Year 12 Chemistry Program 2022

Week	Learning Objectives	Text References & Activities	Lab work and Activities	Assessments

2021 Term 4 weeks 6-8	**Topic 1: REDOX**
	1. Describe oxidation as the process that involves the loss of electrons from a chemical species, and reduction as the process involving the gain of electrons by a chemical species.
	2. Apply oxidation numbers to identify the species being oxidised and reduced in a redox reaction.
	3. Write and balance half equations for oxidation and reduction in acidic conditions.
	4. Write and balance redox equations in acidic conditions.
	5. Provide observations for metal / metal ion and halogen / halide displacement reactions in aqueous solution.
	6. Describe electrochemical cells as devices that allow for transformation between chemical potential and electrical energy.
	7. Describe the key features of a galvanic cell using labelled diagrams.
	8. Describe and explain the role of the following in the operation of a galvanic cell:
	   a. Anode processes – using half equations
	   b. Cathode processes – using half equations
	   c. Electrolyte
	   d. Salt bridge and ion migration
	   e. Electron flow in external circuit.
	9. Explain the use of a hydrogen half-cell as the standard for determining half-cell reduction potentials.
	10. State that standard reduction potential (E^o) values are measured at solution concentrations of 1 mol L^{-1}, temperature of 298 K, and gas pressure of 100 kPa.
	11. Use standard electrode potentials to calculate the electrical potential difference (E_{cell}) of an electrochemical cell.
	12. Describe spontaneous redox reactions as those reactions occurring in galvanic cells and fuel cells where the E_{cell} has a positive value.
		Pearson 12
		Ch 8 redox reactions
		Ch 9 galvanic cells
		Ch 10 electrolysis
		
		Lucarelli
		Ch 6:
		Oxidation & Reduction
		Sets 8 & 9
		
		Ch 7:
		Electrochemistry
		Set 10 – Galvanic Cells
		Set 11 – Electrolysis
		
		Ch 8:
		Electrochemistry in Action
		Set 12
		
		STAWA Sets
		18 – Oxidation number
		19 – Half equations
		20 – Redox equations
		21 – Galvanic cells
			STAWA Exp 19: Redox involving metals
			
			STAWA Exp 20: Halogen / halide displacement
			
			STAWA Exp 24: Corrosion of iron
			
			STAWA Exp 25: Galvanic cells
			
			STAWA Exp 27: Investigating electrolysis
				CAP 1:
				Term 1 Week 4:
				<u>Redox Topic test</u>
				Worth 4% of year
				
				AND
				
				<u>Extended Response (Redox)</u>
				Worth 5% of year

2022 Term 1 weeks 1-3	13. Predict whether reactions will be spontaneous using standard reduction potentials.
	14. Write half equations and balanced equations for redox reactions occurring in galvanic cells.
	15. Use standard reduction potentials to determine the relative strength of oxidising and reducing agents.
	16. Compare the voltages generated by electrochemical cells constructed from different materials, using E_{cell} values.
	17. Conduct experimental work safely, competently and methodically to collect valid and reliable data, including the use of electrochemical cells. (SIS)
	18. Organise and process data from experiments using galvanic cells, in order to compare reactivity of substances involved. (SIS)
	19. Apply knowledge and understanding of electrochemical reactions in the context of corrosion of metals corrosion of iron that 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
	20. Apply knowledge and understanding of electrochemical reactions in the context and combustion reactions in both limited and excess oxygen environments.
	21. Apply knowledge and understanding of galvanic cells in the context of batteries (primary: for example the Leclanché cell, and secondary cells: for example the lead-acid accumulator and other secondary cells).
	22. Apply knowledge and understanding of galvanic cells in the context of fuel cells for example, the hydrogen fuel cell.
	23. Describe electrolysis as a process in which electrical energy is used to produce chemical change.
	24. Explain that electrolytic cells use an external electrical potential difference to provide the energy to allow a non-spontaneous reaction to occur.
	25. Describe the key features of an electrolytic cell using labelled diagrams.
	26. Describe and explain the role of the following in the operation of an electrolytic cell:
	    a. Anode processes – using half equations
	    b. Cathode processes – using half equations
	    c. Ion flow in the electrolyte
	    d. Electron flow in external circuit.
		22 – Electrolytic cells
		23 – Redox in context		

