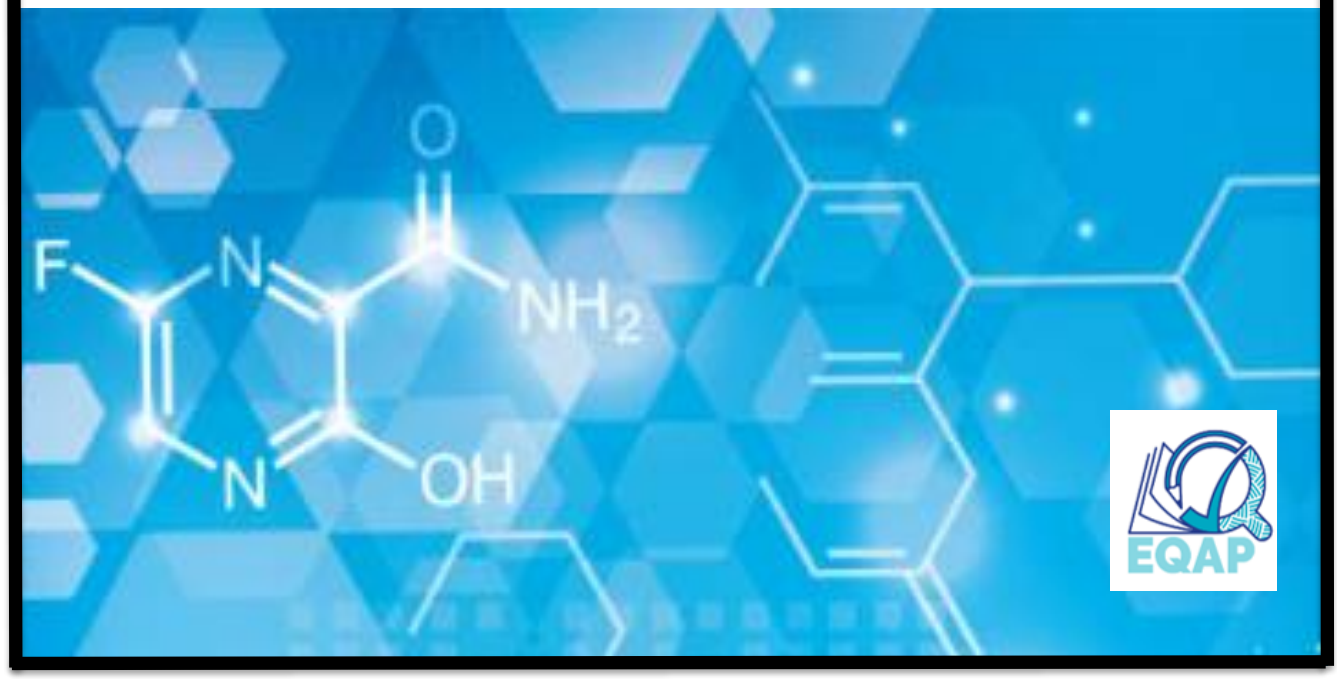
Pacific Community
Communauté du Pacifique

SOUTH PACIFIC FORM SEVEN CERTIFICATE

CHEMISTRY

SYLLABUS



EQAP

GENERAL INFORMATION

The Office of the Educational Quality and Assessment Programme (EQAP) is located at:

3 Luke Street, Nabua
Suva
Fiji.
Tel: (679) 3315600
Email: eqap@spc.int
Web: www.spc.int / www.eqap.org.fj

Any correspondence regarding this syllabus should be addressed to:

The Director EQAP
Pacific Community (SPC)
Private Mail Bag
Suva
Fiji

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1.0 Preamble and Rationale

This syllabus defines the requirements for the South Pacific Form Seven Certificate Chemistry (SPFSC) examination.

Each of the student outcomes is to be read in conjunction with the Learning Objectives given for each outcome in this syllabus.

Students also require knowledge and understanding of outcomes from the national Year 12 Senior Secondary Certificate or its equivalent, which are related to the specific outcomes of this syllabus.

This syllabus is derived from a revision of the South Pacific Board for Educational Assessment (SPBEA) syllabus and the New Zealand National Certificate of Educational Assessment (NCEA) Level 3 Chemistry Achievement Standards as published by New Zealand Qualifications Authority (NZQA).

