28/08/25

Rates of Reaction
Chemistry

Context

- There are various ways to increase the rate of reaction that transfer over from Nat 5 Chemistry, but sometimes with new definitions.
- There is also a new type of rate of reaction, relative rate, which is used in different cases.

Definitions

- Catalyst (new:) — a chemical which can be added to a reaction and speeds up the rate of reaction by lowering the activation energy by providing an alternative pathway. It can be recovered chemically unchanged.

Equations

- Average rate — $\text{rate} = \frac{\Delta q}{\Delta t}$
- Relative rate — $\text{rate} = \frac{1}{t}$

Technique

- The ways to increase rates of reaction are mainly the same as Nat 5, and are as follows:
- Increase temperature — since particles are moving with more kinetic energy, collisions are more likely and particles are more likely to have enough energy for successful collisions.
- Increase concentration — since there are more reactant particles, there are more successful collisions.
- Decrease particle size / increase surface area — similar to concentration, more reactant particles are exposed / available to react, so there are more successful collisions.
- Add a catalyst — lowers the activation energy providing an alternate pathway (see later notes).

- Difference between rates of reaction: there are two different rates of reaction are used for slightly different things.
- Average rate – used to compare rates between different timeframes in the same reaction, measured in unit of quantity per unit of time (e.g. gs^{-1}, $mL\,min^{-1}$, $cm^3\,s^{-1}$)
- Relative rate – used to compare overall rates between reactions, measured in one over unit time (e.g. s^{-1}, min^{-1})

Things to Remember

- Catalysts provide an alternative pathway
- Concentration is the only method of increasing rate that increases the mass / volume of products produced.
- Always write more <u>successful</u> collisions, not just more collisions.

Basic Collision Theory

02/09/25 Chemistry

Context

- At HL Chem we need to understand why and when reactions occur.

Definitions

- Activation energy - the energy required to overcome any forces of repulsion from the electrons & breake any bonds within the reactant molecules

Technique

- For the rate of reaction to be increased, more successful collisions have to occur.
- There are two ways by which to make more successful collisions occur:
  - Increase the number of collisions in total.

  This can be done by increasing surface area, increasing concentration, or increasing pressure. There are more exposed reactant particles, so more collisions will occur.
  - Increase no. of particles with Activation Energy. This can be achieved by increasing the temperature or adding a catalyst.
- Particles need to have enough energy - the activation energy - and to collide at the correct angle, for collisions to be successful.

Thing to Remember

Reaction Diagrams

02/09/25 Chemistry

Context

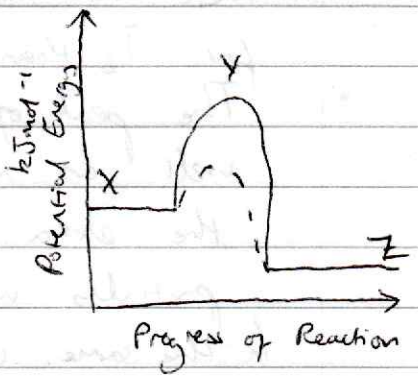
- There are two diagrams introduced at H Chemistry which give different information about the reaction.
- Energy distribution diagrams are usually unannotated and show the Activation Energy and relative proportions of particles with enough energy to react.
- Potential energy diagrams show enthalpy change & activation energy. They also show whether a reaction is exo- or endo- thermic.

Definitions

- Enthalpy (H) - essentially the energy stored within a substance's bonds.

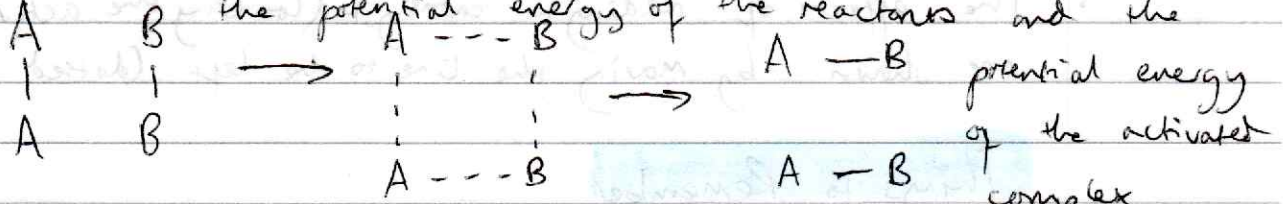
Equations

- Enthalpy change - $\Delta H = Z - X$
- Activation energy - $E_A = Y - X$



Technique

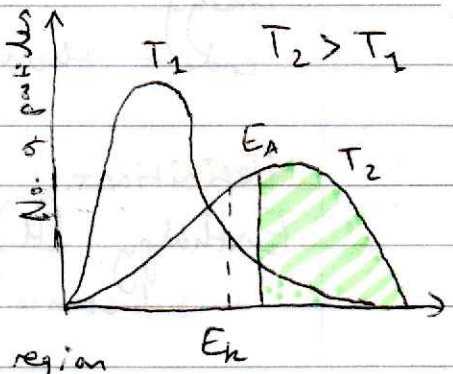
- Energy potential diagrams show the energy required for a reaction to occur in terms of the difference between the potential energy of the reactants and the potential energy of the activated complex



(a state where the bonds between reactants are starting to break and new ones are starting to form. The activation energy is the difference between the activated complex at Y and the reactants at X.

- The enthalpy change can be found by the difference between the potential energy of the products at Z and the reactants at X. A negative enthalpy change corresponds to an exothermic reaction as energy is given out. A positive enthalpy change is hence an endothermic reaction.
- Adding a catalyst to a reaction lowers the activation energy but does not change enthalpy change. Therefore the catalyst only affects the curved part of the graph (effects shown with a dotted line).

- Energy distribution diagrams show how many particles have how much energy, and indicate what proportion of particles have the required energy to react.



- There are more particles in the shaded region for T_2 than T_1, ∴ more successful collisions will occur.
- The peak of the crest of T_2 is lower than that of T_1 (as well as naturally being further right). This is because the extra heat is not distributed equally, so fewer particles will have the same higher temperature.
- In the same way, a lower temperature would push the curve of T_1 up & to the left, as more particles would have a lower temperature.
- The effects of adding a catalyst (lowering the activation energy) are shown by moving the line to the left (dotted line).

Things to Remember

- A catalyst being added is shown by a lower activation energy - further to the left, or lower, for the respective diagrams.
- A higher temperature has a lower crest on energy distribution diagrams.