

Topic Synopsis

Rate of a Chemical Reaction

Chemical Kinetics

- Chemical kinetics has been derived from the greek term '**Kinesis**', meaning '**movement**'.
- It deals with the study of the rates of chemical reactions and their mechanisms.

Rate of a Chemical Reaction

- It is defined as the change in the concentration of a reactant or a product with time.
- For a reaction $R \rightarrow P$,

- Rate of disappearance of R = $\frac{\text{Decrease in concentration of R}}{\text{Time taken}} = -\frac{\Delta[R]}{\Delta t}$

- Rate of appearance of P = $\frac{\text{Increase in concentration of R}}{\text{Time taken}} = +\frac{\Delta[P]}{\Delta t}$

- Units of Rate of a Reaction:
 - For reactions containing aqueous or solid reactants: $\text{mol L}^{-1}\text{s}^{-1}$
 - For reactions containing gaseous reactants: atm s^{-1}

Average Rate of Reaction

- Average rate is the change in concentration of reactants or products divided by the time taken for that change to occur.

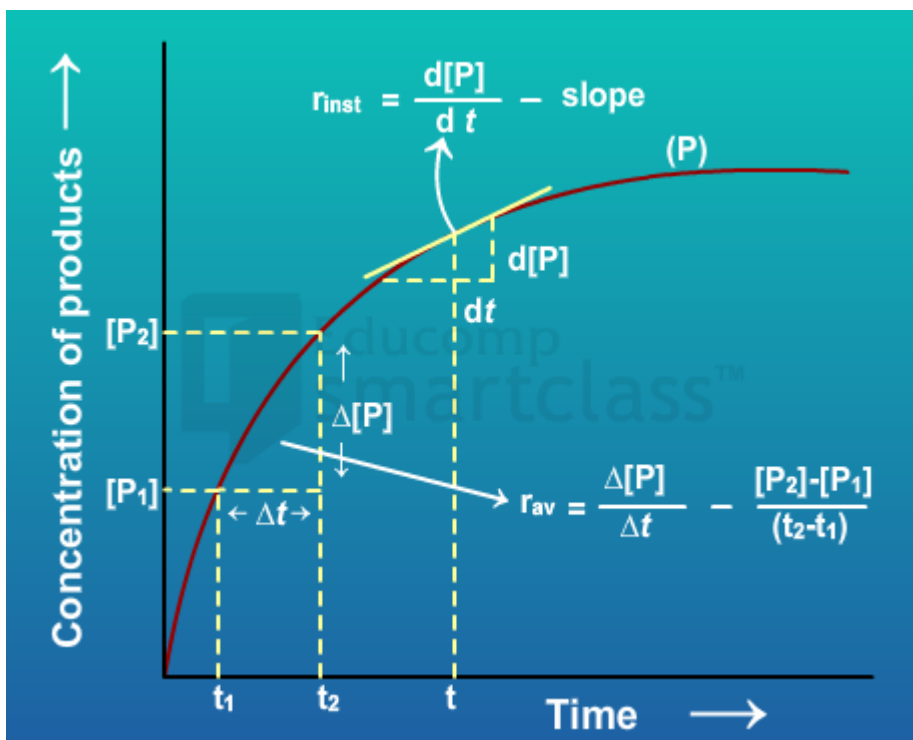
$$r_{av} = -\frac{\Delta[R]}{\Delta t} = +\frac{\Delta[P]}{\Delta t}$$

Instantaneous Rate of Reaction

- Instantaneous rate is the rate of the reaction at a particular moment of time.

$$r_{inst} = -\frac{d[R]}{dt} = +\frac{d[P]}{dt}$$

- It is determined by drawing a tangent at time 't' on either of the curves for concentration of reactants and products versus time 't' and calculating its slope.
- The average rate as well as the instantaneous rate of the reaction can be understood by the following figure:

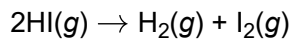


Reaction Rates and Stoichiometric Coefficients

- For a reaction of the type $aA + bB \rightarrow cC + dD$, the rate of reaction is given by:

$$\text{Rate} = -\frac{1}{a} \frac{\Delta[A]}{\Delta t} = -\frac{1}{b} \frac{\Delta[B]}{\Delta t} = -\frac{1}{c} \frac{\Delta[C]}{\Delta t} = -\frac{1}{d} \frac{\Delta[D]}{\Delta t}$$

- For example, for a reaction:



$$\text{Rate} = -\frac{1}{2} \frac{\Delta[\text{HI}]}{\Delta t} = \frac{\Delta[\text{H}_2]}{\Delta t} = \frac{\Delta[\text{I}_2]}{\Delta t}$$