Candidates will complete a course of study that follows the aims and objectives of a comparable Form 7 course in Chemistry such as the NCEA Level 3 Chemistry, USP Foundation Chemistry, etc.

The course is designed for students who may undertake further studies in a tertiary institution as well as for those students who will complete their formal education at the end of Form 7.

2.0 Course Aims

Chemistry is the study of the composition and properties of matter, and the changes it undergoes. Chemistry is a science that develops through people investigating matter in both living and nonliving systems.

Central to all study of chemistry is the recognition that, for any substance, the properties and behaviours that we can observe, and measure are the result of the properties and behaviors of sub-microscopic particles (atoms, ions and molecules) that we cannot see; it is of these particles that the substance is made.

Chemists carry out reactions at what is known as the macroscopic level, and they think about reactions at the particulate or sub-microscopic level and they often use symbols to represent their observations. A chemistry Programme of study should link these three levels of understanding for each chemical phenomena studied. It is also important that all learning in chemistry is related to its practical applications in everyday life.

Studying chemistry enables students to:

- investigate, and develop their understanding of the nature and behaviour of matter;
- learn about the development of the major ideas in chemistry and about the people involved in their development;
- become aware of the ways that chemists today use their knowledge to meet particular needs of society;
- develop an understanding of the interactions between chemistry and technology;
- realize that an understanding of chemistry is fundamental in such diverse fields as medicine, agriculture, manufacturing and engineering, as well as in many other aspects of the lives of Pacific Islanders;
- raise questions and debate issues related to chemistry, society and the environment;
- develop scientific skills and attitudes.

3.0 Prerequisites

Students taking this course are expected to have successfully completed the Year 12 Chemistry course or its equivalent. It is assumed that candidates will have carried out practical investigations in their Year 12 Chemistry course.

4.0 General Objectives

On completing this course students should be able to:

- demonstrate an understanding of the central concepts and patterns appropriate to the study of chemistry at this level;
- explain chemical observations and measurements using their knowledge and understanding of the nature of the constituent particles (atoms, ions and molecules);
- interpret and use a range of chemical information from qualitative and quantitative investigation;
- apply knowledge of chemistry to explain aspects of the natural world and how chemistry is used in society to meet needs, resolve issues, and develop new technologies;
- use the language and symbols relevant to chemistry when explaining chemical phenomena.

5.0 Content Components

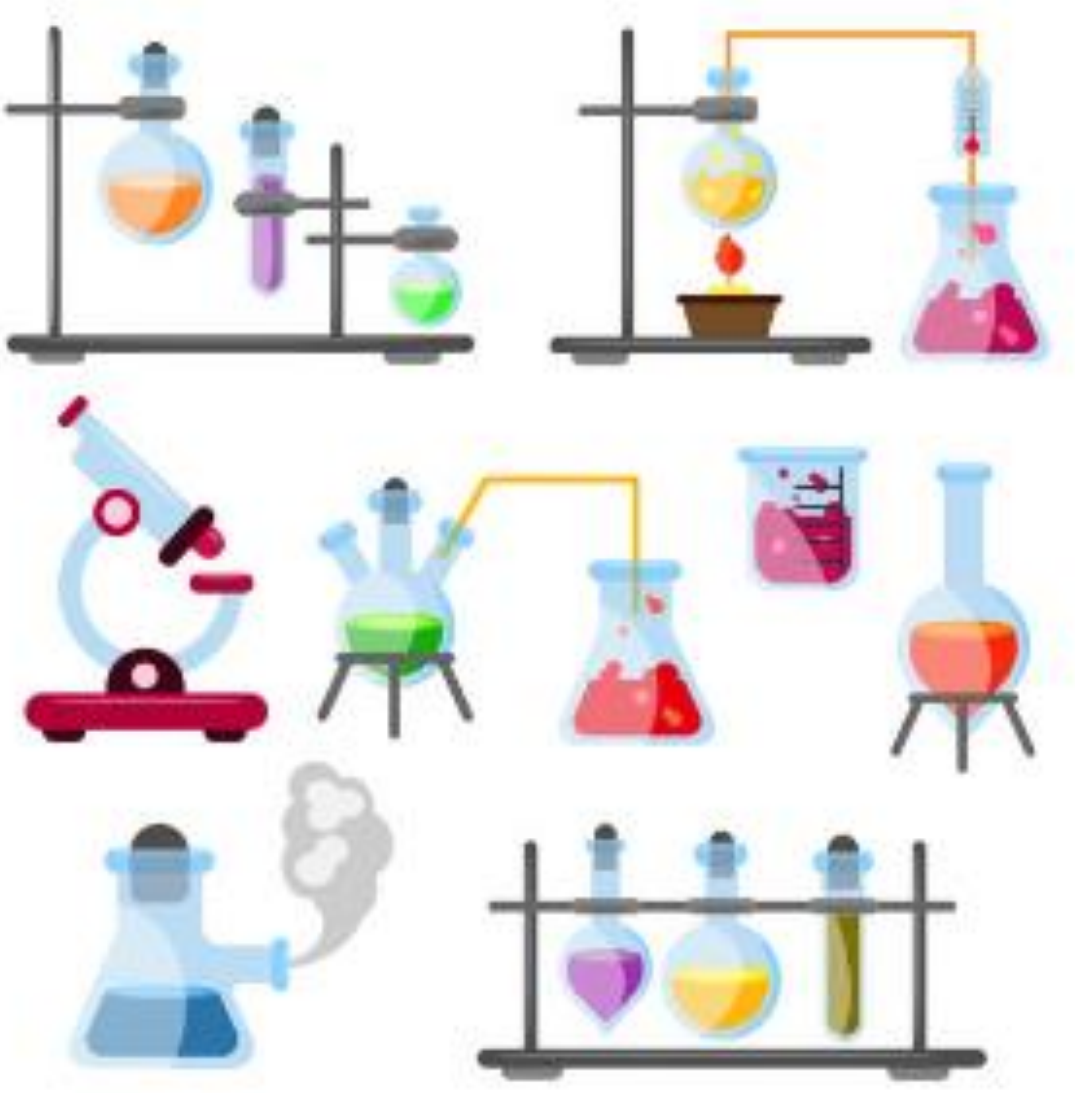
The content of the SPFSC Chemistry course is organised under five Strands and a number of Sub-Strands under each Strand. These are outlined below:

