

CH # 15 NATURES OF LIGHT AND ELECTROMAGNETIC SPECTRUM

THEORIES OF LIGHT

NEWTON'S CORPUSCULAR THEORY:

- Light is emitting from luminous body in the form of tiny particles called corpuscles.
- These corpuscles move in a straight line with the velocity of light.
- Corpuscles of different size correspond to radiation of different wavelength and colors.
- These corpuscles reach the eye and give the sensation of light.

DISCARDED BY FOUCAULT:

In 1850 French physicist Foucault proved that Newton's result that velocity of light in water should be greater than air is wrong. Newton's corpuscular theory was thus abandoned.

DEFECT IN NEWTON'S CORPUSCULAR THEORY:

- Newton concluded that velocity of light in water should be more than in air which was not correct.
- According to Newton higher the temperature of the body more will be the velocity of the corpuscles. This result also proves to be wrong.
- This theory is not able to explain the phenomenon of diffraction of light.
- This theory is not able to explain the phenomenon of interference of light.

PHENOMENONS WHICH SUPPORT CORPUSCULAR THEORY:

- This theory successfully explains the phenomenon Reflection of light.
- This theory successfully explains the phenomenon Refraction of light.

HUYGENS'S WAVE THEORY OF LIGHT:

- Because of shorter wave length of light formation of images in mirror, formation of images in lenses, formation of shadow, phenomenon of reflection, phenomenon of refraction explained satisfactorily on the basis of this theory.
- This theory successfully explains the phenomenon of diffraction of light.
- This theory successfully explains the phenomenon of interference of light

EXPERIMENT BY THOMAS YOUNG'S (Young's double slit experiment):

In 1801 Thomas Young performed an experiment which supported the wave theory of light by showing interference bands of light.

- Bright bands were formed when one set of wave joined another set of the wave in such a way that crest and troughs were reinforced.
- Dark band were formed when these crests and troughs cancelled each other.

PHENOMENONS WHICH SUPPORT WAVE THEORY:

- This theory successfully explains the Formation of shadow.
- This theory successfully explains the phenomenon interference of light.
- This theory successfully explains the phenomenon Diffraction of light.

MAXWELL'S ELECTROMAGNETIC THEORY OF LIGHT:

- Waves are electromagnetic in nature.
- The electromagnetic waves travel with the velocity of light and they do not require any material medium for their propagation.

MORLEY AND MICHELSON EXPERIMENT:

Morley and Michelson showed experimentally that ether did not exist as a medium for the propagation of light waves because light can travel through a vacuum.

PLANK'S QUANTUM THEORY OF LIGHT OR DUAL NATURE OF LIGHT AND PHOTOELECTRIC EFFECT:

"Heat radiated from hot bodies is in the form of tiny packets of energy."

In 1905, Max Plank concluded after experiment that radiation was emitted in the form of tiny packets of energy. This assumption was then used by Einstein. According to Einstein:

- When a light is shown onto a metal surface electrons are emitted from it.
- The physical nature of light was not that of wave but of little packets of energy called photons.
- Light has a dual nature. It is never both at same time. Sometimes it behaves as a particle and sometimes as a wave.
- It explained the existing phenomenon of light through empty space.

PHOTON OR QUANTUM:

"Light consist of little packets of energy which are called photons or quantum of light which behave as a particle nature of light."

SOME USEFUL TERMS

DISPERSION OF LIGHT:

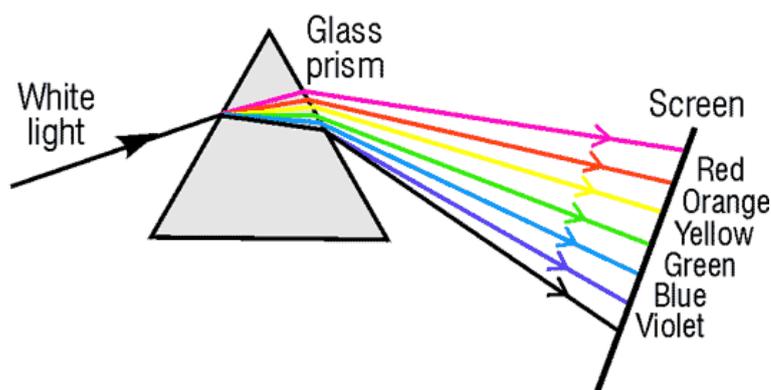
"The splitting of light into its constituent colours is called dispersion of light. The light is split up in seven colours which are Violet, Indigo, Blue, Green, yellow, Orange, Red (VIBGYOR)."

