Chemical kinetics

- Rate of Reaction - is the speed at which reactants are used up or products are formed.

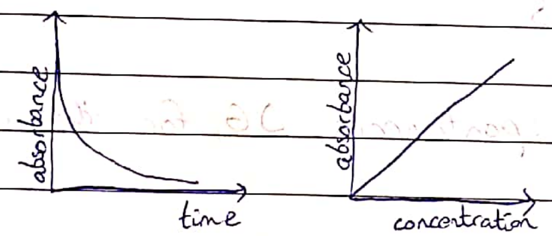
- Rate of reaction is defined as the change in concentration of reactants or change in concentration of products. per unit time.

- average rate = $\frac{\text{change in concentration}}{\text{time}}$.

- The reaction of propanone + Iodine

$$CH_3COCH_{3(aq)} + I_{2(aq)} \xrightarrow{H^+} CH_3COCH_2I_{(aq)} + H^+_{(aq)} + I^-_{(aq)}$$

The color changes from brown to colour less.
Therefore using a calorimeter.

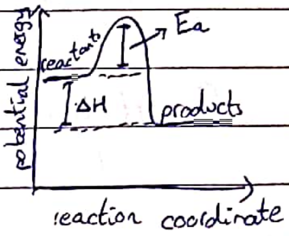


- Measurement of the rate at which CO_2 is produced.
- Measurement of the rate at which the mass decreases.

- Collision theory
  - A collision must involve more than a certain minimum amount of energy.
  - Molecules must collide with the correct orientations.

The minimum amount of energy that colliding particles must possess to result in a reaction is called activation energy.

- Activation energy is the energy needed to overcome repulsions, to start breaking bonds, to deform molecules and to allow rearrangements of atoms, electrons etc.



- Factors affecting Rate of reaction

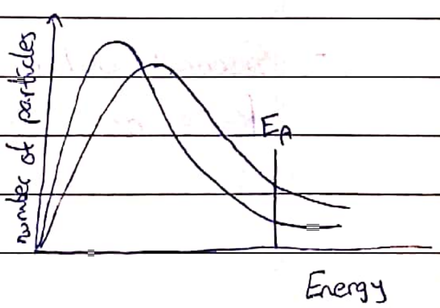
• Concentration of reactants
- more particles in a certain volume, the particles collide more often (the collision frequency is higher) and therefore there is greater chance of a successful collision.

• Effect of pressure
- ~~Dec~~ Increasing the pressure – the collision frequency increases.

• Effect of surface area
- Increasing the surface area increases the number of particles exposed at the surface. – the effective concentration of the particles is increased – thus greater chance of reaction occuring.

• Effect of temperature
- The average kinetic energy of the particles in a gas is proportional to its temperature in kelvin. - As the temperature increases the molecules have more energy and therefore move faster. This means the collision frequency increases, - this is the minor effect. But as ~~th~~ temperature increases the particles collide harder (with more energy).

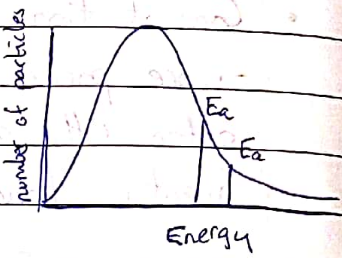
- The main reason that the rate of reaction increases with temperature is an increasee in number of particles with energy greater than or equal to the activation energy.



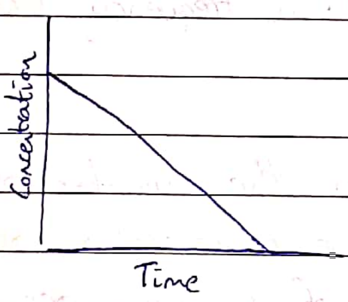
- Catalysis
- A catalyst is a substance that increases the rate of a chemical reaction without itself being used up in the reaction.

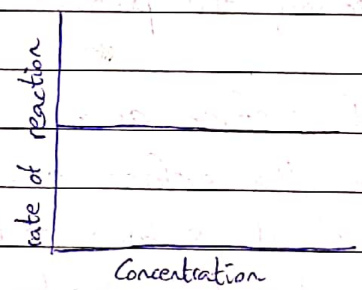
- A catalyst acts by allowing the reaction to proceed by an alternative pathway of lower activation energy.

- $rate = k[W]^m[X]^n$

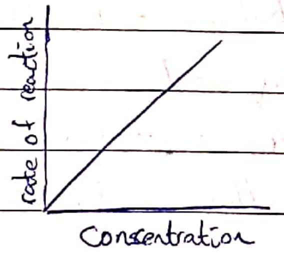


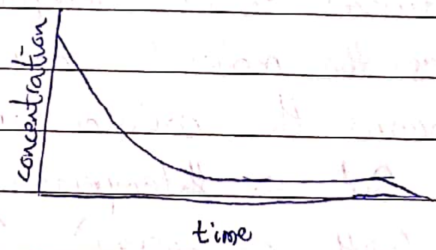
- Zero order reactions
The rate ~~of~~ is independent of the concentration.



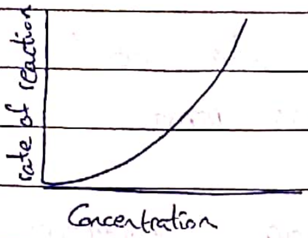


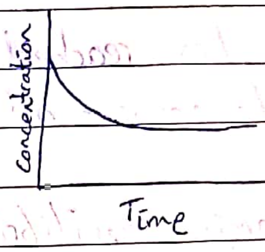
- First-order reactions
The rate is directly proportional to the concentration.





- Second-order reactions
Rate of reaction is proportional to concentration squared.





- Reaction mechanism consists of a series of steps that make up a more complex reaction. Each simple step involves a maximum of two molecules colliding.

- The slowest step is the rate determining step.

- The rate equations contains concentrations of reactants in the involved in the rate-determining step.

- As the temperature increases, the rate constant increases exponentially.

$$k = Ae^{-\frac{E_a}{RT}}$$

E_a → activation energy

A ↳ frequency factor - takes account ~~for~~ of the frequency of collisions and the orientation of the collisions.

$\ln k$ vs $\frac{1}{T}$ graph - slope gives activation energy by R

$\ln k = \frac{-E_a}{R} \times \frac{1}{T} + \ln A$. - y intercept gives $\ln A$

may be written as $\ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

- Higher the activation energy smaller the value of k

- Catalyst decrease E_a, therefore $e^{-E_a/RT}$ is bigger and hence k is bigger