	27. Write half equations and balanced equations for redox reactions occurring in electrolytic cells. 28. Explain why electrolysis of molten salts and aqueous solutions of salts may yield different products. 29. Describe and explain the differences between galvanic and electrolytic cells. 30. Describe and explain how electrolytic cells are used in a range of industrial situations, including metal plating (example Silver) and refining (example purification of copper).			

Term 2
weeks 4-7
	Topic 2: EQUILIBRIUM
	1. Use collision theory to explain and predict the effects changes in concentration, temperature, pressure, catalysts and surface area on the rate of reaction.
	2. Describe chemical systems as either 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).
	3. Explain observable changes in chemical and physical equilibrium systems at an atomic / molecular level.
	4. *Conduct experimental work safely, competently and methodically for the collection of valid and reliable data, including the effects of changes to equilibrium systems. (SIS)*
	5. Explain how 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.
	6. Describe and explain the characteristics of a system in dynamic equilibrium, in terms of rates of reaction and macroscopic properties.
	7. Explain the reversibility of chemical reactions in terms of the activation energies of the forward and reverse reactions.
	8. Predict, using Le Châtelier's principle, the impact of the following changes to a system initially at chemical equilibrium:
	    a. changes in temperature
	    b. changes in solution concentration
	    c. changes in partial pressures of gases
	    d. addition of a catalyst
		Pearson 12
		Ch1: rate of chemical reaction
		Ch2: Equilibrium systems in environment
		
		Lucarelli
		Ch1: Energy & Reaction Rate
		Set 1
		
		Ch2: Chemical Eqm
		Set 2
		
		STAWA Sets:
		4 – Rates & Energy
		5 – Eqm constants
		6 – Eqm systems
		7 – Eqm research & extended answer
			STAWA Exp 3 as DEMO: NO_2 / N_2O_4
			
			STAWA Exp 4
				CAP 2:
				Term 1 Week 7:
				SIS investigation – Corrosion
				Worth 5% of year
				
				AND
				
				Lab Validation - Equilibrium
				Worth 5% of year

	9. Using collision theory, explain and predict how the changes listed above affect the rates of the forward and reverse reactions, and how this may lead to a shift in the position of equilibrium. 10. Predict the effect of changes in temperature on the position of equilibrium by considering the enthalpy changes of the forward and reverse reactions. 11. Use equilibrium constants to qualitatively predict the relative amounts of reactants and products at equilibrium. 12. Draw and interpret graphs of concentration against time and rate against time for equilibrium systems, including the effect of changes in concentration, partial pressure, total volume, total pressure and temperature. 13. Write equilibrium law expressions for homogeneous and heterogeneous systems. 14. Compare and explain the relative proportions of reactants and products at equilibrium by considering equilibrium constant expressions and values. 15. Explain how industrial processes such as the Haber process and Contact process often involve a compromise of rate, equilibrium yield and economic considerations. 16. *Evaluate the effect of carbon dioxide emissions on global temperatures, ocean pH and marine life. (SHE)*			
Term 1 weeks 8-10 Term 2 weeks 1-2	**Topic 3: ACIDS & BASES** 1. Define acids as substances that can act as proton (hydrogen ion) donors, and classify acids as monoprotic or polyprotic depending on the number of protons available for donation. 2. Define bases as proton acceptors. 3. Describe the ionisation of acids and the dissociation of bases with equations. 4. Explain the difference between the terms "strong" and "concentrated" when referring to solutions. 5. Identify strong acids (including $HC\lambda$, H_2SO_4 & HNO_3) and strong bases (including $NaOH$, KOH & $Ca(OH)_2$). 6. Describe the strength of acids and bases using the degree of ionisation at equilibrium in aqueous solution. 7. Identify weak acids (including H_3PO_4, CH_3COOH & other organic acids) and weak bases (including NH_3 & Na_2CO_3).	Pearson 12 Ch 4 Acids and bases Ch 5 Buffers Ch 6 Indicators Ch 7 Volumetric analysis Ch 19 Science Inquiry Lucarelli Ch 3: Review Acid-Base Properties Set 3	STAWA Exp 12: Standard Na_2CO_3 solution STAWA Exp 13: Standardising $HC\ell$ (Part B) STAWA Exp 14: Standardising NaOH (Part B) STAWA Exp 15: Acid content in vinegar STAWA Inv 18:	**CAP 3:** **Term 2 Week 2:** <u>Equilibrium and Acid / base Topic test</u> Worth 8% of year

