. What are the laws of reflection?

Ans –




If the reflecting surface is very smooth, the reflection of light that occurs is called specular or regular reflection. The laws of reflection are as follows:

1. The incident ray, the reflected ray & the normal to the reflection surface at the point of the incidence i.e in the same plane.

2. The angle which the incident ray makes with the normal is equal to the angle which the reflected ray makes to the same normal.

3. The reflected ray & the incident ray are on the opposite sides of the normal.

18. State the laws of refraction of light

Ans – Laws of refraction states that :

The incident ray & the refracted ray are on the opposite sides of the normal at the point of incidence & all three lie in the same plane. The ratio of sine of the angle of refraction is a constant. This is also known as smell's law of refraction.

$$\frac{\sin i}{\sin r} = constant$$

19. Define absolute refractive index

Ans – The absolute refractive index is the refractive index of a medium in vacuum.

more specifically, it is the ratio of the speed of light in vacuum to the speed of light in that medium.

It is always greater than one

20. What is dispersion of light?

Ans – When white light is passed through a glass prism it splits into its spectrum of colours ( in order violet, indigo, blue, green, yellow, orange & red) & this process of white light splitting into its constituent colours is termed as dispersion.

21. Give an example of scattering of light.

Ans – As a result of scattering of light, sky appears

1. Blue at noon 2) Reddish or orange at sunrise or sunset.

22. Define refractive index

Ans – The ratio $\frac{\sin i}{\sin r} = constant = n$ where 'n' is medium with respect to first medium.

23. Define spectrum

Ans – The band of coloured components of a light beam is called its spectrum.

24. Define mirage.

Ans – An optical illusion caused by atmospheric conditions, especially the appearance of a sheet of water in a desert or on a hot road caused by the refraction of light from the sky by heated air.

25. Define angle of incidence

Ans – The angle made by incident ray with normal to the surface at point of incidence

26. What is angle of refraction?

Ans – The angle mode by refracted ray with normal to the surface is called angle of refraction.

27. What is angle of emergence?

Ans – The angle made by emergent ray with the normal to the surface at point of emergence is called angle of emergence.

28. Define angle of deviation?

Ans – When ray of light passes through a prism, the angle between the incident ray & emergent ray is called angle of deviation.

29. Mention any two phenomena in nature where refraction of light takes place.

Ans – Mirage & twinkling of star.

30. When light enters water form air, what change is observed in its speed?

Ans – As light enters water from air, it bends towards the normal.

31. What is partial & total internal reflection?

Ans – When light enters a rarer medium from a denser medium, it gets partially reflected & come back into the denser medium as per law of reflection. This is called partial reflection.

As light goes form denser to rarer medium. it bends away from normal i.e angle of incidence I is less than angle of reflection r.

For a particular value of I, the value of r becomes equal to $90^0$

This value of I is called critical angle.

For angle of incidence larger than crucial angle the angle of refraction is larger than $90^0$ thus all light gets reflected back into the dense medium. This is called total internal reflection

