Unit 3 - Chemical Reactions

HIGHER CHEMISTRY

The Chemical Industry

1. The UK chemical industry is a major contributor to both the quality of our life and our national economy.

2. Stages in the manufacture of a new product can include research, pilot study, scaling-up, production and review.

3. A chemical manufacturing process usually involves a series of steps.

4. A feedstock is a reactant from which other chemicals can be extracted or synthesised.

5. The major raw materials in the chemical industry are fossil fuels, metallic ores and minerals, air and water.

6. Chemical manufacture may be organised as a batch or continuous process.

7. Process conditions are chosen to maximise economic efficiency.

8. Manufacturing costs include capital costs, fixed costs and variable costs.

9. The UK chemical industry is, by and large, capital rather than labour intensive.

10. Safety and environmental issues are of major importance to the chemical industry.

11. Both historical and practical factors affect the location of chemical industries.

12. The efficient use of energy is significant in most chemical processes.

13. Factors influencing the choice of a particular route include cost, availability and suitability of feedstocks, yield of products, opportunities for the recycling of reactants and marketability of by-products.

Hess's Law

1. Hess's Law states that the enthalpy change for a chemical reaction is independent of the route taken.

2. Enthalpy changes can be calculated by the application of Hess's Law.

Equilibrium

1. Reversible reactions attain a state of dynamic equilibrium when the rates of the forward and reverse reactions are equal.

2. At equilibrium, the concentrations of reactants and products remain constant but not necessarily equal.

3. Changes in concentration, pressure and temperature can alter the position of equilibrium.

4. A catalyst speeds up the rate of attainment of equilibrium but does not affect the position of equilibrium.

5. The effects of pressure, temperature, the use of a catalyst, recycling of unreacted gases and the removal of product can be considered in relation to the Haber Process.

Acids and Bases

1. The pH scale is a continuous range from below 0 to above 14.

2. Integral values of pH from 0 to 14 can be related to concentrations of H^+ in mol l^{-1}.

3. In water and aqueous solutions with a pH value of 7, the concentrations of H^+ and OH^- are both 10^{-7} mol l^{-1} at 25^0C.

4. The concentration of H^+ or OH^- in a solution can be calculated from $[H^+][OH^-] = 10^{-14}$ mol^2 l^{-2}.

5. In water and aqueous solutions there is an equilibrium between H^+ and OH^- ions and water molecules.

6. In aqueous solutions, strong acids are completely dissociated but weak acids are only partially dissociated.

7. Equimolar solutions of strong and weak acids differ in pH, conductivity and reaction rate, but not in stoichiometery of reaction.

8. The weakly acidic nature of solutions of ethanoic acid, sulphur dioxide and carbon dioxide can be explained by reference to equations showing the equilibrium.

9. In aqueous solutions, strong bases are completely dissociated but weak bases are only partially dissociated.

10. Equimolar solutions of strong and weak bases differ in pH and conductivity but not in stoichiometery of reaction.

11. The weakly alkaline nature of a solution of ammonia can be explained by reference to an equation showing the equilibrium.

12. A soluble salt of a strong acid and a strong base dissolves in water to produce a neutral solution.

13. A soluble salt of a weak acid and a strong base dissolves in water to produce an alkaline solution.

14. A soluble salt of a strong acid and a weak base dissolves in water to produce an acidic solution.

15. Soaps are salts of weak acids and strong bases.

16. The acidity, alkalinity or neutrality of the above kinds of salt solutions can be explained by reference to the appropriate equilibria.

Redox Reactions

1. An oxidising agent is a substance which accepts electrons; a reducing agent is a substance which donates electrons.

2. Oxidising and reducing agents can be identified in redox reactions.

3. Ion-electron equations can be written for oxidation and reduction reactions.

4. Ion-electron equations can be combined to produce redox equations.

5. Given reactant and product species, ion-electron equations which include H^+ and H_2O can be written.

6. The concentration of a reactant can be calculated from the results of a volumetric titration.

7. The production of 1 mole of an element from its ion, by electrolysis, always requires **n** times 96500C where **n** is the number of electrons in the relevant ion-electron equation.

8. 96500C is the charge associated with 1 mole of electrons.

9. The mass or volume of an element discharged can be calculated from the quantity of electricity passed and vice-versa.

Nuclear Chemistry

1. Radioactive decay involves changes in the nuclei of atoms.

2. Unstable nuclei (radioisotopes) are transformed into more stable nuclei by releasing energy.

3. The stability of nuclei depends on the proton/neutron ratio.

4. The natures and properties of alpha, beta and gamma radiation can be described.

5. Balanced nuclear equations, involving neutrons, protons, alpha particles and beta particles can be written.

6. The half life is the time taken for the activity or mass of a radioisotope to halve.

7. The decay of individual nuclei within a sample is random and is independent of chemical or physical state.

8. The quantity of radioisotope, half-life or time elapsed can be calculated given the value of the other two variables.

9. Radioisotopes are used in medicine, in industry, for scientific research including carbon dating and to produce energy by uranium fission and nuclear fusion.

10. Nuclear fuels and fossil fuels can be compared in terms of safety, pollution and the use of finite resources.

11. Elements are created in the stars from simple elements by nuclear fusion.

12. All naturally occurring elements, including those found in our bodies, originated in stars.