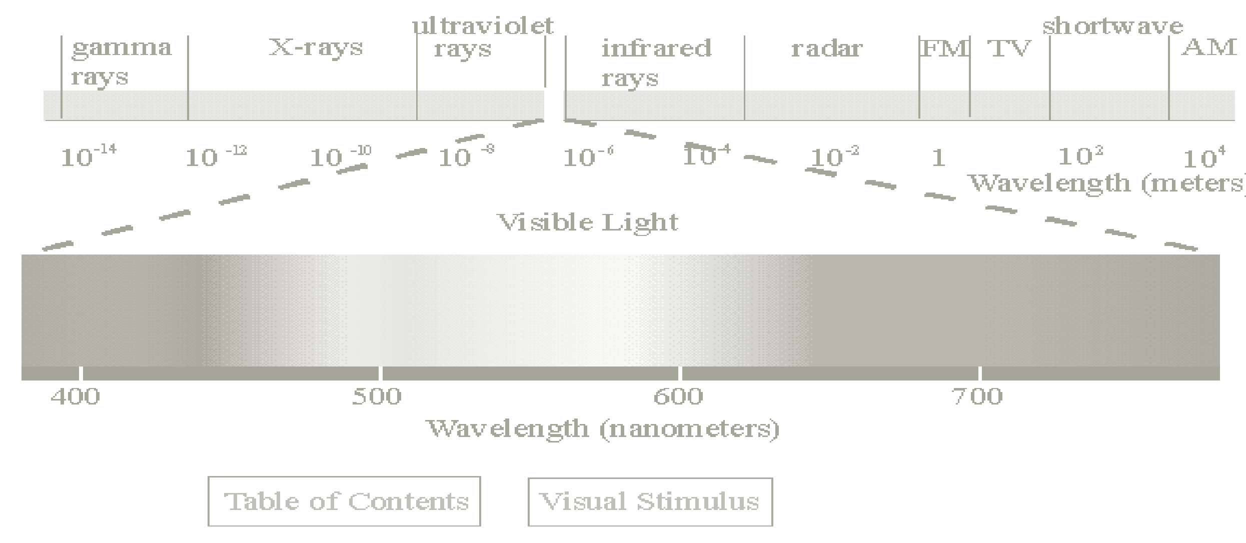
<u>SPECTRUM AND SPECTRAL COLOURS:</u>

The phenomenon of splitting of white light into its constituent colours is known is dispersion.

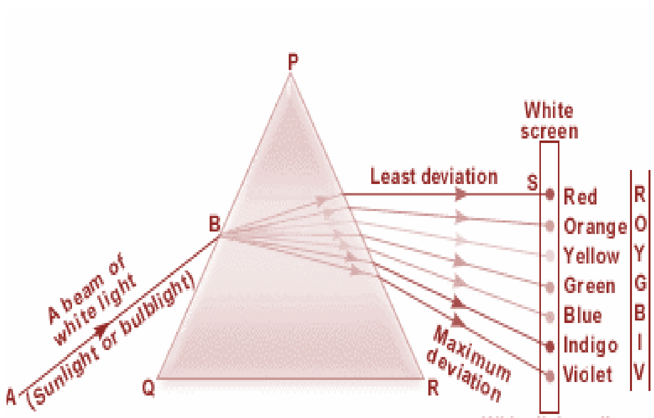
The **visible spectrum** is the portion of the electromagnetic spectrum that is visible to (can be detected by) the human eye. Electromagnetic radiation in this range of wavelengths is called **visible light** or simply light.

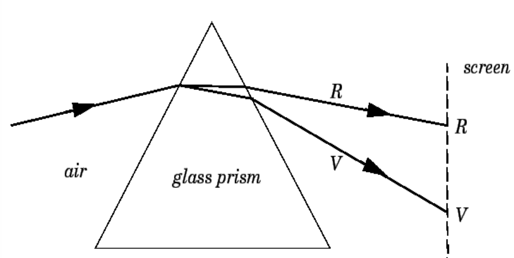


"The colour band obtained on a screen on passing white light through a prism, is called the spectrum.

<u>Dispersion produced in a Prism</u>:

When white light is passed through a prism, it is split into its constituent colours. This phenomenon is called as Dispersion. The band of colours thus obtained is called as "SPECTRUM". The well known colours in this band are Violet, Indigo, Blue, Green, Yellow, Orange, Red.





- **<u>Cause:</u>** When white light is incident on the surface of a prism, light of different colours is refracted or deviated through different angles. Thus the dispersion or splitting of whight light into its constituent colours takes place.