SPECTRUM:

"Band of colours on a screen after passing the light through prism is called spectrum."

SOLAR SPECTRUM OF LIGHT:

- A beam of sunlight allowed to enter a dark room through a hole.
- A prism is placed in the path of beam of light.
- A band of various colors was produced.
- This band of color is known as SOLAR SPECTRUM of light.



EXPLANATION OF SOLAR SPECTRUM:

- As in previous session we discuss that refraction of waves is depend on their frequencies.
- It gives the concept that sun light consist of different frequencies.
- When these waves pass through the prism the wave of higher frequencies bend more than those of lower frequencies.
- Due to this seven colors are obtained which are Violet, Indigo, Blue, Green, Yellow, Orange and Red.
- We can remember these colors by the word VIBGYOR.
- The shortest visible wave length is violet and its deviation is greatest.

- The longest visible wave length is red and its deviation is least.

ELECTROMAGNETIC SPECTRUM:

Light is electromagnetic in nature so the spectrum formed by electromagnetic radiations consists of:

- Radio waves.
- Microwaves.
- Infrared waves.
- Visible waves.
- X-rays.
- Ultra violet waves.
- Gamma waves.

Radio waves:

These waves are electromagnetic waves with a large range of wave lengths from a few millimetres to several meters.

Micro waves:

These waves are radio waves with a shorter wave lengths between 1mm and 300mm. microwaves are use in radar and microwaves and oven.

Infrared waves:

They are also called heat waves, these waves are radiated by hot bodies at different temperature. The earth's atmosphere is at a mean temperature of 250K and radiates infrared waves with a wave length having a mean value of 10 micrometer (10^{-6} m)

Visible waves:

Visible waves have a wave length range between 400 and 700 nanometers. The peak of a solar radiation is at a wave length of about 550nm. The human eye is most sensitive to this wave length.

Ultra violet waves:

Their wave length ranges from 380nm down to 60nm. These are emitted by hot stars having a mean temperature greater than 25000°C.

X-Rays:

These are the waves having wave length range from 1.0nm to 0.1nm.

Gamma rays:

Their wave light is less than 10^{-11} m. They are emitted by the nucleus of certain radioactive substances. They are also released during certain nuclear reactions.

RAINBOW:

"Rainbow is an arc of spectral colours formed across the sky during or after rain fall in the morning or evening."

FORMATION OF RAINBOW:

- When rainfalls, drops of water behave like prism and white light entering the drops of water is split up into colors on refraction.

- The light enters the raindrop from one side and does not pass through. It suffers total internal reflection within the raindrop and emerges out of it through the side it entered at angle of 42° to its original direction.

EMISSION OF LIGHT BY ATOMS:

- Beside sunlight we obtain light from many sources for example from solids and gasses.
- Since light consist of electromagnetic waves and all substances are made up of atoms.
- In atoms, electrons are moving in certain orbits.
- The energy of the electrons in each orbit is well defined.
- The orbit closer to the nucleus has less energy as compare with the orbit away from it.
- When electron in any orbit is excited, it jumps from the orbit at lower energy level to orbit at higher energy level, however it can't remain in the excited state for long time so it jumps back to its parent orbit and radiate energy in the forms of photons equal to the difference of those two energy levels.
- These photons cause light to produce and thus light is emitted by an atom.

GREEN HOUSE:

"A green house is a structure with roof and sides make up of glass and in which tender plants are preserved. The term green house is used for earth's atmosphere which behaves like a green house."

GREEN HOUSE EFFECT:

The infrared radiation emitted by the content cannot escape through the glass and the temperature of the ground rises.

A similar effect that applies to the whole earth. Atmospheric carbon dioxide (CO_2) and water vapours absorb the long wave infrared radiation emitted by the earth. Heat is trapped in this manner and this effect is called greenhouse effect.

HAZARDS OF GREEN HOUSE EFFECTS:

- Heavy industries are polluting the atmosphere, damaging the ozone layer and producing greenhouse effect.
- Temperature of the earth may rise to such an extent that it will melt the polar ice caps raising the level of the ocean, drowning all the coasts.