Strand Number	Strand Title and Major Learning Outcome	Sub Strand Number	Sub-Strand Title and Key Learning Outcome
1.	**Atomic Structure, Bonding and Related Properties** *Students are able to demonstrate knowledge application and critical evaluation of* chemical principles by interpreting information about selected properties of elements and compounds in relation to atomic structure.	1.1	**Atomic Structure and Bonding** *Students are able to demonstrate knowledge application and critical evaluation of* knowledge application in chemical principles by interpreting information about selected properties of knowledge application in atomic structure and bonding and how these determine intermolecular forces.
		1.2	**Nuclear Chemistry** *Students are able to demonstrate knowledge application and critical evaluation of* basic ideas of nuclear chemistry.
		1.3	

Strand Number	Strand Title and Major Learning Outcome	Sub Strand Number	Sub-Strand Title and Key Learning Outcome
			Transition Metals *Students are able to demonstrate knowledge application and critical evaluation of* properties and reactions of transition metals.
2.	**Thermochemistry and Chemistry in the Society** *Students are able to demonstrate knowledge application and critical evaluation of* chemical principles by using thermochemical data to determine energy changes in chemical and physical processes, and present an account of how chemistry can advance society in ways that are benign to the environment and sustainable for the future.	2.1	**Thermochemical Principles and Enthalpy Change** *Students are able to demonstrate knowledge application and critical evaluation of* principles and processes of thermochemistry.
		2.2	**Chemistry in the Society** *Students are able to demonstrate knowledge application and critical evaluation of* chemical principles by presenting an account of how chemistry can advance society in ways that are benign to the environment and sustainable for the future.
3.	**Aqueous Equilibrium Systems** *Students are able to demonstrate knowledge application and critical evaluation of* chemical equilibrium	3.1	**Equilibrium Principles, Acids and Bases** *Students are able to demonstrate knowledge application and critical evaluation of* equilibrium principles and properties and reactions of acids and bases.
		3.2	**Solubility** *Students are able to demonstrate knowledge*