Deviation produced by a triangular prism

This phenomenon can be observed in a lab environment using a triangular glass prism.

A prism is a solid structure having three rectangular and two triangular surfaces. Any two rectangular faces are the refracting surfaces and the third one is the base. The angle between the refracting surfaces is the angle of the prism or refracting angle. The edge formed by the two refracting surfaces is the refracting edge as shown in the diagram.

When a light ray enters one refracting surface of the prism, it bends towards the normal and when it emerges out of the other refracting surface it bends away from the normal. The angle between the incident ray and the emergent ray is the angle of deviation.

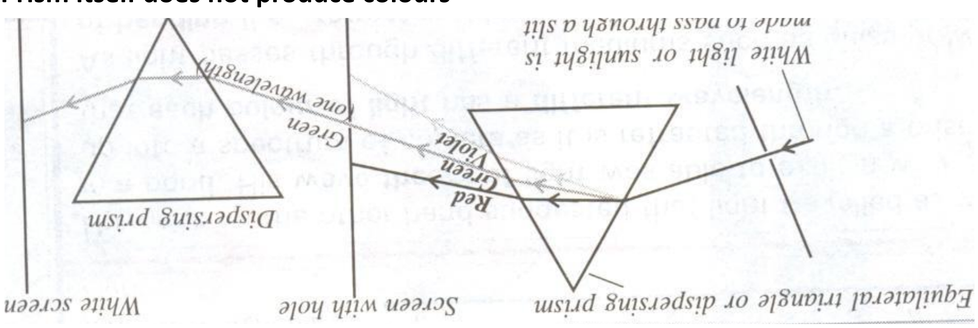
$$\angle i + \angle e = \angle A + \angle d$$

