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UNIT 3

Topic 1: Chemical equilibrium systems

1 Chemical equilibrium

1.1 Recognise that chemical systems may be open or closed

Open chemical system: allows matter and energy to be exchanged with the surroundings.

Closed chemical system: allows energy, but not matter, to be exchanged with the surroundings.

1.2 Understand that physical changes are usually reversible, whereas only some chemical reactions are reversible

Reversible reaction: a reaction that proceeds forwards (reactant → product) or in the reverse/backwards (product → reactant) direction.

- *Physical changes* or phase changes (solid to liquid to gas and vice versa) are usually reversible.
- Only certain *chemical reactions* are reversible.

1.3 Appreciate that observable changes in chemical reactions and physical changes can be described and explained at an atomic and molecular level

Phase Change:

- According to Kinetic Theory, matter is made up of particles which are in continual random motion.
- During a phase change heat energy is either absorbed or released.
    - Exothermic - Heat energy is released as molecules slow down and move closer together, forming intermolecular forces.
    - Endothermic - Heat energy is absorbed as molecules speed up and expand, breaking intermolecular forces.

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Chemical Reaction:

- According to Collision Theory, for a reaction to occur it is necessary for the reacting particles to collide.
    - The energy required to break the bonds for the reaction to occur is the activation energy (E_a).
    - The particles must collide in the correct orientation.
- The energy of the collision breaks bonds in reacting particles.
- The particles re-arrange to form new products.

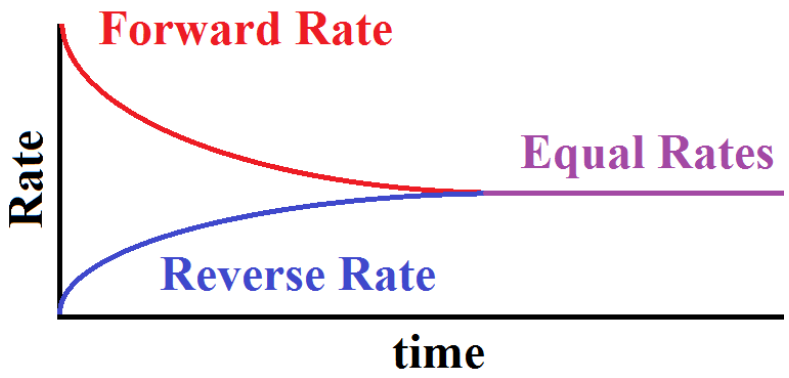
1.4 Symbolise equilibrium equations by using ⇌ in balanced chemical equations

Equilibrium equations must use the correct arrow. Remember this is needed for weak acid and base dissociations as well.

$$A + B \rightleftharpoons C + D$$

1.5 Understand that, over time, physical changes and reversible chemical reactions reach a state of dynamic equilibrium in a closed system, with the relative concentrations of products and reactants defining the position of equilibrium

Equilibrium: a state of chemical reaction where the forward and reverse reactions occur at equal rates in a closed system. Therefore, the concentration of reactants and products does not change with time. *They are not necessarily equal though.*



Equilibrium is dynamic. This means that the chemical reaction continues to proceed, but the amount of products and reactants remain constant.

