Topic 6 Chemical Kinetics (SL)

Syllabus:

6.1 Collision theory and rates of reaction

  The meaning of rate of reaction

  Effective collision

  Following concentration changes in a reaction indirectly by monitoring changes in mass, volume and colour.

  Factors affecting the rates (temperature, pressure/concentration and particle size)

  Definition of Activation Energy (Ea)

  Catalyst would decrease Ea and increase the rate of a chemical reaction.

6.1 Collision theory and rates of reaction

(A) Define the term rate of reaction

- ➢ The change in concentration of reactants or products with time.
    1. The decrease in reactant concentration per unit time
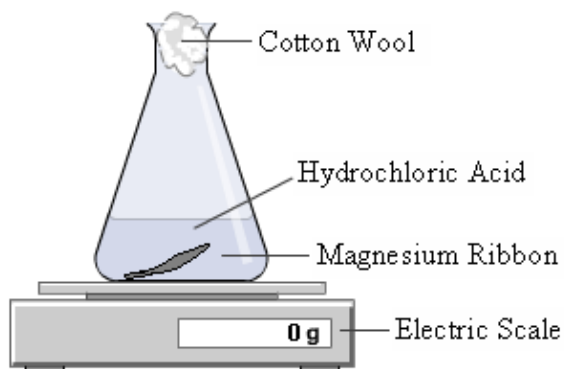   2. The increase in product concentration per unit time
    3. Rate of reaction = $\dfrac{\Delta[\text{product}]}{\Delta\text{Time}} = -\dfrac{\Delta[\text{reactant}]}{\Delta\text{Time}}$
    4. The unit of rate is mol dm^{-3} s^{-1}

(B) Experimental measurement of rates

1. Change in mass

- ➢ This method is only suitable for those reaction that there is gas evolved and gas is not soluble in solution.

- ➢ For example, in the reaction between magnesium and hydrochloric acid, hydrogen gas is evolved.

  $Mg(s) + 2HCl \rightarrow MgCl_2(aq) + H_2(g)$

- ➢ The rate of reaction can be traced by monitoring the mass of hydrogen evolved.

2. Change in volume
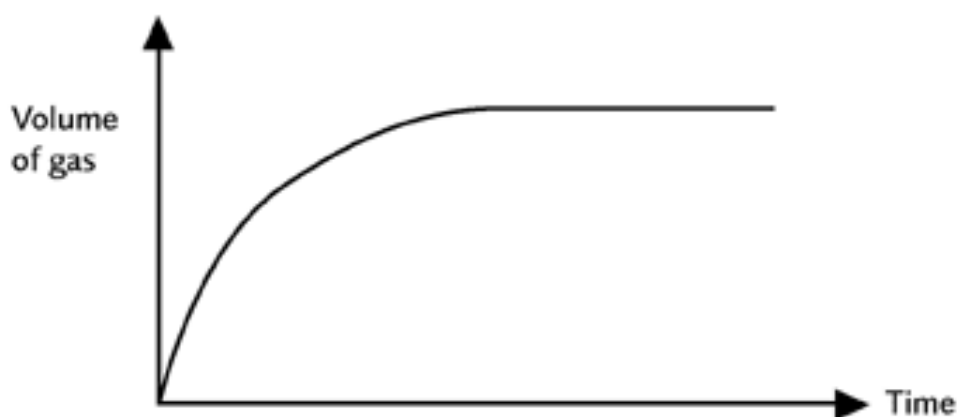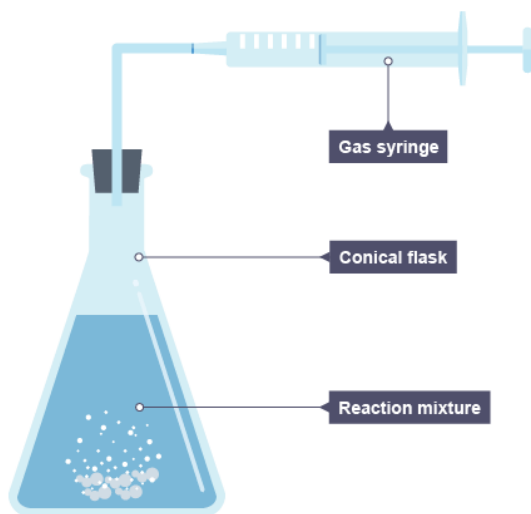
> ➤ This method is only suitable for those reaction that there is gas evolved and gas is not soluble in solution.

> ➤ For example, the reaction between magnesium and hydrochloric acid, hydrogen gas is evolved.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

> ➤ The rate of reaction can be traced by monitoring the volume of hydrogen evolved.

3. Colorimetry

➤ If one of the reactants or products has a colour, the intensity of this colour will change during the reaction.

➤ Colorimetry is the method to measure the intensity of the colour.

➤ An example will be the disappearance of the colour of bromine during the oxidation of methanoic acid by bromine:

$$Br_2(aq) + HCO_2H(aq) \rightarrow 2Br^-(aq) + 2H^+(aq) + CO_2(g)$$

➤ As the reaction proceeds, the concentration of Br_2 decreases, orange brown bromine disappears and rate of Br_2 loss can be determined.