A is the angle of the prism

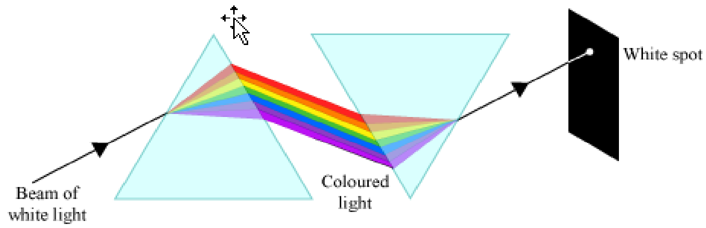
d is the angle of deviation

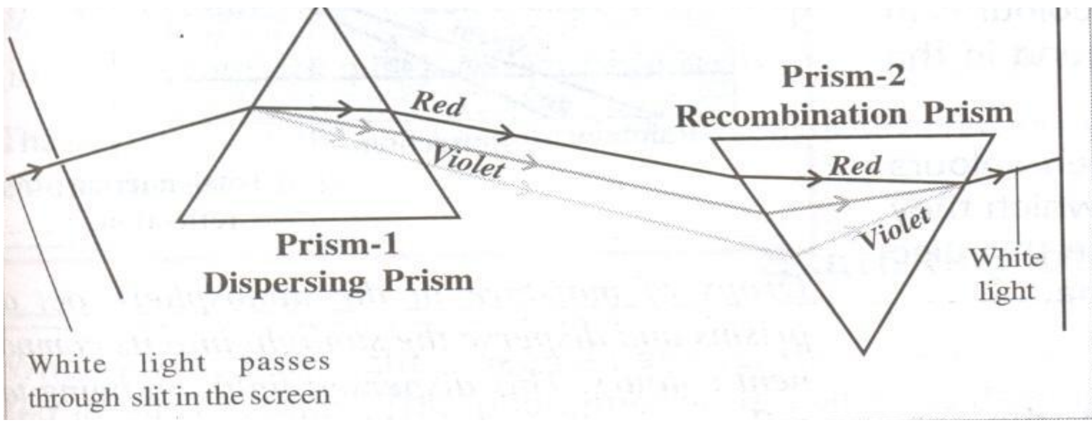
- **NEWTON'S EXPERIMENTS:**

1. **Prism itself does not produce colours**



2. **Recombination of colours**





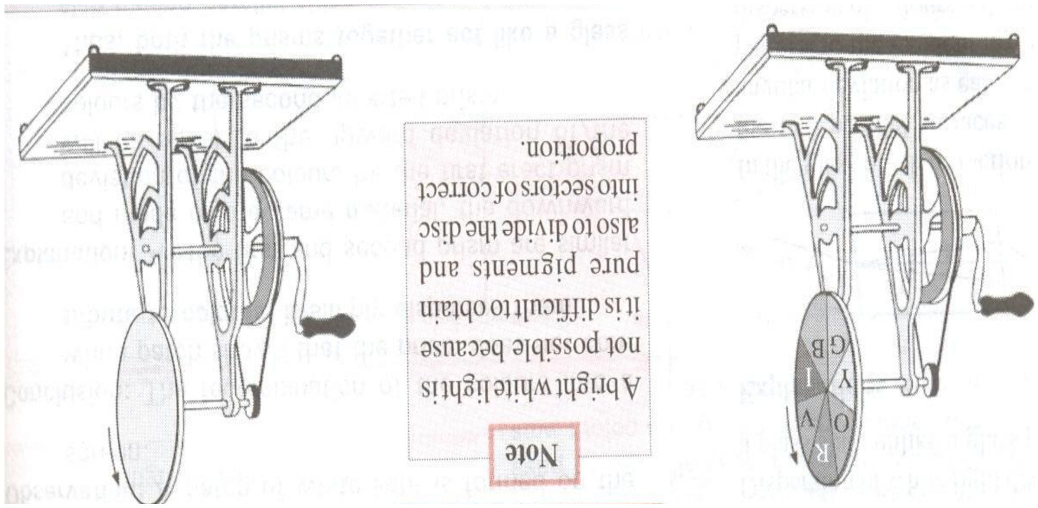
White light (sunlight) from a narrow slit is allowed to pass through prism-1 (base downward). This prism is known as a **dispersing prism**, as it disperses the beam of white light.

The coloured rays bend towards the base (i.e., downwards). This spectrum is allowed to fall on a second prism which is kept in an inverted position (prism-2) with its base upwards.

The second prism recombines the dispersed light. So it is called **recombination prism**.

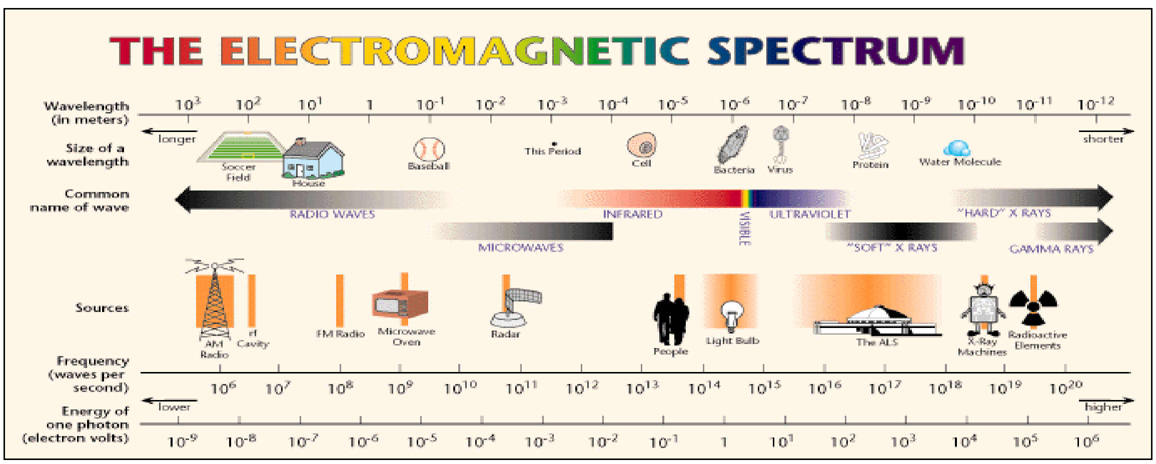
Light emerging from the second prism is collected on the white screen.

NEWTON'S COLOUR DISC: Take a circular cardboard disc or a circular metallic disc Divide it into seven sectors and paint each sector of a particular with a ratio of the Amount of colours found in the sunlight of solar spectrum in the same order in Which they occur [VIBGYOR]. Rotate the disc with a high speed in the vertical plane. As the speed of rotation is increased, the sectors of colours are no longer separately Visible and a sensation of dull white colour is produced.
This is because of the persistence of vision of the human eye.



<u>ELECTROMAGNETIC SPECTRUM:</u>

The portion of spectrum beyond the red end is called the infrared spectrum, while The portion of spectrum just before the violet end is called the ultraviolet spectrum.



The speed 'c', frequency 'γ' and wavelength 'λ' are related by

The complete electromagnetic spectrum in the increasing order of wavelengths or decreasing order of their frequencies is:

<u>Gamma rays, X-rays, Ultraviolet rays, Visible light, Infrared radiations, Microwaves and Radio waves</u>.