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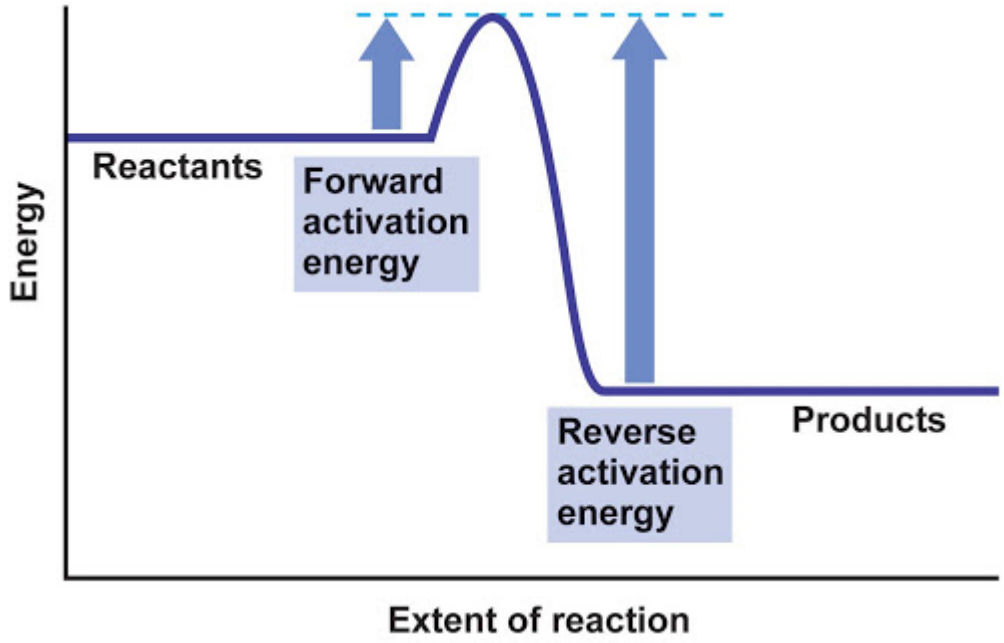
Equilibrium is NOT static because a static equilibrium is when there is no reaction occurring, e.g. a balanced seesaw.

1.6 Explain the reversibility of chemical reactions by considering the activation energies of the forward and reverse reactions

The reversibility of a chemical reaction depends on the activation energy (E_a).

- If the forwards E_a is greater than the backwards E_a, the equilibrium will lie towards the products.
- If the forwards E_a is less than the backwards E_a, the equilibrium will lie towards the reactants.

If the system is closed, the reversible reaction will reach equilibrium.



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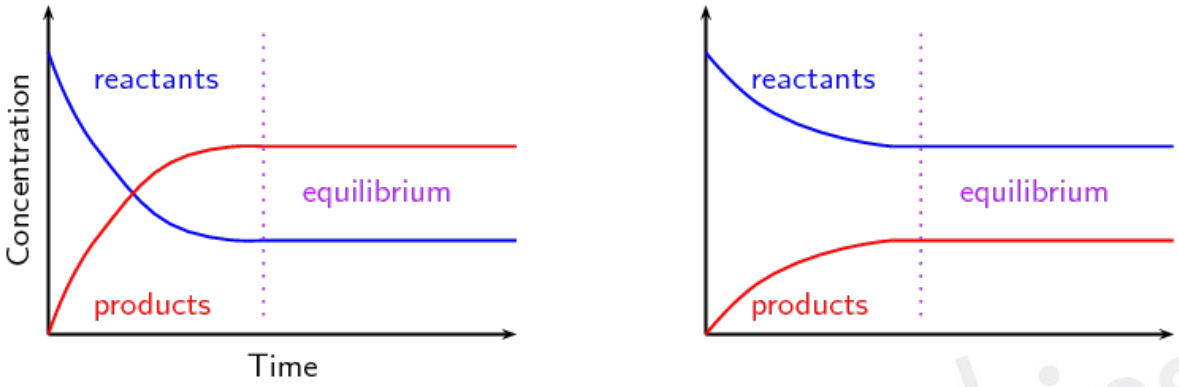
1.7 Analyse experimental data, including constructing and using appropriate graphical representations of relative changes in the concentration of reactants and product against time, to identify the position of equilibrium.



- The forwards rate is initially greater as there are only reactants, so reactants → products.
- The reverse rate is initially zero as there are no products to allow products → reactants.
- As products are formed, the reverse rate increases as it allows products → reactants.
- Eventually the rates will become equal, but concentrations of reactants and products may be different.