Strand Number	Strand Title and Major Learning Outcome	Sub Strand Number	Sub-Strand Title and Key Learning Outcome
	principles by relating the properties of aqueous solutions to the nature and concentration of dissolved species.		*application and critical evaluation of* the significance of solubility, solubility product of different salts and how solubility is affected by certain factors.
4.	**Oxidation-Reduction Processes** *Students are able to demonstrate knowledge application and critical evaluation of* the principles and practical applications oxidation-reduction processes.	4.1	**Oxidation-Reduction Reactions** *Students are able to demonstrate knowledge application and critical evaluation of* oxidation-reduction reactions through experiments and relate it to common practical applications.
		4.2	**Electrode Potential and Electrochemical Cells** *Students are able to demonstrate knowledge application and critical evaluation of* electrode potentials as a measure of reactivity in redox reactions and relate its application to electrochemical cells.
5.	**Organic Chemistry** *Students are able to demonstrate knowledge application and critical evaluation of* principles and applications of organic chemistry.	5.1	**Structure and Isomerism in Organic Chemistry** *Students are able to demonstrate knowledge application and critical evaluation of* functional groups and isomerism in organic compounds through systematic nomenclature and interpretation of chemical structures.
		5.2	**Reactions in Organic Chemistry** *Students are able to demonstrate knowledge application and critically evaluate,* elaborate, justify, relate, evaluate or compare and contrast the links between the structure, functional groups, physical properties and/or reactivity of organic compounds.

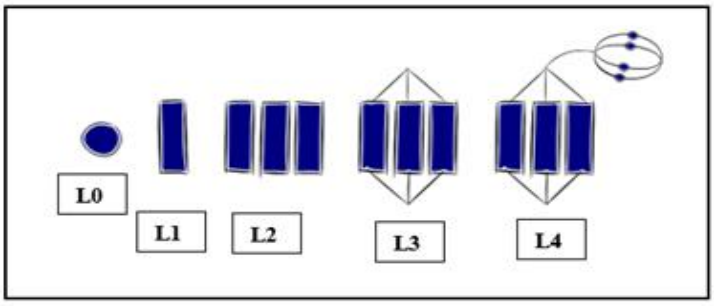
Strand Number	Strand Title and Major Learning Outcome	Sub Strand Number	Sub-Strand Title and Key Learning Outcome
		5.3	**Problem Solving in Organic Chemistry** *Students are able to demonstrate knowledge application and critically evaluate,* plan, analyse, evaluate and conclude practical investigations to solve problems in organic chemistry.



6.0 Unpacking Learning Outcomes

In this syllabus, Learning Outcomes are stated at three levels of generality: Major Learning Outcomes (MLOs) are stated at the strand level, Key Learning Outcomes (KLOs) are stated at the sub- strand level, and Specific Learning Outcomes (SLOs) are unpacked from the Key Learning Outcomes. Each SLO is a combination of a cognitive skill and a specific content component. Each SLO is given a skill level, level 1 – 4, and this skill level results from the categorization of the cognitive skill that is embedded in the SLO using the SOLO taxonomy[1].

The SOLO taxonomy provides a simple, reliable and robust model for three levels of understanding – surface deep and conceptual (Biggs and Collis 1982).



At the **Prestructural** level (L0) of understanding, the task is inappropriately attacked, and the student has missed the point or needs help to start. The next two levels, unistructural and Multistructural are associated with bringing in information (surface understanding). At the **Unistructural** level (L1), one aspect of the task is picked up, and student understanding is disconnected and limited.

The jump to the Multistructural level is quantitative. At the **Multistructural** level (L2), several aspects

- **define** – to state a basic definition of a concept [Unistructural or Level 1]
- **describe** – to give the characteristics of, or give an account of, or provide annotated diagrams. [Multistructural or Level 2]
- **explain** – to provide a reason for a relationship – an event and its impact, a cause and an effect, as to *how* or *why* something occurs. [Relational or Level 3]
- **discuss** – this means *linking ideas* (descriptions, explanations) to make generalisations or predictions or evaluations. It may involve relating, comparing, analysing, and justifying. [Extended Abstract or Level 4]

of the task are known but their relationships to each other and the whole are missed. The progression to relational and extended abstract outcomes is qualitative. At the **Relational** level (L3), the aspects are linked and integrated, and contribute to a deeper and more coherent understanding of the whole. At the E**xtended Abstract** level (L4), the new understanding at the relational level is re-thought at another conceptual level, looked at in a new way, and used as the basis for prediction, generalization, reflection, or creation of new understanding (adapted from Hook and Mills 2011). [http://pamhook.com/solo-taxonomy/..] The progression from Level 1 to Level 4 is exemplified in the progression from *define* →*describe* →*explain* → *discuss* with each succeeding level indicating a *higher level of understanding*, as follows:

[1] Structure of Observed Learning Outcomes by Biggs and Collis (1982)

7.0 Strands, Substrands and Learning Outcomes

Strand 1: Atomic Structure, Bonding and Related Properties

Major Learning Outcome 1

Students are able to demonstrate knowledge application and critical evaluation of chemical principles by interpreting information about selected properties of elements and compounds in relation to atomic structure.

