Topic 2: Managing chemical processes

Subtopic 2.1: Rates of reactions

This subtopic builds on concepts from Stage 1 subtopic 4.4.

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| The rates of a reaction at different times can be compared by considering the slope of a graph of quantity or concentration of reactant or product against time.   * Draw and interpret graphs representing changes in quantities or concentration of reactants or products against time.   Rates of reaction can be influenced by a number of factors, including the presence of inorganic and biological catalysts (enzymes).   * Predict and explain, using collision theory, the effect on rates of reaction due to changes in: * concentration * temperature * pressure (for reactions involving gases) * surface area * the presence of a catalyst.   Energy profile diagrams can be used to represent the relative enthalpies of reactants and products, the activation energy, and the enthalpy change for a chemical reaction.   * Draw and interpret energy profile diagrams. |
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Subtopic 2.2: Equilibrium and yield

This subtopic uses energy concepts from Stage 1 subtopics 2.3, 4.3, and 4.4, and links to Stage 2 subtopics 1.1 (ocean acidification), 4.2 (water treatment), and 4.3 (availability of soil nutrients).

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| Chemical systems may be open or closed.  Over time, reversible chemical reactions carried out in a closed system at fixed temperature eventually reach a state of chemical equilibrium.  The changes in concentrations of reactants and products, as a system reaches equilibrium, can be represented graphically.   * Draw and interpret graphs representing changes in concentrations of reactants and products.   The position of equilibrium in a chemical system at a given temperature can be indicated by a constant, *Kc*, related to the concentrations of reactants and products.   * Write *Kc* expressions that correspond to given reaction equations for homogeneous equilibrium systems. * Undertake calculations involving *Kc* and initial and/or equilibrium quantities of reactants and products for homogeneous equilibrium systems.   The final equilibrium concentrations, and hence position of equilibrium, for a given reaction depend on various factors.   * Predict and explain, using Le Châtelier’s principle, the effect on the equilibrium position of a system of a change in the: * concentration of a reactant or product * overall pressure of a gaseous mixture * temperature of an equilibrium mixture for which the *△H* value for the forward or back reaction is specified. * Predict the change that occurred in a system, or whether a reaction is exothermic or endothermic, given the effect of the change on the equilibrium position of the system. |
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Subtopic 2.3: Optimising production

This subtopic integrates concepts from subtopics 2.1 and 2.2.

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| Designing chemical-synthesis processes involves constructing reaction pathways that may include more than one chemical reaction.  The steps in industrial chemical processes can be conveniently displayed in flow charts.   * Interpret flow charts and use them for such purposes as identifying raw materials, chemicals present at different steps in the process, waste products, and by-products.   Industrial processes are designed to maximise profit and to minimise impact on the environment.   * Explain how certain reaction conditions represent a compromise that will give maximum yield in a short time. * Explain the impact of increases in temperature and pressure on manufacturing conditions and costs, and on the environment. * Explain how use of a catalyst may benefit both the manufacturer and the environment. |
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