Study of fast reactions.

Rates of chemical reactions differ from very slow to very fast. The rates of moderate speed reactions lying in between these two extreme reactions. However, rates of some instantaneous reactions are so fast that they occur within 10^{-12} second or in even less time. For example.

- ***Neutralization*** reactions have half-lifeof 10^{-10} sec ; $H^{+}_{(aq.)} + OH^{-}_{(aq.)} \rightarrow H_2O_{(l)}$
- ***Photosynthesis*** has half-lifeof 10^{-12} sec ; $6CO_2 + 6H_2O \xrightarrow[h\nu]{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$
- ***Some precipitation*** reactions have very short half-life; $AgNO_3 + KCl \rightarrow AgCl \downarrow + KNO_3$
- ***Isomerization*** of retinal in vision has half-life of 10^{-12} sec

Rates of such reactions cannot be studied by ordinary methods because change in concentration cannot be measured during this short interval of time. However, modern techniques such as flow methods, relaxation methods, flash photolysis, laser technique and spectrophotometric methods are used to study such fast reactions.

(1) **Photosynthesis in plants:** Plants obtain their food for growth by the combination of CO_2 and H_2O in presence of chlorophyll and light (a fast reaction) which leads to the preparation of carbohydrate and this phenomenon is known as ***photosynthesis***. The studies on photosynthesis involve flash photolysis technique. The following mechanism has been proposed for photosynthesis. First step of the reaction mechanism involves the excitation of chlorophyll molecule by absorbing photon of red light. The excited chlorophyll molecule transfers its energy in the form of an electron to nearby reactant molecule A within 10^{-12} second. The reactant molecule which accepts this energy is known as ***electron acceptor***.

$$\text{Chlorophyll} \xrightarrow{h\nu} \underset{\text{(Excited molecule)}}{\text{Chlorophyll}^*} \quad ; \quad \text{Chlorophyll}^* + \text{A} \longrightarrow \underset{(A \text{ is } CO_2 \text{ or } H_2O)}{\text{Chlorophyll} + A^-} + \text{Energy}$$

The electron acceptor (A) transfer this electron to another electron acceptor molecule (B). $A^- + B \rightarrow A + B^- + E$

The process leads to release of energy which is used for the series of reaction to yield the synthesis of energy rich molecule of carbohydrates from CO_2 and water. $6CO_2 + 6H_2O \xrightarrow{\text{Energy}} C_6H_{12}O_6 + 6O_2$

(2) **Isomerization of retinal in vision:** The mechanism involves two steps

(i) The retinal molecule (a light sensitive molecule present in the retina of eye) gets excited on exposure to light and undergoes geometrical isomerization and the energy absorbed is stored as chemical energy. The process takes place within 10^{-12} sec.

(ii) As soon as the first step gets completed, the retinal is converted back into its original form within 10^{-12} sec and the energy released is used to send signals to the brain which ultimately causes the sensation of vision.

Differences between Photochemical and Thermochemical reactions

Photochemical reactions	Thermochemical reactions
These reactions are initiated by light radiation.	These reactions are initiated by heat energy.
They cannot occur in dark.	They do occur in dark.
Temperature does not have any significant effect on the rates of such reactions and temperature coefficient is low.	The temperature does have a marked effect on the rates of these reactions and temperature coefficient is generally high.
The value of ΔG may be + *ve* or – *ve*.	ΔG is – *ve* for such reactions.