<u>Scattering of light:</u> Sun light travelling through the earth's atmosphere [clouds, water droplets and dust] changes its direction by the atmospheric particles. This is called scattering.

Scattering can be described as the process of absorption and then re-emission of light energy.

Some of the consequences of Scattering of light: [NOT IN REDUCED SYLLABUS]

1. **The atmosphere scatters the colours in sunlight one by one, starting at the violet end of the spectrum. The scattering of light depends upon the wavelength of light. The wavelength of red colour is more than the wavelength of violet colour. So the blue colour is scattered more than the blue colour. When the Sun is high in the sky, only the violet, indigo, blue and a little green is scattered, producing a blue sky. Due to the scattering of blue light in different directions, the sky appears blue.**

2. **Dust particles and water droplets present in the atmosphere do not obey the scattering law. Water droplets scatter all the colours of the spectrum equally. This results in reconstituted white light and thus clouds appear white.**

3. **When the sun is low in the sky, its path through the atmosphere is longer and yellow, orange and red are scattered near the ground. Thus the sun appears red during the sun set.**

4. **A thin film of oil floating on water creates a pattern of shimmering spectral colours.**

5. **The scattering of light is found to be inversely proportional to the fourth power of the wavelength of light. Thus scattering of red light is very much than that of yellow light. Therefore red light can be seen upto longer distances. Hence danger signals are red.**

6. **White coloured clothes reflects almost all the light incident on it while black clothes absorb all the light rays incident on it which is converted into heat. This is why people prefer black coloured dresses in winter to keep warm.**

7. **When sun light passes through the atmosphere, the fine particles in air scatter the blue colour more than red. The scattered blue light enters our eyes. If the earth had no atmosphere, there would not have been any scattering and the sky would have looked dark. That is why the sky appears dark to passengers flying at very high altitudes or to an astronaut.**

Harmful effects of electromagnetic radiations:

1. Ultra-violet radiations can cause health hazards like skin cancer if our body is exposed to them.
2. X-rays can penetrate through human flesh but are stopped by bones. X-rays can therefore cause some harmful effects to human body.
3. Gamma radiations can easity penetrate through the human body and can cause immense biological damage.

Electromagnetic wave	Source	Detected by	Wavelength range	Speed	Effect on photographic plate	Penetrating power	Effect on human body	Uses
Gamma rays	Radioactive nuclei, cosmic rays	Rutherford	$< 10^{-3}$	$3 \times 10^{8}\ ms^{-1}$	Affects .	Very high	Very harmful. Can burn tissues.	Study of structure of atomic nuclei
X – rays	High energy	Rontgen	1nm – 10^{-3}nm	$3 \times 10^{8}\ ms^{-1}$	Strongly affects	High	Harmful	Medical radiography, crystallography.
Ultraviolet rays	Electric arc and sparks, Sunlight	Prof. J Ritter	400 nm – 1 nm	$3 \times 10^{8}\ ms^{-1}$ $3 \times 10^{8}\ ms^{-1}$	Strongly affects	Ordinary glass absorbs passes through Quartz.	Harmful	i). Very small amounts of UV rays helps Synthesis of vitamin D. ii). For Sterilising purposes iii). Detecting the purity of gems, eggs, ghee, etc.
Visible light	Sun, light from electric bulb, flame, white hot bodies	Newton	700 nm – 400 nm	$3 \times 10^{8}\ ms^{-1}$	Affects	Passes through glass prism	Not very harmful in limited Quantity.	Used in photography, photo-synthesis and to see things around us.
Infra-red rays	Sun, arc lamp, fire, red hot bodies	William Hershell	1 mm – 700 nm		Does not affect ordinary photographic plate but affects specially treated photographic plate.	Absorbed by glass but pass through rock salt	Produces heating effect on the body	i). Used in night photography and also in mist and fog photography as they can penetrate and not much scattered.

								ii). Used by doctors for therapeutic purposes. iii). Used in signals during war. iv). Used in remote controls v). Infrared lamps are used in dark rooms for developing photographs as they do not affect the photographic film chemically, but provide some visibility.
Microwaves	Oscillating current in special vacuum tube [Klystron tube]	Hertz	0.1 m – 1 mm	3 X 10^{8} ms^{-1}	______	Passes through glass, paper, Plastic	Over exposure destruct the tissues	i). Satellite communication ii). Analysis of atomic & molecular structure. iii). For cooking in microwave-ovens and in radar communication.
Radio waves	TV and radio transmittors	Marconi	Above 10m	3 X 10^{8} ms^{-1}	______		---	Used in radar, radio and television communication.