$$, n2 = \frac{\sin i}{\sin r}$$

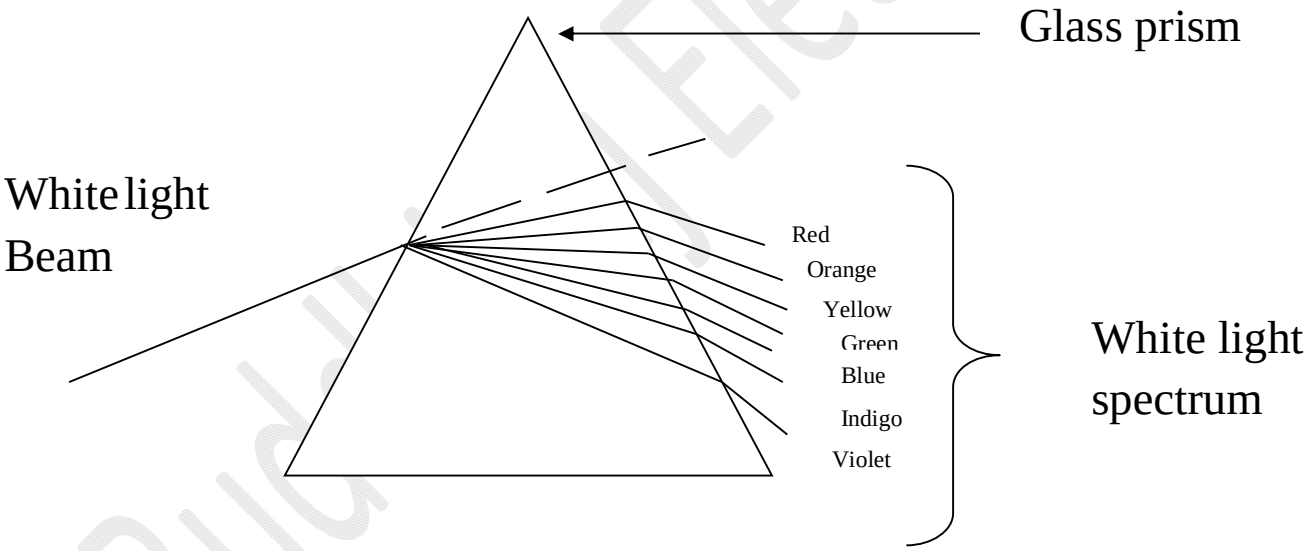
for total internal reflection

$r$ = $90^0$ & I = critical angle

$$, n2 = \frac{\sin i}{\sin 90^0}$$

$$, n2 = \sin i \ (\because \sin 90^0 = 1)$$

32. With neat diagram, Explain the dispersion of light




When white light is passed through a glass prism it splits into its spectrum of colours ( in order violet, indigo, blue, green, yellow orange and red) and this process of white light splitting into its constituent colours is termed as dispersion.

Sir Isaac Newton was the first person to use a glass prism to obtain sun's spectrum.

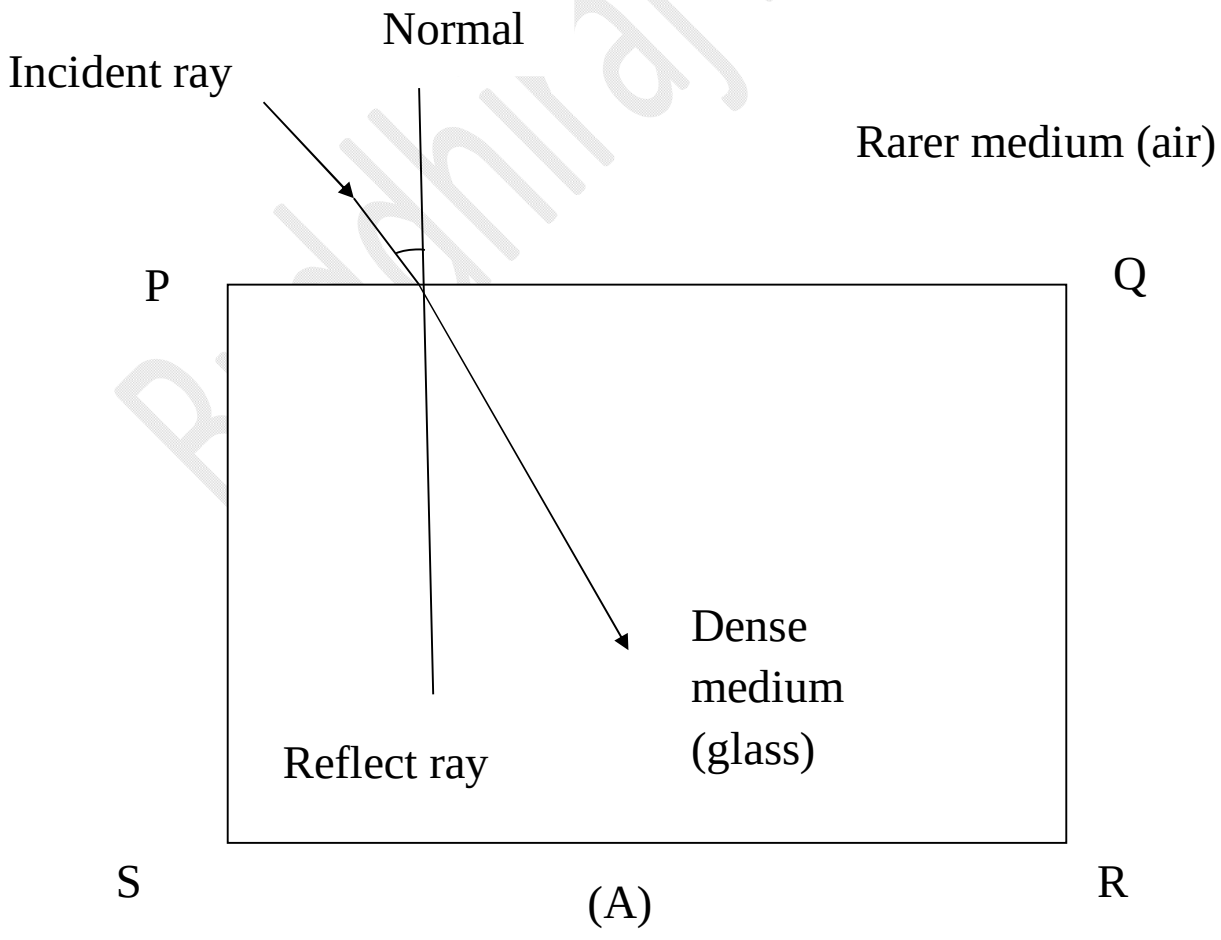
When white light is incident on the prism, different colours bend through different angles among the seven colours, red bends the least while violet bends the most.

