FACTFILE:
GCSE DAS CHEMISTRY: UNIT 2.4

Rewarding Learning

Equilibrium

Learning outcomes:

2.4.1 demonstrate knowledge and understanding that many chemical reactions are reversible and the direction of a reversible reaction can be changed by altering the reaction conditions;

2.4.2 **demonstrate knowledge and understanding that dynamic equilibrium occurs in a closed system when the rates of forward and reverse reactions are equal and the amounts of reactants and products remain constant;**

The majority of the reactions met at GCSE are irreversible. For example – when magnesium reacts with sulfuric acid a metal salt and hydrogen gas are produced.

magnesium + sulfuric acid ⟶ magnesium sulfate + hydrogen

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$$

This reaction will stop when all of the magnesium metal has reacted, essentially the reaction has 'gone to completion' and this is indicated by an arrow ⟶.

If a chemical reaction happens in a container where one or more of the reactants or products can escape this is termed an open system. If a chemical reaction happens in a container where none of the reactants or products can escape this is termed a closed system.

A reversible reaction is a chemical change in which the products can be converted back to the original reactants under suitable conditions. This means a reaction can go in either direction. *reversible reactions* that happen in a closed system eventually reach equilibrium.

A reversible reaction is shown by the sign ⇌.

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

- a half-arrow to the right (direction of forward reaction),
- a half-arrow to the left (direction of backward reaction).

For this equation the forward reaction is:

$$A + B \longrightarrow C + D$$

And the backward reaction is:

$$C + D \longrightarrow A + B$$

A reversible reaction does not go to completion in either direction. All components, original reactants or ensuing products co-exist in the reaction mixture. In a reversible reaction, changing the reaction conditions will change the net direction in which the reaction goes. It will either go more to the right (forward direction) or more to left (backward direction).

The following conditions will change the equilibrium position in a reversible reaction:

- changing the concentration of a reactant;
- changing the concentration of a product;
- changing the temperature;
- changing the pressure in a reaction involving gases.

When a system is in a state of equilibrium nothing appears to be happening. However, the system is *dynamic* meaning it is in constant motion. A chemical system is in dynamic equilibrium when:

- the rate of the forward reaction is the same as the rate of the reverse reaction;
- the concentrations of the reactants and products remain the same.

DYNAMIC EQUILIBRIUM – *this is the equilibrium when the rate of the forward reaction is equal to the rate of the reverse reaction and the amounts of reactants and products remain constant.*

REVISION QUESTIONS

1 (a) Each of the equations in the table below, labelled A to E represents a dynamic equilibrium.

A	N_2 (g) + O_2 (g) $\rightleftharpoons$ 2NO (g)	ΔH = +180 kJ/mol
B	N_2O_4 (g) $\rightleftharpoons$ 2NO (g)	ΔH = +58 kJ/mol
C	$2SO_2$ (g) + O_2 (g) $\rightleftharpoons$ $2SO_3$ (g)	ΔH = –196 kJ/mol
D	N_2 (g) + $3H_2$ (g) $\rightleftharpoons$ $2NH_3$ (g)	ΔH = –92 kJ/mol
E	H_2 (g) + I_2 (g) $\rightleftharpoons$ 2HI (g)	ΔH = –11 kJ/mol

(i) Explain what is meant by the term *dynamic equilibrium*.

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_____ [3]

(ii) What shows that the reaction is reversible?

_____ [1]

(iii) State two things factors which would change the position of equilibrium in a reaction.

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_____ [2]

(b) The equilibrium reaction below is carried out at 325°C in the presence of a nickel catalyst.

$$CO\ (g) + 3H_2\ (g) \rightleftharpoons CH_4\ (g) + H_2O\ (g) \qquad \Delta H = -206\ kJ/mol$$

(i) Name the reactants and the products.

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_____ [4]

(ii) Explain the features of a dynamic equilibrium.

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_____ [2]