	8. *Conduct experimental work safely, competently and methodically to establish the properties of acidic and basic substances. (SIS)* 9. Represent the strength of acids using the acidity constant, K_a, and use the value of K_a to describe the strength of an acid. 10. Identify conjugate acid – base pairs in equilibrium systems. 11. Explain how the Brønsted-Lowry model can be used to explain the relationship between acids and bases in equilibrium systems. 12. Use chemical equations to illustrate the transfer of protons between conjugate acid-base pairs. 13. Represent the hydrolysis of salts of weak acids and weak bases by using equations. 14. Use the Brønsted-Lowry model to explain the acidic, basic and neutral nature of salts derived from acids and bases. 15. Explain why the equivalence point of a neutralisation reaction is not always neutral (pH 7). 16. Describe the key features of a buffer solution. 17. Explain how buffer solutions resist changes in pH. 18. Describe the conditions that determine a solution's buffering capacity. 19. Use collision theory and Le Châtelier's Principle to predict how a buffer solution will respond to the addition of hydrogen ions or hydroxide ions. 20. Describe the self-ionisation of water using an equation, and explain why water is a weak electrolyte. 21. Use the ionic product of water, $K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C, to quantify the self-ionisation of water. 22. Explain why the value of K_w is temperature dependent, and why neutral solutions can have a pH other than 7. 23. Use K_w to calculate the concentration of hydrogen ions or hydroxide ions in solutions of strong acids and strong bases. 24. Describe the relationship between hydrogen ion concentration and pH using the pH scale (an inverse logarithmic scale). 25. Calculate the pH of a solution from the hydrogen ion concentration using $pH = -\log_{10}[H^+]$, and the hydrogen ion concentration from the pH using $[H^+] = 10^{-pH}$. 26. Use pH or $[H^+]$ to calculate the hydroxide ion concentration of a solution.	Ch 4: Understanding Acid-Base Properties Set 4 – Acid base behaviour Set 5 – pH calcs Set 6 – Buffers Ch 5: Volumetric Analysis Set 7 STAWA Sets: 8 – Conjugate pairs 9 – Strength 10 – Hydrolysis 11 - K_w 12 – Indicators 13 – pH scale 14 – Buffers 15 – Titrations 1 16 – Titrations 2 17 - Applications	Acid content in wine STAWA Exp 7: Using indicators STAWA Exp 9: pH of salt solutions STAWA Exp 10: Making & testing buffers STAWA Inv 16: Antacids titration (optional titration practice)	