Thus as shown in fig, the seven colours emerge along different paths & get separated & we get a spectrum of seven colours.

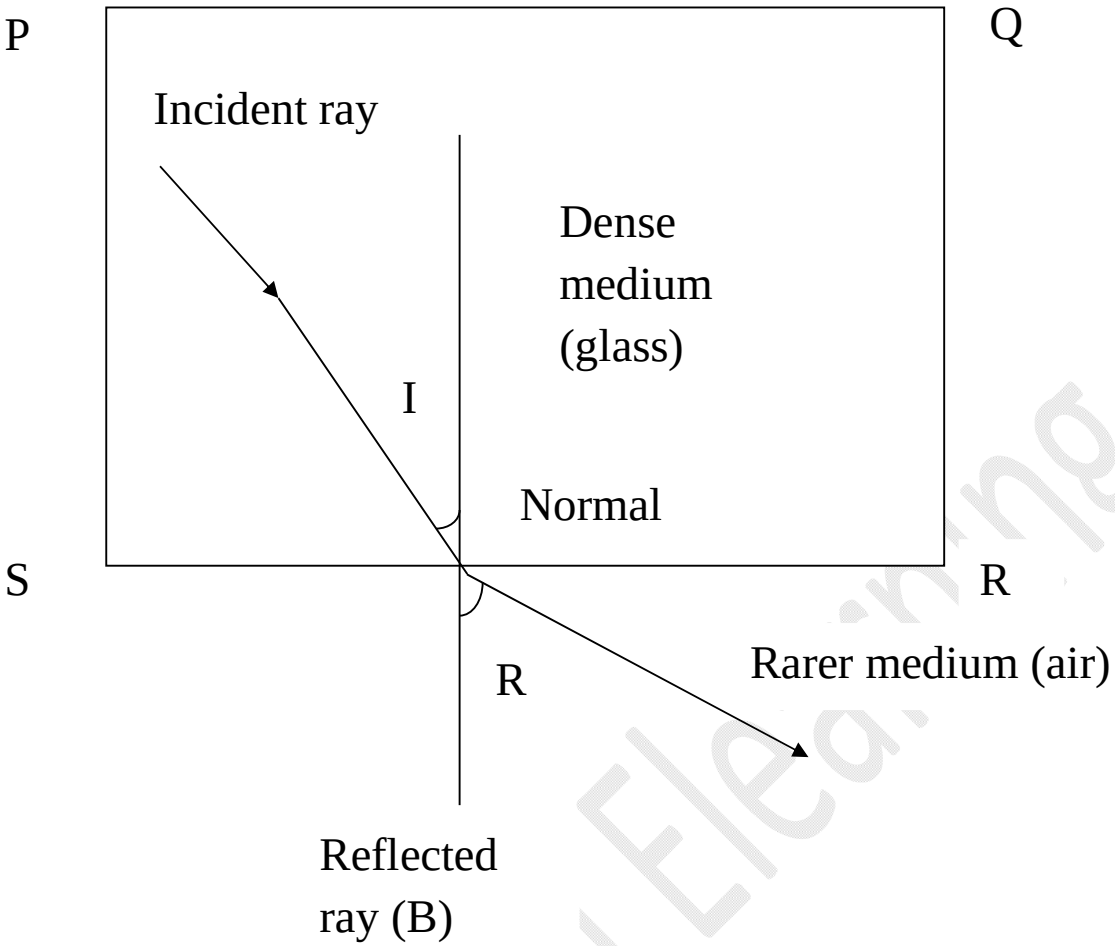
33. Draw a ray diagram indicating change in the path of light when a ray of light travelling

