Photochemistry –

The branch of chemistry which deals with the study of chemical reactions which are caused by the absorption of light radiation (photon). Only the absorbed radiation can cause a chemical change.

Those reaction which takes place by the absorption of the visible and ultra-violet (UV) radiation is called a photochemical reaction.

for examples:-

(1) photochemical reaction between H_2 & Cl_2

$$H_2(g) + Cl_2(g) \xrightarrow{h\nu} 2HCl(g)$$

(2) Photochemical reaction between H_2 & Br_2

$$H_2(g) + Br_2(g) \xrightarrow{h\nu} 2HBr(g)$$

(3) Photolytic decomposition of HI.

$$2HI \xrightarrow{h\nu} H_2 + I_2.$$

The term photobiology deals with photochemistry of biological reactions and has helped a great deals with the mechanism of photosynthesis and other complex biological phenomena.

Organic compounds such as vitamin D_2, Cubanes (antiviral agent), Caprolactum (monomer of nylon) and several insecticides and cleaning solvents have also been synthesis photochemically.

The impact of photochemistry on medicine is felt in the photodynamic therapy i.e laser radiation therapy.

*. Absorption of light :-

*. Beer- Lambert law :-

When a beam of monochromatic radiation of suitable frequency passes through a solution, it is absorbed by the solution. As a result, the intensity of the light when it finally emerges from the solution, is reduced.

If 'I_0' is the intensity of the incident beam

I_t is the intensity of transmitted beam

then, the Intensity of light absorbed is given by—

$$I_a = I_0 - I_t \qquad \text{——— (1)}$$

The intensity of the beam is defined as the energy falling on unit area perpendicular to the beam per unit time. It is proportional to the number of photon incident on unit area in unit time.

Mathematically,

$$\frac{dI}{I} = -\alpha c\, dx \qquad \text{——— (2)}$$

where, dI is the change in intensity produced by the absorption of radiation on passing through a thickness dx of the solution of Concentration c and α is the proportionality Constant.

on intigrating eqn — (2) between the limits $I = I_0$ at $x = 0$ & $I = I$ at $x = b$ gives.

$$\int_{I_0}^{I} \frac{dI}{I} = -\alpha c \int_0^b dx$$

$$\Rightarrow \quad \ln(I/I_0) = 2.303 \log(I/I_0) = -\alpha b c. \qquad \text{——— (3)}$$

A/c to eqⁿ - (3), the intensity of a beam of mono-chromatic radiation decreases exponentially with increase in the thickness 'x' and the concentration 'c' of the absorbing medium.

This is called Beer-Lambert law.

* Laws of Photochemistry

(1). Grotthus - Draper law :-

This law is also called the principle of photochemical activation.

A/c to this law -

"Only those radiation which are absorbed by the system can bring about the photochemical change."

(2). Stark-Einstein law of photochemical Equivalence :-

This law is also called principle of quantum activation.

A/c to this law -

" Each molecule taking part in a chemical reaction, when induced by the exposure to light, absorbs one quanta of radiation to cause the reaction."

Let us suppose,

ν is the frequency of radiation absorbed thus the corresponding quantum of energy absorbed per molecule will be $h\nu$. The Energy E absorbed per mole of the reacting substance is given by -

$$\Delta E = h\nu = \frac{Nhc}{\lambda}$$

Where, 'c' is the velocity of light.

λ is the wave length

h = plank's constant = 6.626×10^{-34} J sec.

The energy absorbed per mole of the reacting substance is called <u>one Einstein</u>.

By
Dr. A. R. Gholap
Chemistry
V.S. College