

3.2 Physical Chemistry

3.2.1 Enthalpy change

(a) explanation that some chemical reactions are accompanied by enthalpy changes that are exothermic (ΔH , negative) or endothermic (ΔH , positive)					
(b) construction of enthalpy profile diagrams to show the difference in the enthalpy of reactants compared with products					
(c) qualitative explanation of the term <i>activation energy</i> , including use of enthalpy profile diagrams					
(d) explanation and use of the terms: (i) <i>standard conditions</i> and <i>standard states</i> (physical states under standard conditions) (ii) <i>enthalpy change of reaction</i> (enthalpy change associated with a stated equation, $\Delta_r H$) (iii) <i>enthalpy change of formation</i> (formation of 1 mol of a compound from its elements, $\Delta_f H$) (iv) <i>enthalpy change of combustion</i> (complete combustion of 1 mol of a substance, $\Delta_c H$) (v) <i>enthalpy change of neutralisation</i> (formation of 1 mol of water from neutralisation, $\Delta_{\text{neut}} H$)					
(e) determination of enthalpy changes directly from appropriate experimental results, including use of the relationship: $q = mc\Delta T$					
(f) (i) explanation of the term <i>average bond enthalpy</i> (breaking of 1 mol of bonds in gaseous molecules) (ii) explanation of exothermic and endothermic reactions in terms of enthalpy changes associated with the breaking and making of chemical bonds (iii) use of average bond enthalpies to calculate enthalpy changes and related quantities (see also 2.2.2 f)					
(g) Hess' law for construction of enthalpy cycles and calculations to determine indirectly: (i) an enthalpy change of reaction from enthalpy changes of combustion (ii) an enthalpy change of reaction from enthalpy changes of formation (iii) enthalpy changes from unfamiliar enthalpy cycles					
(h) the techniques and procedures used to determine enthalpy changes directly and indirectly.					

3.2.2 Reaction rates

(a) the effect of concentration, including the pressure of gases, on the rate of a reaction, in terms of frequency of collisions					
(b) calculation of reaction rate from the gradients of graphs measuring how a physical quantity changes with time					
(c) explanation of the role of a catalyst: (i) in increasing reaction rate without being used up by the overall reaction (ii) in allowing a reaction to proceed via a different route with lower activation energy, as shown by enthalpy profile diagrams					
(d) (i) explanation of the terms <i>homogeneous</i> and <i>heterogeneous</i> catalysts (ii) explanation that catalysts have great economic importance and benefits for increased sustainability by lowering temperatures and reducing energy demand from combustion of fossil fuels with resulting reduction in CO ₂ emissions					
(e) the techniques and procedures used to investigate reaction rates including the measurement of mass, gas volumes and time					
(f) qualitative explanation of the Boltzmann distribution and its relationship with activation energy (see also 3.2.1 c)					
(g) explanation, using Boltzmann distributions, of the qualitative effect on the proportion of molecules exceeding the activation energy and hence the reaction rate, for: (i) temperature changes (ii) catalytic behaviour (see also 3.2.2 c).					

3.2.3 Chemical equilibrium

(a) explanation that a dynamic equilibrium exists in a closed system when the rate of the forward reaction is equal to the rate of the reverse reaction and the concentrations of reactants and products do not change					
(b) Le Chatelier's principle and its application for homogeneous equilibria to deduce qualitatively the effect of a change in temperature, pressure or concentration on the position of equilibrium					
(c) explanation that a catalyst increases the rate of both forward and reverse reactions in an equilibrium by the same amount resulting in an unchanged position of equilibrium					
(d) the techniques and procedures used to investigate changes to the position of equilibrium for changes in concentration and temperature					
(e) explanation of the importance to the chemical industry of a compromise between chemical equilibrium and reaction rate in deciding the operational conditions					
(f) expressions for the equilibrium constant, K_c , for homogeneous reactions and calculations of the equilibrium constant, K_c , from provided equilibrium concentrations					
(g) estimation of the position of equilibrium from the magnitude of K_c .					