a) In air is incident on glass slab

b) In glass emerges into air




(A)




34. Distinguish between reflection of light and refraction of light

| Reflection of light | Refraction of light |
|---|---|
| 1. When a ray of light approach a smooth polished surface & the light ray bounces back is called the reflection of light. | Refraction is the change in the direction of a wave passing from one medium to another. |
| 2. In reflection the angle of incidence is equal to angle of reflection | 2. In refraction angle of incidence & angle of refraction are not equal. |
| 3. In reflection of light there is no change in the medium | 3. In refraction of light the rays travel from one medium to |

| | |
|---|---|
| | another. |
| 4. In reflection there is no change in speed of light eg. reflection of light through mirror. | 4. In refraction, there is change in speed of light eg. twinkling of stars |

35. What is refraction of light? How is it related to refractive index?

Ans – The phenomenon of a change in the direction of propagation of light when it passes obliquely form one transparent medium to another is called refraction of light.

For a given angle of incidence, the extent of refraction of light is different in different media.

When the refractive index of the second medium is greater than the refractive index of the first medium, more is the bending of the refracted ray towards the normal.

When the refractive index of the first medium is greater than the refractive index of the second medium, lesser is the bending of the ray of light away from the normal.

36. State the formulae for the refractive index of the second medium with respect to the first medium.

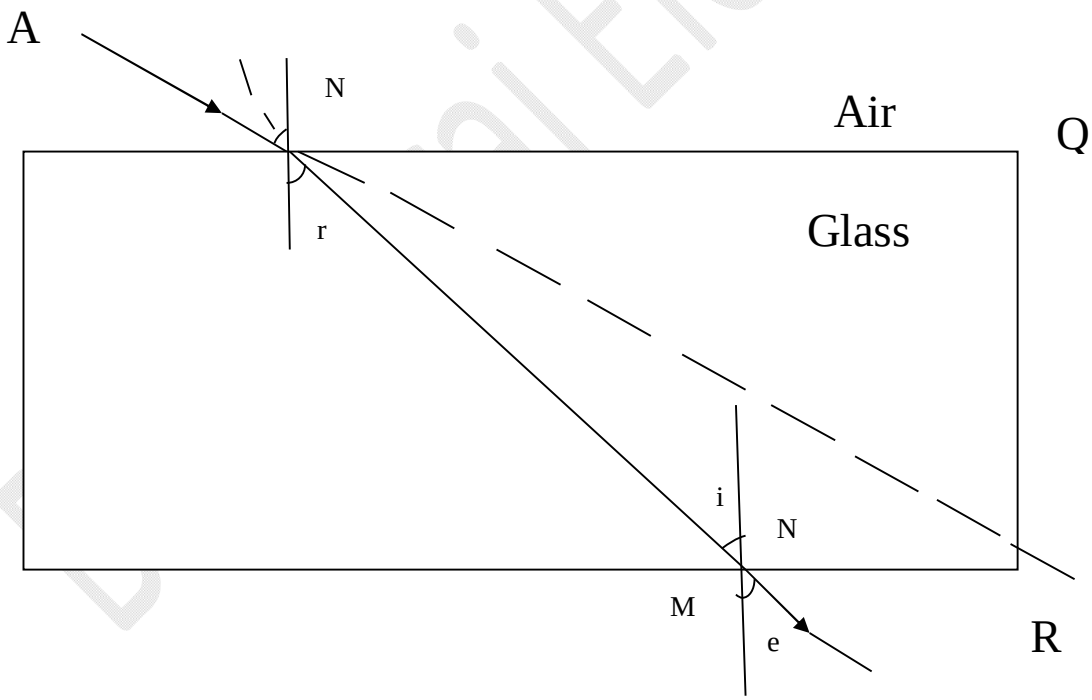
Ans – The refractive index of the second medium with respect to the first medium,

