OCR (B) Chemistry A-level

Storyline 6: The Chemical Industry

Definitions and Concepts

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Definitions and Concepts for OCR (B) Chemistry A-level

The Chemical Industry

Kinetics

Activation energy: The minimum energy needed for a reaction to occur between two colliding particles.

Arrhenius equation: $k = Ae^{-Ea/RT}$, where k is the rate constant, A is the pre-exponential factor, E_a is the activation energy, R is the gas constant and T is the temperature.

Concentration-time graph: A graph in which concentration is plotted on the y-axis and time on the x-axis. The gradient of the line is equal to the rate of reaction.

Continuous monitoring: During a rate experiment, continuous measurements are taken as the reaction progresses. The results can then be plotted on a concentration-time graph.

First order reactant: Doubling the concentration of a first order reactant will double the rate of reaction (if all other conditions remain the same).

Gradient: Change in y ÷ change in x.

Half-life ($t_{1/2}$): The time taken for the concentration of a species to half.

Initial rate: The rate of a reaction at time t=0.

Order: A number that relates the rate of a reaction to the concentrations of each reactant.

Overall order: The sum of the orders with respect to each reactant.

Rate-concentration graph: A graph that has concentration plotted on the x-axis and rate on the y-axis.

Rate constant (k): A constant value that relates the rate of a reaction at a given temperature to the concentrations of the species in a reaction mixture that affect the rate. For a first order reaction, this can be determined using the relationship $k = \ln 2/t_{1/2}$.

Rate determining step: The slowest step in a multi-step reaction. The overall rate is decided by this step. Species present in the rate determining step will also be in the rate equation.

Rate equation: Relates rate to the concentrations of the reactants multiplied by the rate constant. Each concentration is raised to the power of the order with respect to that reactant.

$$Rate = k[A]^m[B]^n,$$

where k is the rate constant and where m and n are the orders of reaction with respect to reactants A and B.

In this example, the reaction is 1st order with respect to B, and 2nd order with respect to A. Therefore increasing the concentration of B by a factor of 2 will increase the rate by the same factor. However, increasing the concentration of A by 3 will increase the rate by a factor of $3^2 = 9$.

Reaction mechanism: A step-by-step sequence of the individual reactions that make up the overall reaction.

Second order reactant: Doubling the concentration of a second order reactant will quadruple the rate of reaction (if all other conditions remain the same).

Zero order reactant: Doubling the concentration of a zero order reactant will have no impact on the rate of reaction (if all other conditions remain the same).

Equilibrium

Catalyst: A substance that speeds up the rate of a reaction without being used up. It increases the rate of reaction by providing an alternative reaction pathway with a lower activation energy.

Equilibrium: A chemical state in which the forward and reverse reactions of a process occur at the same rate. This means there is no overall change in the concentrations of the reactants and products.

Equilibrium constant (K): A value that relates the amount of products and reactants at equilibrium in a reversible reaction at a specific temperature. K is unaffected by pressure and the presence of a catalyst but is affected by temperature.

Heterogeneous equilibrium: An equilibrium reaction that involves substances in different states (solid, liquid gaseous or aqueous).

Homogeneous equilibrium: An equilibrium reaction that involves substances all in the same state (solid, liquid gaseous or aqueous).

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K_c: A value that relates the concentrations of products and reactants present at equilibrium in a reversible reaction at a specific temperature. The equilibrium constant that is equal to the concentration of products raised to their stoichiometric coefficients divided by the concentration of reactants raised to the power of their stoichiometric coefficients. Liquids and solids are not included in heterogeneous K_C expressions as their concentrations effectively remain constant.

Inorganic Chemistry and the Periodic Table

Nitrogen: An element in Group 5 of the periodic table.

NO: A molecule called nitric oxide, a colourless gas.

NO_2: A molecule called nitrogen dioxide, a brown gas.

N_2O: A molecule called nitrous oxide, a sweet-smelling, colourless gas.

Triple bond: A type of covalent bond which involves 6 bonding electrons.

Sustainability

By-products: Products of reactions which are not wanted or needed, they often have to be removed for the product mixture which requires more time and money. Addition reactions don't have any by-products.

Costs: The costs associated with a reaction, including the cost of the reactants, any catalysts and the conditions of the reaction (high temperatures and pressures are very costly).

Hazards: The dangers or risks associated with a specific reaction or reaction conditions.