# **Year 12 ATAR Chemistry Units 3 and 4 2021**

# **Course Outline**

| **Semester, Week** | **Syllabus content** | **Assessment** |
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| Semester 1, Weeks 1-5. | **Semester 1 – Equilibrium, acids and bases, and redox reactions**  Structure of the syllabus   * course outline * assessment outline   Use of significant figures in calculations  Chemical equilibrium systems   * Collision theory can be used to explain and predict the effects of concentration, temperature, pressure, the presence of catalysts and surface area of reactants on the rates of chemical reactions. * Chemical systems include physical changes and chemical reactions and may be open (which allow matter and energy to be exchanged with the surroundings) or closed (which allow energy, but not matter, to be exchanged with the surroundings). * Observable changes in chemical reactions and physical changes can be described and explained at an atomic and molecular level. * Over time, in a closed system, reversible physical and chemical changes may reach a state of dynamic equilibrium, with the relative concentrations of products and reactants defining the position of equilibrium. * The characteristics of a system in dynamic equilibrium can be described and explained in terms of reaction rates and macroscopic properties. * The reversibility of chemical reactions can be explained in terms of the activation energies of the forward and reverse reactions. * The effect of changes of temperature on chemical systems initially at equilibrium can be predicted by considering the enthalpy changes for the forward and reverse reactions; this can be represented on energy profile diagrams and explained by the changes in the rates of the forward and reverse reactions. * The effects of changes in concentration of solutions and partial pressures of gases on chemical systems initially at equilibrium can be predicted and explained by applying collision theory to the forward and reverse reactions. * The effects of changes in temperature, concentration of species in solution, partial pressures of gases, total volume and the addition of a catalyst on equilibrium systems can be predicted using Le Châtelier’s Principle. * Equilibrium law expressions can be written for homogeneous and heterogeneous systems; the equilibrium constant (K), at any given temperature, indicates the relationship between product and reactant concentrations at equilibrium. * The relative amounts of reactants and products (equilibrium position) can be predicted qualitatively using equilibrium constants (Kc). | Task 1: Test - Reaction Rates and Equilibrium Test (3 %)  Task 2: Extended Response - Research Project (Holiday Homework) with Validation Test on Ocean Equilibrium (5 %) |
| Semester 1, Weeks 6-10. | Acids and Bases   * Acids are substances that can act as proton (hydrogen ion) donors and can be classified as monoprotic or polyprotic, depending on the number of protons available for donation. * The strength of acids is explained by the degree of ionisation at equilibrium in aqueous solution which can be represented by chemical equations and acidity constants (Ka). * The relationship between acids and bases in equilibrium systems can be explained using the Brønsted-Lowry model and represented using chemical equations that illustrate the transfer of protons between conjugate acid-base pairs. * The hydrolysis of salts of weak acids and weak bases can be represented using equations; the Brønsted-Lowry model can be applied to explain the acidic, basic and neutral nature of salts derived from bases and monoprotic and polyprotic acids. * Buffer solutions are conjugate in nature and resist changes in pH when small amounts of strong acid or base are added to the solution; buffering capacity can be explained qualitatively; Le Châtelier’s Principle can be applied to predict how buffers respond to the addition of hydrogen ions and hydroxide ions. * Water is a weak electrolyte; the self-ionisation of water is represented by Kw = [H+ ][OH- ] where Kw = 1.0 x 10-14 at 25 oC. * Kw can be used to calculate the concentration of hydrogen ions or hydroxide ions in solutions of strong acids or bases. * The pH scale is a logarithmic scale and the pH of a solution can be calculated from the concentration of hydrogen ions using the relationship pH = - log10 [H+]. * Acid-base indicators are weak acids, or weak bases, in which the acidic form is a different colour from the basic form. * Volumetric analysis methods involving acid-base reactions rely on the identification of an equivalence point by measuring the associated change in pH, using appropriate acid-base indicators or pH meters, to reveal an observable end point. * Data obtained from acid-base titrations can be used to calculate the masses of substances and concentrations and volumes of solutions involved. | Task 3: Hydrolysis of Salts Practical and Validation Test (5 %)  Task 4: Volumetric Analysis Test (3 %) |