$$2n1 = \frac{\sin i}{\sin r} = \frac{v1}{v2}$$

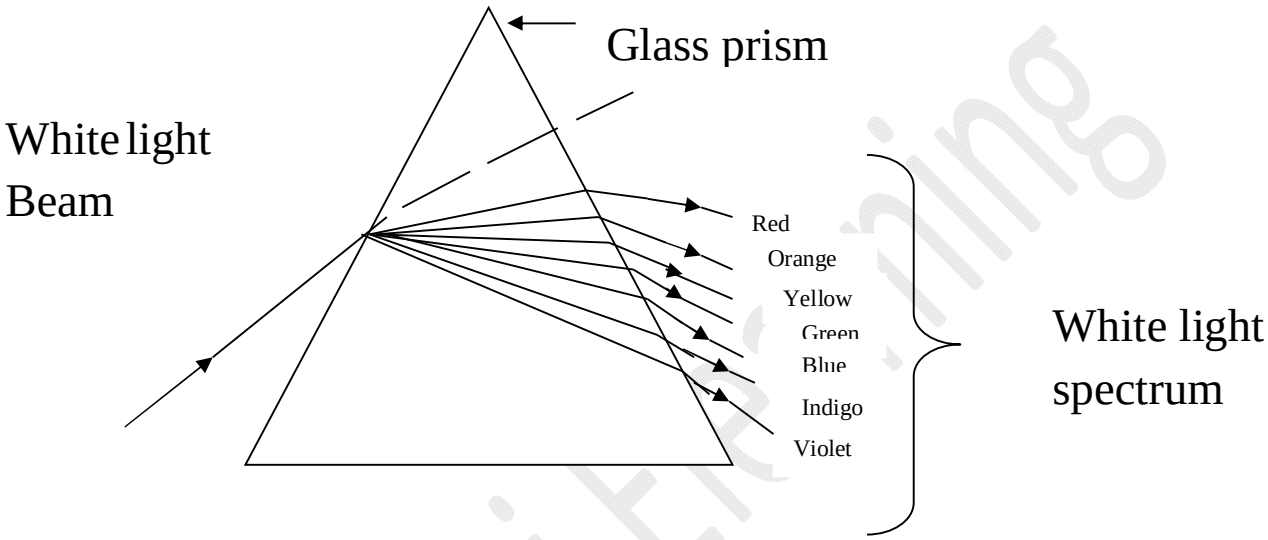
where i is the angle of incidence r is the angle of refraction (as the ray of light passes obliquely from the first medium to the second medium), v1 is the magnitude of the velocity (speed) of light in the first medium & v2 is the magnitude of the velocity of light in second medium.

