WJEC England GCSE Chemistry

Topic 9: Rate of chemical change and dynamic equilibrium

Notes

(Content in bold is for Higher Tier only)

Calculating rates of reactions

- Practical methods for determining the rate of a given reaction
  - Gas collection
  - Loss of mass
  - Precipitation
- Observed changes in mass in non-enclosed systems
  - Could decrease if a gas is produced and therefore released into the surroundings due to the non-enclosed system
- Rates of reactions can be measured using the amount of product used, or amount of product formed over time:

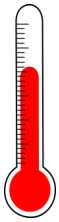
$$\text{Rate of reaction} = \frac{\text{amount of reactant used}}{\text{Time}}$$

$$\text{Rate of reaction} = \frac{\text{amount of product formed}}{\text{Time}}$$

  - Quantity of reactant or product can be measured by the mass in grams or by a volume in cm^3
  - Units of rate of reaction may be given as g/s or cm^3/s
  - (HT only) use quantity of reactants in terms of moles and therefore, units for rate of reaction in mol/s

- To find the rate of reaction graphically
  - Draw tangents to curves and use the slope of the tangent as a measure of the rate of reaction
  - calculate the gradient of a tangent to the curve on these graphs as a measure of rate of reaction at a specific time

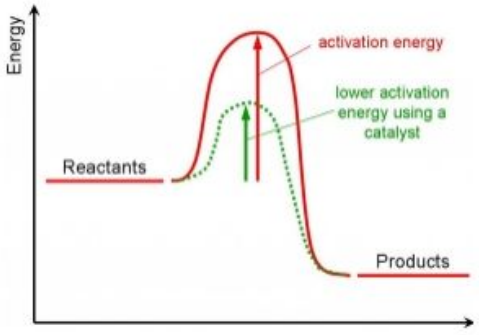
Factors which affect the rates of chemical reactions



- Increasing the temperature increases the rate of reaction. As increasing temperature increases the speed of the moving particles, so they collide more frequently and energetically.
- Increasing pressure in reacting gases increases the rate of reaction, as it increases the frequency of collisions.
- Increasing concentration of reacting solutions increases the rate of reaction, as it increases the frequency of collisions.
- Increasing the surface area of solid reactants increases the rate of reaction, as it increases the frequency of collisions.

Catalysts

- Catalysts are substances that speed up chemical reactions without being changed or used up during the reaction.
    - Whatever stays the same throughout the reaction can be easily identified as the catalyst, they usually aren't included in the reaction equation
- Enzymes act as catalysts in biological systems



- Catalysts provide a different pathway for a chemical reaction that has a lower activation energy.
- This increases the proportion of particles with energy to react.

Reversible reactions

- In some chemical reactions, the products of the reaction can react to produce the original reactants
    - These are called reversible reactions
    - The direction of the reaction can be changed by changing the conditions

E.g. The Haber Process: nitrogen + hydrogen ⇌ ammonia

- Dynamic equilibrium occurs when the rates of forward and reverse reactions are equal

The effect of changing conditions on equilibrium

- **The relative amounts of all the reacting substances at equilibrium depend on the conditions of the reaction.**
- **If a system is at equilibrium and a change is made to any of the conditions, then the system responds to counteract the change.**
    - **Effects of changing conditions on a system at equilibrium can be predicted using Le Chatelier's Principle.**

Effect of changing concentration:

- **If the concentration of one of the reactants or products is changed, the system is no longer at equilibrium and the concentrations of all the substances will change until equilibrium is reached again.**

- **If concentration of reactants is increased: position of equilibrium shifts towards products (right) so more product is produced until equilibrium is reached again**
- **if concentration of products is increased: position of equilibrium shifts towards reactants (left) so more reactant is produced until equilibrium is reached again**

Effect of changing temperature:

- **If temperature is increased: equilibrium moves in the direction of the endothermic reaction (e.g. if forwards reaction is endothermic and temperature is increased, equilibrium shifts right to produce more product)**
- **If temperature is decreased: equilibrium moves in the direction of the exothermic reaction**
- **For the forwards being exo/endothermic and yield meaning the amount of product from the forwards reaction:**

	Exothermic	**Endothermic**
An increase in temperature...	Decreases yield of reaction- equilibrium moves left	Increases yield of reaction- equilibrium moves right
A decrease in temperature...	Increases yield of reaction- equilibrium moves right	Decreases yield of reaction- equilibrium moves left

Effect of changing pressure:

- **In gaseous reactions, an increase in pressure will favour the reaction that produces the least number of molecules as shown by the symbol equation for that reaction.**

If a reaction produces a...	**...larger volume of gas (more moles on product side)**	**...smaller volume of gas (fewer moles on product side)**
An increase in pressure...	Decreases yield of reaction	Increases yield of reaction
A decrease in pressure...	Increases yield of reaction	Decreases yield of reaction

Practical assessments

- SP9A Investigation into the effect of one factor on the rate of a reaction using a gas collection method
- SP9B Investigation into the effect of one factor on the rate of the reaction between dilute hydrochloric acid and sodium thiosulfate
- SP9C Investigation into the effect of various catalysts on the decomposition of hydrogen peroxide