| Semester 1, Weeks 11-14. | Oxidation and Reduction   * Oxidation-reduction (redox) reactions involve the transfer of one or more electrons from one species to another. * Oxidation involves the loss of electrons from a chemical species, and reduction involves the gain of electrons by a chemical species; these processes can be represented using half-equations and redox equations (acidic conditions only). * A range of reactions involve the oxidation of one species and reduction of another species, including metal and halogen displacement reactions, and combustion in both limited and excess oxygen environments. * The species being oxidised and reduced in a redox reaction can be identified using oxidation numbers. * The relative strength of oxidising and reducing agents can be determined by comparing standard electrode potentials, and can be used to predict reaction tendency. * Electrochemical cells, including galvanic and electrolytic cells, consist of oxidation and reduction half-reactions connected via an external circuit through which electrons move from the anode (oxidation reaction) to the cathode (reduction reaction). * Galvanic cells produce an electric current from a spontaneous redox reaction. * The electric potential difference of a cell under standard conditions can be calculated from standard electrode potentials; these values can be used to compare the voltages generated by cells constructed from different materials. * Electrochemical cells can be described in terms of the reactions occurring at the anode and cathode, the role of the electrolyte, salt bridge (galvanic cell), ion migration, and electron flow in the external circuit * Corrosion of iron is an electrochemical process that can be prevented by a range of techniques, including by exclusion of oxygen and/or water and through cathodic protection and sacrificial anodes * Cell diagrams can be used to represent electrochemical cells * Electrolytic cells use an external electrical potential difference to provide the energy to allow a non-spontaneous redox reaction to occur * Describe the use of electrolysis in electrolytic refining, including for purification of copper, and metal electroplating, including for silver. | Task 5: Acids and Bases, and Redox Test (5 %) |
| Semester 1, Weeks 15-16. | Examination revision | Task 6: Semester 1 examination – Unit 3 only (20 %)  Task 7: Practical exam – Volumetric analysis - acid base titration and validation test (5 %) |
| Semester 2, Weeks 1-8. | **Semester 2 – Organic chemistry and chemical synthesis**  Properties and structure of organic materials   * organic molecules have a hydrocarbon skeleton and can contain functional groups, including alkenes, alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides; functional groups are groups of atoms or bonds within molecules which are responsible for the molecule’s characteristic chemical properties * structural formulae (condensed or showing bonds) can be used to show the arrangement of atoms and bonding in organic molecules that contain the following functional groups: alkenes, alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides * functional groups within organic compounds display characteristic chemical properties and undergo specific reactions; these reactions include addition reactions of alkenes, redox reactions of alcohols, and acid-base reactions of carboxylic acids; these reactions can be used to identify the functional group present within the organic compound * IUPAC nomenclature is used to name organic species, including those with a parent chain of up to 8 carbon atoms with simple branching and one of the following functional groups: alkenes, alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides * isomers are compounds with the same molecular formulae but different structures; different types of isomerism include chain and position structural isomerism and cis-trans isomerism * all alcohols can undergo complete combustion; with oxidising agents, including acidified MnO4- or Cr2O72- oxidation of primary alcohols produces aldehydes and carboxylic acids, while the oxidation of secondary alcohols produce ketones; these reactions have characteristic observations and can be represented with equations * alcohols can react with carboxylic acids in a condensation reaction to produce esters and can be represented with equations * organic compounds display characteristic physical properties, including boiling point and solubility in water and organic solvents; these properties can be explained in terms of intermolecular forces (dispersion forces, dipole-dipole interactions and hydrogen bonds) which are influenced by the nature of the functional groups * empirical and molecular formulae can be determined by calculation and the