	27. Calculate pH, [H$^+$] and [OH$^-$] when solutions of strong acids and bases are mixed. 28. Recognise that pH and K_a values are inversely related for equimolar solutions of weak acids. 29. Describe acid-base indicators as weak acids or bases, which have different structures and colours in their protonated and deprotonated forms. 30. Explain how the change in pH of a solution causes acid-base indicators to change colour. 31. Explain the difference between the equivalence point of a reaction and the end point of an indicator. 32. Justify the selection of an indicator for an acid-base titration on the basis of the pH of the reaction's equivalence point and the indicator's end point. 33. Draw and interpret pH curves for neutralisation reactions between strong and weak acids and bases. 34. Perform titration calculations to establish the concentration of an acidic or basic solution. 35. Explain the reasons why back titrations are performed. 36. Perform back titration calculations to establish the concentration of an acidic or basic solution. 37. *Communicate effectively using appropriate language, nomenclature and format in a scientific report. (SIS)* *VOLUMETRIC ANALYSIS* 38. Describe the principles underlying volumetric analysis. 39. Select an appropriate indicator for an acid-base titration. 40. Describe how to create an accurate primary standard solution. 41. Explain the reasoning behind the choice of substance for a primary standard solution. 42. Calculate the concentration of a solution using titration data. 43. Use outcomes from titration calculations to reflect on purity and composition of substances. 44. Describe what systematic and random errors are and explain how they affect the results of a titration. 45. Calculate percentage error on a measurement. 46. Describe how to minimise experimental error (systematic and random) in titration.			

	47. Evaluate the effects of experimental errors on the outcomes of titration calculations.			
Term 2 week 3	**ASSESSMENT FREE WEEK**			
Term 2 week 4+5	**SEMESTER 1 EXAMS** Topic 1: Redox Topic 2: Equilibrium Topic 2: Acids & Bases			**Semester 1 Exam** **Term 2 Weeks 4+5** Worth 20% of year
Term 2 weeks 6-7	**Topic 3: ACIDS & BASES** **Volumetric analysis practicals** *48. Demonstrate competence using volumetric equipment. (SIS)* *49. Demonstrate competence in collecting accurate and precise titration data. (SIS)*			**In-class Assessment:** **Term 2 Week 8:** <u>Acid-base Titration</u> Worth 5% of year Assessing Volumetric Analysis Skills

Term 2 weeks 8 - 10
Term 3 week 1-2
	Topic 4: ORGANIC
	1. Revision: Write IUPAC names, molecular, condensed and structural formulae of the following, for up to 8 carbon atoms.
	    a. Alkanes – straight and branched chain
	    b. Cycloalkanes
	    c. Alkenes – straight and branched chain
	    d. Cycloalkenes
	    e. Alkynes – straight and branched chain
	    f. Alkyl groups
	    g. Haloalkanes
	2. Revision: Identify and describe aromatic compounds, as substances containing a benzene ring.
	3. Revision: Describe isomers as compounds with the same molecular formula but different structures.
	4. Revision: Draw and name isomers, specifically chain isomers, position isomers and geometric (cis-trans) isomers.
		<u>Pearson 12</u>
		Ch 13: structure of Organic molecules
		Ch14: Reactions of organic molecules
		Ch15: from monomers to polymers
		Ch 17: from amino acids to proteins
		Ch18: Uses of proteins
		
		<u>Lucarelli</u>
		Ch 10:
		Alkanes & alkenes
		Set 15
			STAWA Exp 29: Functional groups & isomers modelling
			
			STAWA Exp 30: Bromine water test for unsaturated hydrocarbons (optional)
			
			STAWA Exp 31: Reactivity of alcohols – see assessments
				CAP 4:
				Term 3 Week 4:
				<u>SIS – Lab Validation Organic</u>
				Worth 5% of year
				