Substrand 1.1 Atomic Structure and Bonding (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of knowledge application in chemical principles by interpreting information about selected properties of knowledge application in atomic structure and bonding and how these determine intermolecular forces.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** electron configuration / monoatomic ion / polarity in a given context.	1	Che1.1.1.1
2	**write** the ground state electron configurations of atoms /monoatomic ions using *s*, *p* and *d* notation (including abbreviated configuration - restricted to the first 36 elements).	2	Che1.1.2.1
3	**explain** the maximum number of electrons that can occupy an orbital using *s*, *p*, *d*, *f* notation.	3	Che1.1.3.1
4	**state** the four quantum numbers in a given context.	1	Che1.1.1.2
5	**describe** the four quantum numbers of an electron in a given context.	2	Che1.1.2.2
6	**explain** the exceptional electron configuration present in some atoms and ions (limited to Cr and Cu).	3	Che1.1.3.2
7	**apply** rules for assigning electrons to sub-shells and draw orbital diagrams (e.g. Ne, P, Ti).	4	Che1.1.4.1
8	**discuss** the term isoelectronic (restricted to the first 20 elements).	4	Che1.1.4.2
9	**state** Aufbau principle/Hund's rule / Pauli exclusion principle in a given context.	1	Che1.1.1.3
10	**apply** Hund's Rule to state the factors that increase the stability of electrons in levels/shells/sublevels/subshells (e.g. C, N, O).	4	Che1.1.4.3
11	**compare and contrast** the atomic radius and the ionic radius of respective elements (e.g. Cl and Cl^-/Na and Na^+).	3	Che1.1.3.3
12	**compare and contrast** the successive ionization energies (IE) of an element (e.g. 1st IE and 2nd IE of Mg).	3	Che1.1.3.4
13	**analyze** the trends in the ionization energies across the period and down the group of the Periodic Table (e.g. Ne, Na and Mg).	4	Che1.1.4.4

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
14	**draw** Lewis structures of some molecules and polyatomic ions (up to 6 electron pairs e.g. SO_3, NH_4^+, CO_3^{2-}, SO_4^{2-}).	3	Che1.1.3.5
15	**discuss** Lewis structures (up to 6 electron pairs about the central atom, including multiple-bonded species and polyatomic ions).	4	Che1.1.4.5
16	**identify / state** the shape of a molecule, within a given problem.	1	Che1.1.1.4
17	**define** dative bond in a given context.	1	Che1.1.1.5
18	**draw/explain** the atoms bonded together to form dative bonds (e.g. CO)	4	Che1.1.4.6
19	**explain** the shape of molecules and polyatomic ions (up to 6 electron pairs about the central atom) in terms of their electronic structure.	3	Che1.1.3.6
20	**determine** the polarity of molecules and relate this to their degree of electronegativity.	2	Che1.1.2.3
21	**identify/state** the intermolecular forces in a given context.	1	Che1.1.1.6
22	**draw** diagrams of molecules with different types of intermolecular attractions.	3	Che1.1.3.7
23	**comment** on the intermolecular forces / attraction between given molecules.	3	Che1.1.3.8
24	**discuss** the physical properties (melting and boiling points, viscosity, vapour pressure, surface tension) in terms of intermolecular attraction.	4	Che1.1.4.7
25	**account** for the intermolecular attractions between molecules/ions in relation to the shape, polarity, permanent dipoles, hydrogen bonding, induced dipole attractions and ion-dipole attractions.	4	Che1.1.4.8
26	**apply** concepts on real life applications of atoms / significance of chemical bonding to everyday life.	4	Che1.1.4.9

Substrand 1.2 Nuclear Chemistry (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of basic ideas of nuclear chemistry.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** fission / fusion reactions/ radioactivity/nuclear generators in a given context.	1	Che1.2.1.1
2	**compare and contrast** fission and fusion reactions.	3	Che1.2.3.1
3	**explain** nuclear transformations resulting in alpha, beta and gamma emission using nuclear equations.	3	Che1.2.3.2
4	**define** half-life in a reaction in a given context.	1	Che1.2.1.2
5	**comment** on the half-life of a radioactive isotope.	3	Che1.2.3.3