structure of an organic compound established from the chemical reactions they undergo, and other analytical data * addition reactions can be used to produce polymers, including polyethene and polytetrafluoroethene * the structure of an addition polymer can be predicted from its monomer and the structure of an addition polymer can be used to predict the monomer from which it was derived * condensation reactions can be used to produce polymers, including polyamides and polyesters * the structure of a condensation polymer can be predicted and drawn from its monomer(s) and the structure of a condensation polymer can be used to predict the monomer(s) from which it was derived * α-amino acids can be represented using a generalised structure * the characteristic properties of α -amino acids include the formation of zwitterions and the ability to react to form amide (peptide) bonds through condensation reactions * α -amino acids undergo condensation reactions to form polypeptides (proteins) in which the α-amino acid monomers are joined by peptide bonds * the sequence of α-amino acids in a protein is called its primary structure * secondary structures of proteins, (α-helix and β-pleated sheets) result from hydrogen bonding between amide and carbonyl functional groups; hydrogen bonding between amide and carbonyl functional groups within a peptide chain leads to α -helix structures while hydrogen bonding between adjacent polypeptide chains leads to β-pleated sheets   the tertiary structure of a protein (the overall three-dimensional shape) is a result of folding due to interactions between the side chains of the α -amino acid in the polypeptide, including disulfide bridges, hydrogen bonding, dipole-dipole interactions, dispersion forces and ionic interactions | Task 8: Organic Chemistry Test, including empirical formula and stoichiometry (5 %)**.**  Task 9: Extended Response - Proteins and Amino acids with validation test (5 %)  Task 10: Practical – Preparation of esters. Lab with Validation Test (5 %) |
| Semester 2, Weeks 9-14. | Chemical synthesis   * chemical synthesis to form products with specific properties may require the construction of reaction sequences with more than one chemical reaction and involves the selection of particular reagents and reaction conditions in order to optimise the rate and yield of the product. * quantities of products in a chemical synthesis reaction can be calculated by comparing stoichiometric quantities with actual quantities and by determining the limiting reagent * the percentage yield of a chemical synthesis reaction can be calculated by comparing theoretical versus actual product quantities * reagents and reaction conditions are chosen to optimise yield and rate for chemical synthesis processes, including in the production of ammonia (Haber process), sulfuric acid (Contact process) and biodiesel (base-catalysed and lipase-catalysed methods) * enzymes are protein molecules which are biological catalysts and can be used on an industrial scale to produce chemicals that would otherwise require high pressure or temperature conditions to achieve an economically viable rate, including fermentation to produce ethanol versus hydration of ethene * chemical synthesis processes may involve the construction of reaction sequences with more than one chemical reaction, including the hydration of ethene to form ethanol and the subsequent reaction of ethanol with acetic (ethanoic) acid to produce ethyl ethanoate * the base hydrolysis (saponification) of fats (triglycerides) produces glycerol and the salt of a long chain fatty acid (soap) * the structure of soaps contains a non-polar hydrocarbon chain and a carboxylate group; the structure of the anionic detergents derived from dodecylbenzene contains a non-polar hydrocarbon chain and a sulfonate group * the cleaning action of soaps and detergents can be explained in terms of their non-polar hydrocarbon chain and charged group; the properties of soaps and detergents in hard water can be explained in terms of the solubilities of their calcium salts * industry produces a vast range of plastics, including addition polymers (for example, polyethene and polytetrafluoroethene) and condensation polymers (for example, nylon and polyethylene terephthalate [PET]) which have different properties and uses * the varied structures of different plastics due to characteristics, including cross-linking, chain length, and intermolecular forces leads to a range of distinct properties and consequent uses (for example, the different structures, properties and related uses for polyethene, polytetrafluoroethene, nylon and polyethylene terephthalate [PET]) | Task 11: - Polymers, Chemical Synthesis and Stoichiometry Test (4 %) |
| Semester 2, Weeks 15-16. | Examination revision | Task 12: Semester 2 Exam Unit 3 and 4 (30 %)  Task 13: Semester 2 Practical Exam (5 %) |