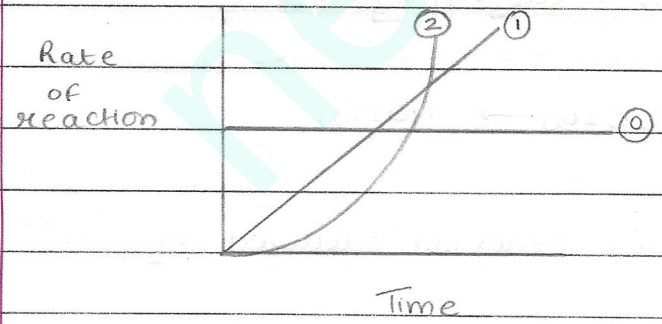
21 - Reaction Kinetics

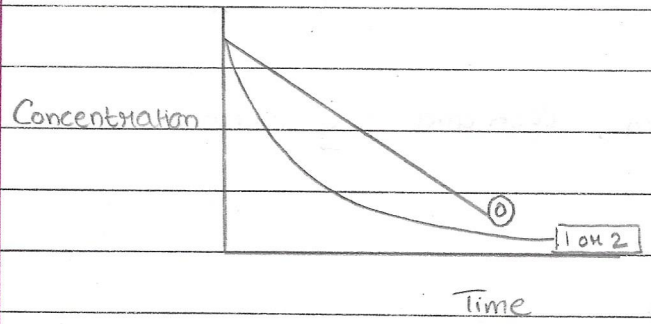
Q-1) What is rate of reaction?

> Rate of reaction is a measure of the rate at which reactants are used up or the rate at which products are formed.

$$\text{Rate} = k[A]^m[B]^n$$

- k: rate constant; units vary.
- m, n: order
- overall order = $m+n$.
- $[A]$, $[B]$: concentration of reactant.
- Rate: [mol dm^{-3} s^{-1}]





1st order will have a constant half life.
[Time for concentration to halve each time is the same]

For 1st order: $k = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{t_{1/2}}$

* The rate determining step is the slowest step overall. The reactants before this step are included in determining the order of reaction.

> Increasing temperature increases the value of the rate constant (k) ∴ increases the rate of reaction.

> Decreasing activation energy ~~also decreases~~ increases k.

> For a 2 step reaction, the curve with the higher activation energy will be the rate determining step.

Q-2) Catalysis.

> Homogeneous catalysis:
Reaction mixture and catalysts ~~Reactants and products~~ are in the same phase (state)

eg: The oxidation of SO_2 is catalysed by NO_2

$$SO_{2(g)} + NO_{2(g)} \longrightarrow SO_{3(g)} + NO_{(g)}$$

$$NO_{(g)} + \tfrac{1}{2}O_{2(g)} \longrightarrow NO_{2(g)}$$

eg: The iodine-peroxodisulfate reaction catalyed by Fe^{3+}.

$$2Fe^{3+}_{(aq)} + 2I^-_{(aq)} \longrightarrow 2Fe^{2+}_{(aq)} + I_{2(aq)}$$

$$2Fe^{2+} + S_2O_8^{2-} \longrightarrow 2Fe^{3+} + 2SO_4^{2-}$$

eg: Catalytic role of enzymes ; lock and key model.

> Heterogeneous catalysis.
Reaction mixture and catalysts are not in same phase (state)

eg: The Haber process catalysed by iron.

① Diffusion of H_2 and N_2 on surface of iron

② Adsorption ; these ~~weaken~~ covalent bonds within N_2 and H_2

③ Reaction : $N_2 + 3H_2 \longrightarrow 2NH_3$

④ Desorption : bonds between NH_3 and iron weaken.

⑤ Diffusion of NH_3 away from the surface.

* The same mechanism is for catalytic converters in car engines catalysed by Platinum.

Q-3) What is order of reaction?

> The order of reaction with respect to a particular reactant is the power to which the concentration of that reaction is raised in the rate equation.