COURSE OUTLINE
COURSE 12 CHEM ATAR /ATAR YEAR 12: 2022
UNIT 3 AND UNIT 4

This course will run the two units, 3 and 4, concurrently. The student Semester 1 grade will therefore be an estimate.

Term	Week	Topic and key teaching points	Syllabus content	Assessment
Term 1	Weeks 1-4	*Unit 3* *Topic 1 - Chemical equilibrium systems* ***Levels of carbon dioxide in the atmosphere are rising and have a significant impact on global systems, including surface temperatures. The increasing level of carbon dioxide in the atmosphere causes more carbon dioxide to dissolve in the ocean producing carbonic acid and leading to increased ocean acidity. This is predicted to have a range of negative consequences for marine ecosystems such as coral reefs. Calcification is the process which results in the formation of calcium carbonate structures in marine organisms. Acidification shifts the equilibrium of carbonate chemistry in seawater, decreasing the rate and amount of calcification among a wide range of marine organisms. The United Nations Kyoto Protocol and the Intergovernmental Panel on Climate Change aim to secure a global commitment to reducing greenhouse gas emissions over the next few decades.***	**Science Understanding** ❖ 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 ❖ the reversibility of chemical reactions can be explained in terms of the activation energies of the forward and reverse reactions	**Task 1** – Reaction rates and catalysis **Task 2** - Effects of changing the conditions in chemical systems initially at equilibrium

			❖ 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 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 ❖ 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	**Wk 3** **Hand out Ocean Acidification** **Assignment**

			❖ the relative amounts of reactants and products (equilibrium position) can be predicted qualitatively using equilibrium constants (K_c)	
Term 1	Weeks 6-10	**Topic 2 - Acids and bases** *Models and theories are contested and refined or replaced when new evidence challenges them, or when a new model or theory has greater explanatory scope. Davy initially proposed that acids were substances that contained replaceable hydrogen (hydrogen that could be partly or totally replaced by metals) and bases were substances that reacted with acids to form salts and water. The Arrhenius model, which includes only soluble acids and bases, identified acids as substances which produce hydrogen ions in solution and bases as substances which produce hydroxide ions in solution. Subsequently, the Brønsted-Lowry model describes acid-base behaviour in terms of proton donors and proton acceptors. This approach*	**Science Understanding** ❖ 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 (K_a) ❖ 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	**Wk 7** **Task 3** **Extended Response – Ocean** **Acidification** **Wk 10** **Task 4** **Titration Validation Test-reports/quizzes**

		includes a wider range of substances and can be more broadly applied. *Application of Buffers Biochemical systems, agriculture, food and paper industry*	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 $K_w = [H^+][OH^-]$ where $K_w = 1.0 \times 10^{-14}$ at 25 °C ❖ K_w 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 $pH = - \log_{10} [H^+]$ ❖ 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 ❖ 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 (K_a)	
Term 2	**Weeks 1-3**	**Topic 3 -Oxidation and reduction** *Spontaneous redox reactions can be used as a source of electrical energy, including primary, secondary and fuel cells. Fuel cells are a potential lower-emission alternative to the internal combustion engine and are already being used to power various modes of transport. Organisations, including the International Partnership for Hydrogen and Fuel Cells in the Economy, have been created to foster global cooperation on research and development, common codes and standards, and information sharing on infrastructure development.*	❖ 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, combustion and corrosion ❖ the species being oxidised and reduced in a redox reaction can be identified using oxidation numbers	**Task 5** **Acids and bases/volumetric analysis/Equilibrium Test**

			❖ 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 ❖ 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; electrolytic cells are used in a range of industrial situations, including metal plating and the purification of copper	**WK 5** **Task 6** **Redox , Galvanic cells & electrolysis Topic Test**

Term 2	Week 4-5	**Exams**	❖ **Semester 1 Exams**	<u>**Task 7**</u> **Semester 1 Exams**
Term 2 Weeks 6-7		**Redox- electrolysis / Electrowinning**	❖ Exam Review- ❖ electrolytic cells use an external electrical potential difference to provide the energy to allow a non-spontaneous redox reaction to occur; electrolytic cells are used in a range of industrial situations, including metal plating and the purification of copper	
Term 2	**Week 8-10**	**Unit 4** **Topic - Properties and structure of organic materials (Part A)**	❖ 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	**Hand out research on ethanol production**

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 MnO_4^- or $Cr_2O_7^{2-}$ 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.	**WK 10** **Task 8** **Organic Chemical reaction validation Test**

| Term 3 | Week 1-3 | **Topic 4 Properties and structure of organic materials (Part B)**

The Protein Data Bank (PDB) houses an international repository of structural data of proteins. The information is accessed and contributed to by scientists worldwide. The function of a protein is closely linked to its structure | ❖ α-amino acids can be represented using a generalised structure
❖ he 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 ⬚-amino acid in the polypeptide, including disulfide bridges, hydrogen bonding, dipole-dipole interactions, dispersion forces and ionic interactions | |

Term 3	Weeks 4-8	**Topic 5 - Chemical synthesis** *Scientific knowledge can be used to design alternative chemical synthesis pathways, taking into account sustainability, local resources, economics and environmental impacts (green chemistry), including the production of ethanol and biodiesel.*	❖ 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 hydrolysis of ethene ❖ chemical synthesis processes may involve the construction of reaction sequences with more than one chemical reaction, including the hydrolysis of ethene to form ethanol and the subsequent reaction of ethanol with acetic (ethanoic) acid to produce ethyl ethanoate	<u>**Task 9**</u> **Ethanol Extended Response**

			❖ 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 (polyethene, polytetrafluoroethene) and condensation polymers (nylon and polyethylene terephthalate [PET]) which have different properties and uses	**TASK 10** **Chemical Synthesis/Organic Chemistry Topic Test**
Term 4 Wks 9-10	**EXAMS**	**Semester 2 Exams**	❖ **Semester One and Two Content**	**TASK 11** **Semester Two Exam**

Term 4	Week 1	Exam Review	❖	
Term 4	Weeks 4-7	WACE EXAMS	❖	