				AND
				
				<u>Extended Response (Synthesis)</u>
				Worth 5% of year

	5. Describe functional groups as groups of atoms or bonds that are responsible for the characteristic chemical properties of a molecule or homologous series of molecules.
	6. Identify the functional groups for alkenes, alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides.
	7. Use IUPAC nomenclature to write names for organic species with a parent chain of up to 8 carbon atoms and simple branching, and one of the following functional groups: alkenes, alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides.
	8. Draw structural and condensed formulae for organic species with a parent chain of up to 8 carbon atoms and simple branching, and one of the functional groups listed above.
	9. Explain that functional groups undergo specific reactions which can be used to identify the functional group present, including:
	    a. Addition reactions of alkenes
	    b. Redox reactions of alcohols
	    c. Acid-base reactions of carboxylic acids.
	10. Use observations from reactions with bromine or iodine solutions to identify the presence of a carbon-carbon double bond in an alkene.
	11. Describe the following reactions of alcohols using balanced equations, and provide expected observations:
	    a. Complete combustion
	    b. Oxidation of primary and secondary alcohols by oxidising agents such as acidified MnO_4^- or $Cr_2O_7^{2-}$.
	12. Describe and explain the different outcomes for oxidation of primary, secondary and tertiary alcohols.
	13. Describe the sequential oxidation of primary alcohols to produce aldehydes and carboxylic acids.
	14. Use observations from reactions with acidified oxidising agents to identify the type of alcohol present.
	15. Describe the following reactions of carboxylic acids using balanced equations, and provide expected observations:
	    a. Acid-base reactions
	    b. Acid catalysed condensation reactions with alcohols to produce esters.
	16. Use observations from reactions to identify the presence of a carboxylic acid.
		Ch 11:
		Functional Groups
		Set 16
		
		12.1 – 12.2:
		Oxidation of alcohols
		Set 17
		
		12.3 – 12.4:
		Carboxylic acids &
		esterification
		Set 18 Qs 1 – 7
		
		Ch 13:
		Empirical formulae
		Set 19
		
		Ch 14:
		Polymers & proteins
		Set 20
		
		STAWA Sets
		24 – Organic
		compounds
		25 – Reactions of
		organic compounds
		26 – Calculations
		involving carbon
		compounds
			STAWA Exp 32:
			Making Esters
			
			Making Nylon:
			See resources
			folder for
			method safer
			than STAWA
			
			STAWA Exp 35:
			Protein
			modelling
			And / or
			modelling with
			sweets
			
			STAWA Exp 38:
			Conditions
			affecting protein
			structure
			(optional)	

	17. Describe the intermolecular bonding in a substance, and explain how the functional groups present bring about this bonding. 18. Explain the characteristic physical properties of organic compounds, including boiling point and solubility (in water and in organic solvents), in terms of intermolecular forces (dispersion, dipole-dipole and hydrogen bonding). 19. Determine the empirical and molecular formulae of organic substances from analytical data. 20. Use empirical and molecular formulae, along with data from chemical reactions, to suggest the structure of an organic compound. 21. Describe and write equations for addition polymerisation reactions, including the production of polyethene and polytetrafluoroethene. 22. Describe and write equations for condensation polymerisation reactions, including the production of polyesters and polyamides for example for example, nylon and polyethylene terephthalate. 23. Predict the structure of addition and condensation polymers from its monomer(s), and vice versa. 24. Describe the varied structures of different plastics due to its characteristics, including crosslinking, chain length, and intermolecular forces which leads to a range of distinct properties and consequent uses 25. Give some uses of common polymers including polyethene, polytetrafluoroethene, nylon and polyethylene terephthalate, and explain how their properties make them suitable for those uses. 26. Recognise and draw the generalised structure for α-amino acids. 27. Describe the characteristic properties of α-amino acids, including the ability to form zwitterions. 28. Explain why the pH of solutions of α-amino acids is not always pH 7. 29. Describe how α-amino acids undergo condensation reactions to form polypeptides and proteins, by the formation of amide (peptide) bonds. 30. Describe the primary structure of a protein as its sequence of α-amino acids. 31. Describe and draw the common secondary structures in proteins (α helices and β sheets), and explain how they result from the hydrogen bonding of amide groups on the backbone of the protein chain. 32. Describe the tertiary structure of a protein as the overall 3D shape, and explain how interactions between the side chains of α-amino acids holds it together.	27 – Empirical, molecular & structural formulae 28 – Amino acids 29 – Proteins	

