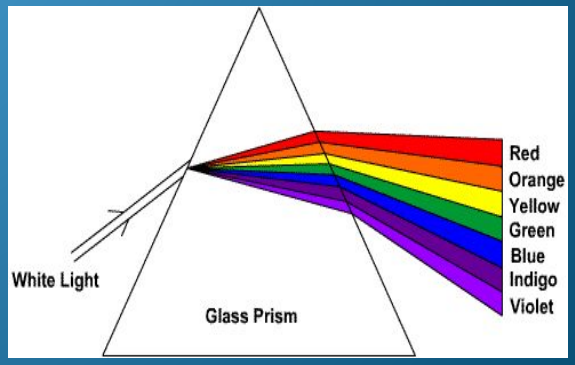
DISPERSION

Dispersion :

The phenomenon of splitting of white light into its component colors on passing through a refracting medium (like prism) is called DISPERSION of light.

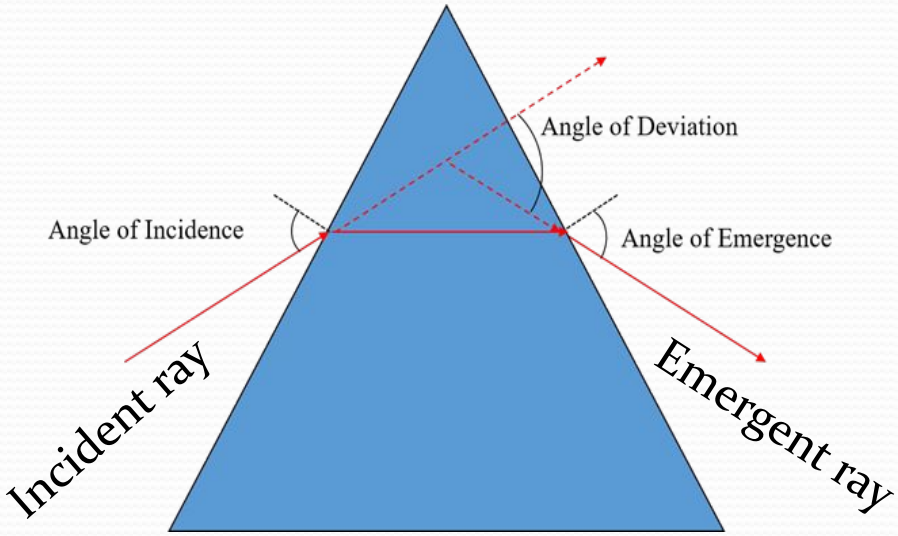
The pattern of colors obtained on the screen is called spectrum.



- The dispersion of white light occurs because different colors of light bend through different angles w.r.t. the incident ray.
- The red light bends the least while the violet light the most.
- In case of normal incidence, dispersion does not occur as refraction does not occur.
- Different wavelengths travel at different speeds through a medium . Since refractive index at a medium depends upon speed of wave through medium, shorter wavelengths have higher refractive index in glass.
- Examples of dispersion are Rainbow, colors observed in diamond etc.

Angle of deviation:

- Angle between emergent ray and direction of Incident ray is called angle of deviation.
- In case of a prism, angle of deviation for violet rays (δ_v) is greater than angle of deviation for red rays(δr).



we know that, refractive index(μ) = $\sin(A+\delta)/2 \,/\, \sin A/2$

When angles are small,

$$\mu = \frac{\frac{A+\delta}{2}}{\frac{A}{2}} = \frac{A+\delta}{A}$$

$$\mu A = A + \delta$$

$$\delta = (\mu - 1) A$$

Dispersive Power:

The difference in angles of deviation of any two colors is called angular dispersion for the two colour.

If δ_v ,δ_r are the angles of deviations and μ_r ,μ_v are the refractive indices for violet, red rays respectively, then

$$\delta_v = (\mu_v - 1) A$$

$$\delta_r = (\mu_r - 1) A$$

$$\delta_v - \delta_r = (\mu_v - \mu_r) A$$

Angular dispersion = $\delta_v - \delta_r = (\mu_v - \mu_r) A$ ---------- (1)

where A is the angle of the prism.

If δ and μ are the angle of deviation and Refractive index for the mean ray

$$\delta = (\mu - 1) A \quad \text{---------} \quad (2)$$

Now (1)/(2)

$$\delta_v - \delta_r / \delta = (\mu_v - \mu_r) A / (\mu - 1) A$$

$$= (\mu_v - \mu_r) / (\mu - 1)$$

$$\omega = d\mu / (\mu - 1)$$

where $\mu = (\mu_v + \mu_r) / 2$

The factor $(\delta_v - \delta_r) / \delta$ is called Dispersive power(ω) of the material of the prism.

Def : The dispersive power (ω) of the material is defined as the ratio of angular dispersion to mean deviation.

$$\omega = d\mu / (\mu - 1)$$

we know that, Lens maker's formula

$$1/f = (\mu-1)(1/R1 - 1/R2)$$

differentiating ,

$$(-1/f^2)df = [d\mu]\ (1/R1 - 1/R2)$$

$$(-df/f^2) = [d\mu]\ (1/R1 - 1/R2)$$

$$(\mu-1)\ (1/R1 - 1/R2)(-df/f) = [d\mu]\ (1/R1 - 1/R2)$$

$$(-df/f) = d\mu / (\mu-1) = \omega.$$

$$\boxed{\omega = (-df/f)}$$

In general, $\omega = (\delta_2 - \delta_1)/\delta = (\mu_2 - \mu_1)/(\mu - 1) = (-df/f)$