37. Draw well labeled diagram of the following

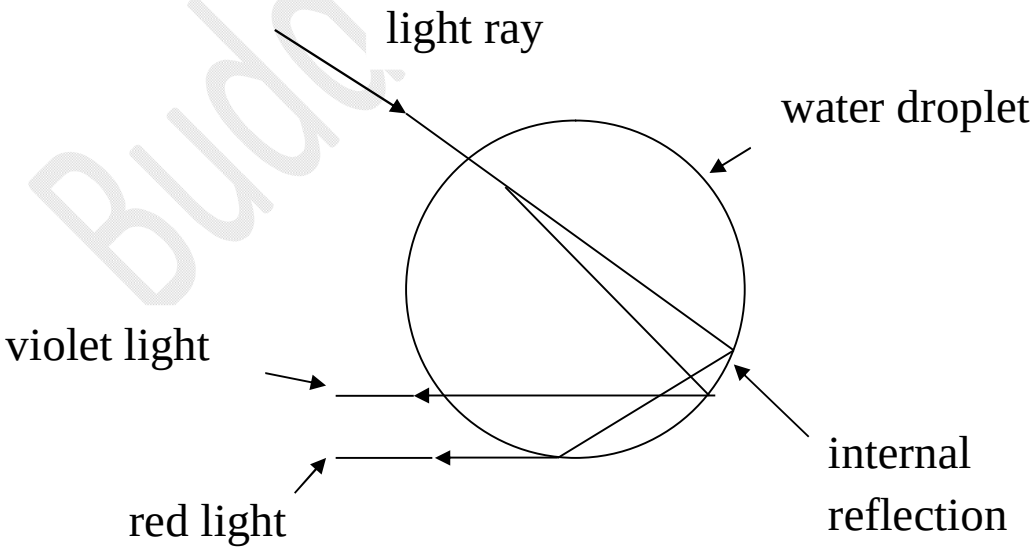
Refraction of light through a glass slab



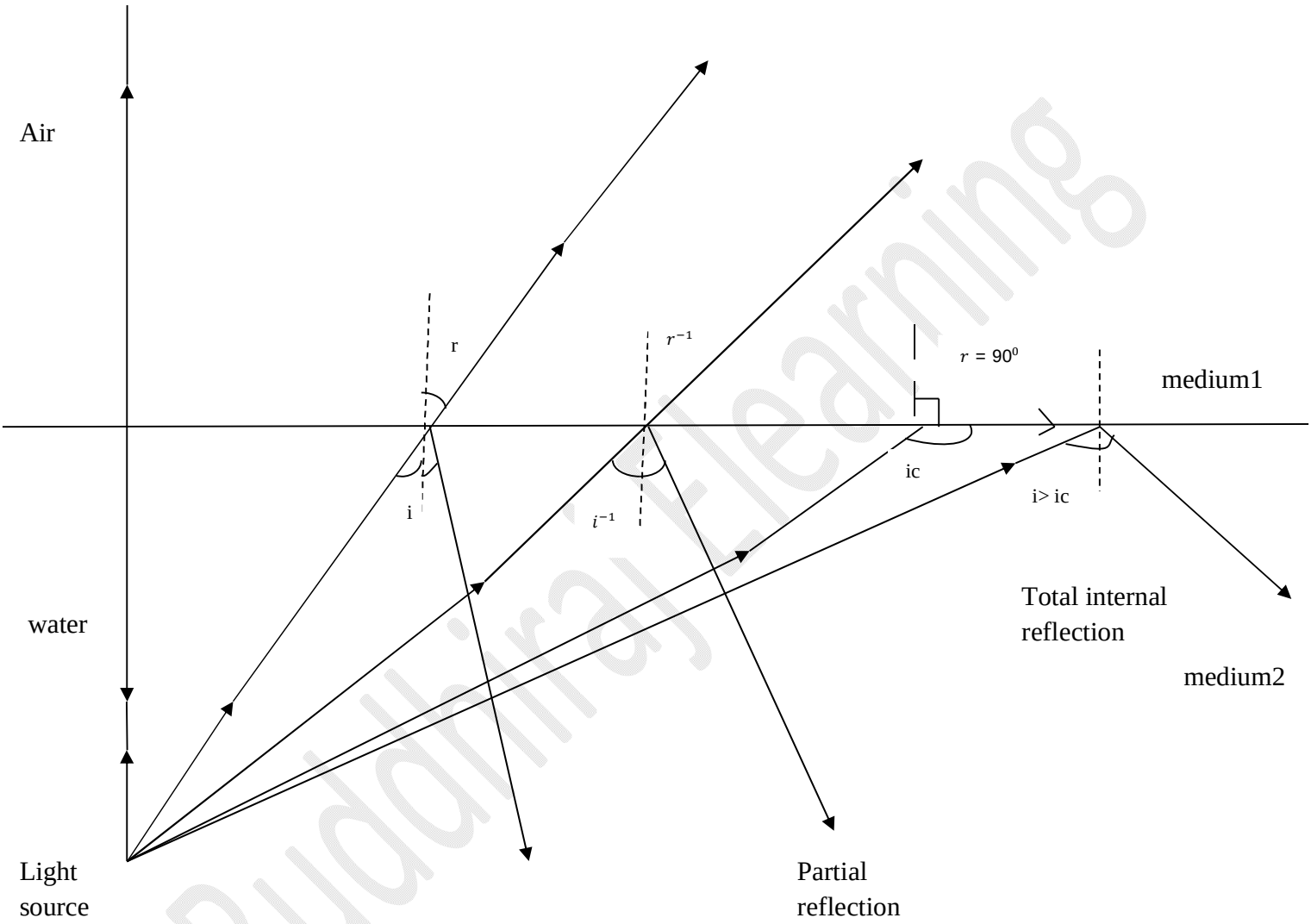
## 38. Dispersion of light through a glass prism