	33. Describe and draw the interactions between parts of the protein chain that contribute to its tertiary structure, including disulfide bonds, ionic bonds, hydrogen bonding, dipole-dipole interactions and dispersion forces. 34. Describe the role of the Protein Data Bank. 35. *Communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports. (SIS)*			

Term 3 weeks 3-6	**Topic 5: SYNTHESIS**
	1. Explain that chemical synthesis to form products with specific properties may involve the construction of reaction sequences with more than one chemical reaction.
	2. Explain why particular reactions, reagents and reaction conditions may be selected, in order to optimise the rate and yield of production.
	3. Evaluate the choices of reaction conditions in order to optimise rate and yield in the following processes:
	    a. Production of ammonia (Haber process)
	    b. Production of sulfuric acid (Contact process)
	    c. Production of biodiesel
	        i. base-catalysed method
	        ii. lipase-catalysed method.
	4. Calculate quantities of reactants and products in a chemical reaction, including limiting reagents, using stoichiometric ratios.
	5. Calculate the percentage yield of a chemical reaction and use this to comment on the overall effectiveness of the reaction.
	6. Use percentage yield values for individual stages of a multi-stage synthesis to calculate the overall yield of the process.
	7. Describe how enzymes can act as biological catalysts and explain the benefits and drawbacks to using enzymes in industrial synthesis.
	8. Explain why enzymes work best within specific ranges of conditions, including temperature and pH.
	9. Compare and contrast the production of ethanol via fermentation and hydrolysis of ethene, and explain the advantages and disadvantages of each method.
	10. Describe the synthetic route for the production of ethyl ethanoate, linking to the production of ethanol and ethanoic acid, and their subsequent esterification reaction.
		Pearson 12
		Ch 11: Key products from the chemical industry
		Ch 12: Resources and the environment
		Ch 16 From fats and oils to soaps and biodiesel
		
		Lucarelli
		Ch 9: Stoichiometry
		Sets 13 & 14
		
		Ch 11.10:
		Fats & Oils
		
		12.5 – 12.6:
		Soaps & Detergents
		Set 18 Qs 8 – 11
		
		Ch 14:10:
		Enzymes
			Inv 42: Making ethyl ethanoate (optional)
			
			Inv 43: Empirical formula of $CuCl_2$ (optional)
			
			Exp 44: Making biodiesel (optional)
				CAP 5:
				Term 3 Week 7:
				<u>Organic and Synthesis Topic Test</u>
				Worth 8% of year

	11. Describe how biodiesel is produced from fats and oils, via base-catalysed and lipase-catalysed processes, and evaluate the advantages and disadvantages of each method. 12. Describe how soap is produced by base hydrolysis (saponification) of fats. 13. Explain the cleaning action of soaps, using condensed structures of soap particles, and discussion of intermolecular bonds formed by the hydrophilic and hydrophobic sections. 14. Use balanced equations to describe the reactions of soaps with calcium and magnesium ions. 15. Describe the structure of detergents using a diagram. 16. Explain why detergents are preferable to soaps in some circumstances, using knowledge of solubility of the salts produced. 17. Evaluate the sustainability, resource requirements, economics and environmental impact of synthesis methods, including the production of ethanol and biodiesel. 18. *Identify, research, construct and refine questions for investigation; propose hypotheses; and predict possible outcomes. (SIS)* 19. *Design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments. (SIS)* 20. *Conduct investigations safely, competently and methodically for the collection of valid and reliable data. (SIS)*	Ch 15: Chemistry in Industry Set 21 STAWA Sets 31 - % composition & yield 32 – Limiting reagents 33 – Calcs with gases 34 & 35 – Empirical formulae	
Term 3 week 7	**REVISION**		
Term 3 week 8	**ASSESSMENT FREE WEEK**		**Term 3 week 8**
Term 3 weeks 9-10	**SEMESTER 2 EXAMS** Covers all of year 12 content.		Worth 30% of year	**Term 3 week 9&10**
Term 4 weeks 1-2	**REVISION**		
Term 4 Week 3 Onwards	**WACE EXAMS**		