➤ Colorimeter should be calibrated with known concentration solution.
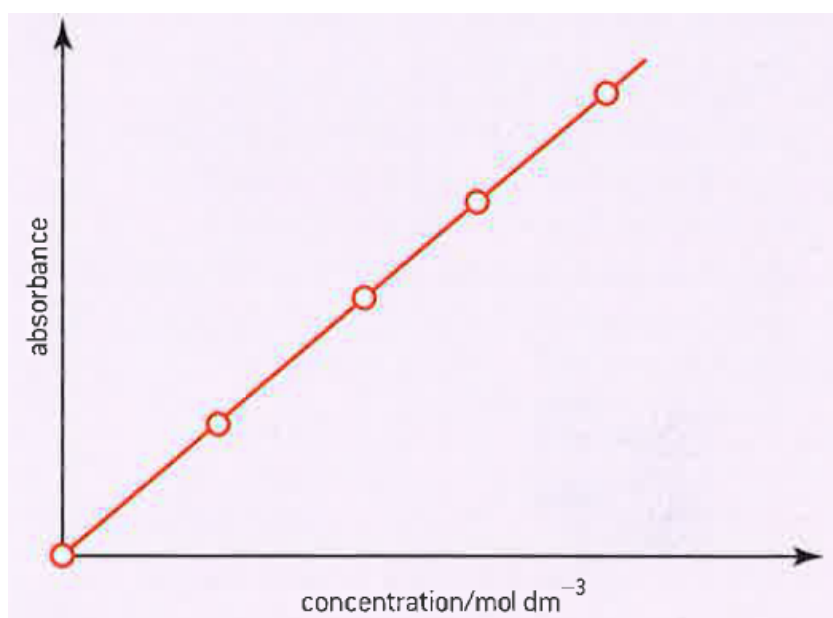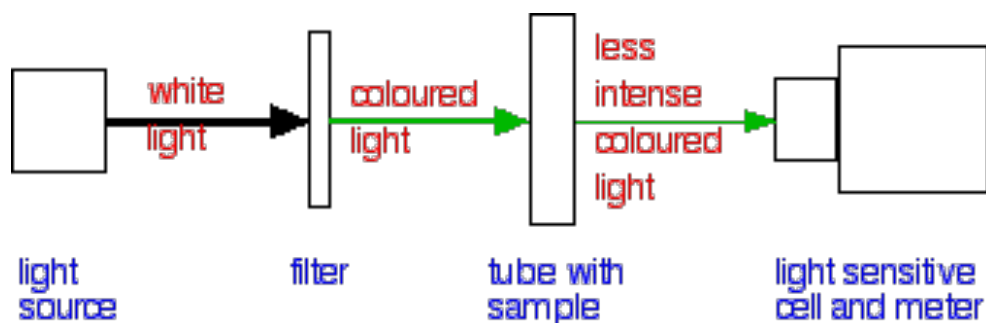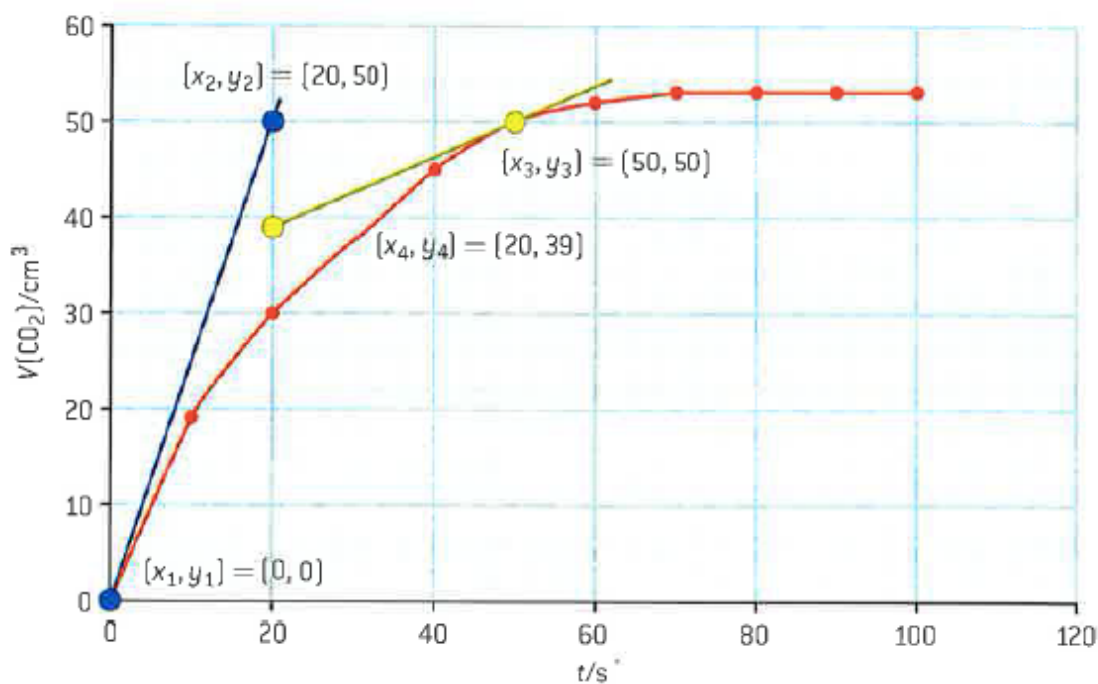
> Initial rate = slope of tangent line at t = 0s
>
> $\dfrac{50 - 0}{20 - 0} = 2.5 \text{ cm}^3 \text{ s}^{-1}$

> Instantaneous rate = Slope of tangent line at a particular time
>
> $\dfrac{50 - 39}{50 - 20} = 0.367 \text{ cm}^3 \text{ s}^{-1}$

> Average rate is a measure of the change in concentration of reactant or product in a given time interval.
>
> The above reaction is complete at 70 s.
>
> $\dfrac{53}{70} = 0.757 \text{ cm}^3 \text{ s}^{-1}$