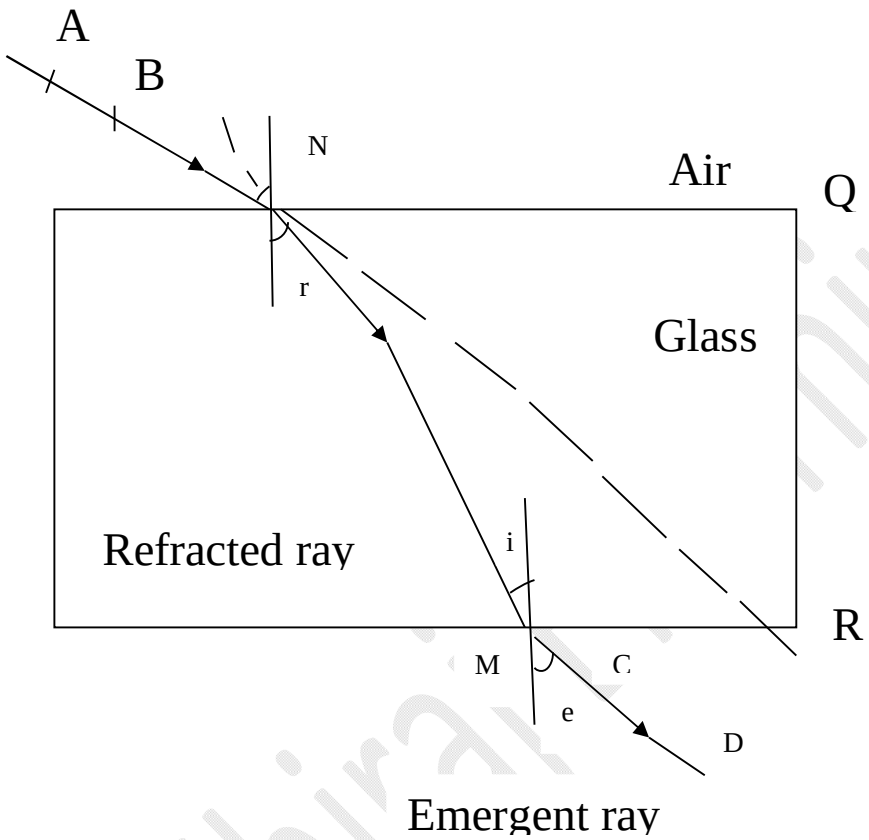

## 39. Formation of rainbow in a water droplet



# 40. Partial & total internal reflection



41. If the angle of incidence & angle of emergence of a light ray falling on a glass slab are I & e respectively prove that i = e




in the following figure SR || PQ & NM is the refracted ray, hence r = i

now ${}_{g}n_{a} = \frac{\sin i}{\sin r}$ &

${}_{a}n_{g} = \frac{\sin i}{\sin e}$

also $g^{n}a = \frac{1}{a^{n}g}$

$$\therefore \frac{\sin i}{\sin r} = \frac{\sin e}{\sin i}$$

As r = I it follows that sin i = sin e

$$\therefore i = e$$

42. Give two example of the effect of atmospheric refraction on a small scale in local environment

Ans – i) The occurrence of mirage & ii) flickering of an object seen rising above the hot fire are examples of the effect of atmospheric refraction on a small scale in local environment.

43. If the absolute refractive indices of glass and water are $\frac{3}{2}$ and $\frac{4}{3}$ respecitvely what is the refractive index of glass with respect to water?

Ans – data: $n_g = \frac{3}{2}, n_w = \frac{4}{3}, g^n w = ?$

$$n_g = \frac{c}{u_g}, n_w = \frac{c}{u_w}, g\ hw = \frac{u_w}{u_g}$$

$$\therefore g^n w = \frac{n_g}{n_w} = \frac{\frac{3}{2}}{\frac{4}{3}} = \frac{3 \times 3}{4 \times 2} = \frac{9}{8}$$

This is the refractive index of glass with respect to water.

44. The speed of light in a transparent medium is $2.4 \times 10^8\ m/s$ calculate ithe absolute refractive index of the medium

Ans – Data: c= $3 \times 10^8\ m/s$

U = $2.4 \times 10^8\ m/s$, n =?

n = $\frac{c}{u} = \frac{3 \times 10^8\ m/s}{2.4 \times 10^8\ m/s}$

= $\frac{3}{2.4} = \frac{30}{24} = \frac{5}{4} = 1.25$

The absolute refractive index of the medium = 1.25

45. The velocity of the light in a medium is $2 \times 10^8\ m/s$ what is the refracitve index of the medium with respect to air if the velocity of light in air is $3 \times 10^8\ m/s$ ?

Ans - Data: U1= $3 \times 10^8\ m/s$

U2 = $2 \times 10^8\ m/s$, 2n1 = ?

2n1 = $\frac{v1}{v2}$

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

= 1.5

The refractive index of the medium with respect to air is 1.5

46. The refractive index of water is 4/3 and the speed of light air is $3 \times 10^8$ m/s find the speed of light in water

Ans - Data: $2n_1 = 4/3$, $U_1 = 3 \times 10^8$ m/s, $U_2$ =?

2n1 = $\frac{U1}{U2}$

$$\therefore U2 = \frac{U1}{2n1}$$

$$\therefore U2 = \frac{3 \times 10^8\ m/s}{4/3} = \frac{9 \times 10^8\ m/s}{4} = 2.25 \times 10^8\ m/s$$

The speed of light in water = $2.25 \times 10^8\ m/s$

47. Light travels with a velocity $1.5 \times 10^8\ m/s$ in a medium on enterning second medium its velocity becomes $0.75 \times 10^8\ m/s$ what is the refractive to the first medium?

Ans – velocity of light in the first medium = $U_1 = 1.5 \times 10^8\ m/s$

Velocity of light in the second medium = $U_2 = 0.75 \times 10^8 \frac{m}{s}$

Refractive index of the second medium with respect to the first medium = ${}^2n_1 = ?$

$${}_2n_1 = \frac{U1}{U2}$$

$${}_2n_1 = \frac{1.5 \times 10^8}{0.75 \times 10^8} = 2$$

Hence the refractive index of the second medium with respect to the first medium is 2

48. If the speed of light in a medium is $1.5 \times 10^8\ m/s$ what is the absolute refractive index of the medium?

Ans - Data : $U = 1.5 \times 10^8\ m/s$

C = $3 \times 10^8\ m/s$, n = ?

n = $\frac{C}{U} = \frac{3 \times 10^8\ m/s}{1.5 \times 10^8\ m/s} = 2$

This is the absolute refractive index of the medium

49. write the formula of refractive index

Ans – n = $\frac{\sin i}{\sin r}$

50. Even after sunset, we can see the sun on horizon?

Ans:- (1) the earth is surrounded by an atmosphere which is denser near the surface of the earth . when the rays of the light from the sun enter the earth's atmosphere from outer space , they travel from a rarer medium to denser medium . hence, they bend towards the normal on refraction.

(2) hence, even when the sun is below the horizon while rising or setting, its rays reach us due to refraction and it appears to be on the horizon . therefore , the sun is seen on the horizon a little before sunrise as well as for some time even after sunset.