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
6	**identify/state** a feature or example of alpha / beta / gamma emissions in a given context.	1	Che1.2.1.3
7	**describe** properties of radioactive particles (alpha / beta / gamma emissions).	2	Che1.2.2.1
8	**use** radioactive data to carry out calculations involving simple quantitative treatment of half - life.	3	Che1.2.3.4
9	**account** for the scientific/commercial uses of radioactivity (e.g. tracer studies, industry, medicine, carbon dating) and these uses seen in future.	4	Che1.2.4.1
10	**discuss** the effect of nuclear radiation on molecular structures and living organisms and how it continues today.	4	Che1.2.4.2
11	**link** the properties of radioactive particles with the way they are used.	3	Che1.2.3.5
12	**discuss** the impact of the use of nuclear chemistry on everyday applications.	4	Che1.2.4.3
13	**discuss** how nuclear chemistry can be applied in daily lives and to the environment e.g. food, agriculture, transport, water.	4	Che1.1.4.4

Substrand 1.3 Transition Metals (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of properties and reactions of transition metals.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** transition metals in a given context.	1	Che1.3.1.1
2	**give** examples of transition metals in a given context.	1	Che1.3.1.2
3	**describe** the characteristic properties of transition metals (variable oxidation state, colour of ions and formation of complex ions).	3	Che1.3.3.1
4	**write** electron configuration using s, p, d notations for the transition metals and their ions.	2	Che1.3.2.1
5	**relate** the properties of transition metals to their electronic structure (e.g. Fe, Fe^{2+}, Fe^{3+}).	3	Che1.3.3.2
6	**state** the trends in transition metal properties in a given context.	1	Che1.3.1.3
7	**discuss** actors that influence the characteristic properties (variable oxidation state, colour of ions and formation of complex ions) of transition metals.	4	Che1.3.4.1

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
8	**differentiate** between paramagnetic and diamagnetism in transition metals (give appropriate examples).	3	Che1.3.3.3
9	**discuss** with an example why transition metals and their compounds are effective catalysts.	4	Che1.3.4.2
10	**identify/name** the following complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$ in a given context.	1	Che1.3.1.4
11	**draw** shapes of transition metal complex ions (tetrahedral, square planar, octahedral).	1	Che1.3.1.5
12	**explain** the properties of complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	3	Che1.3.3.4
13	**explain** the meaning of the term ligand in a complex ion e.g. H_2O, NH_3, OH^-, Cl^-.	3	Che1.3.3.5
14	**define** coordination number in a given context.	1	Che1.3.1.6
15	**calculate** coordination number in complex ions.	2	Che1.3.2.2
16	**describe** the term coordinate bond formation in common complex ion ligands e.g. H_2O, NH_3, OH^-, Cl^-.	2	Che1.3.2.3
17	**calculate** the overall charge of complexes: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	3	Che1.3.3.6
18	**write** chemical equations for the formation of complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	2	Che1.3.2.4
19	**relate** chemical equations and observations for the formation of complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	3	Che1.3.3.7
20	**account** for some biologically significant structures that utilizes complex ions e.g. blood, photosynthesis, vitamins, cisplatin).	4	Che1.3.4.3
21	**evaluate** on the importance of transition metals in the human body, today's technology, living organisms and everyday life.	4	Che1.3.4.4
22	**analyse** the impact (benefits / risks) of transition metal on the environment, agriculture and health.	4	Che1.3.4.5

Major Learning Outcome 2

Students are able to demonstrate knowledge application and critical evaluation of chemical principles by using thermochemical data to determine energy changes in chemical and physical processes, and present an account of how chemistry can advance society in ways that are benign to the environment and sustainable for the future.

Substrand 2.1 Thermochemical Principles and Enthalpy Change (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of principles and processes of thermochemistry.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** enthalpy change of reaction in a given context.	1	Che2.1.1.1
2	**write** thermochemical equations of reactions in a given context.	2	Che2.1.2.1
3	**define** bond energy in a given context.	1	Che2.1.1.2
4	**account** for exothermic reactions and exothermic reactions and relate to bond making and bond breaking processes using everyday phenomena.	4	Che2.1.4.1
5	**define** heat capacity/specific heat capacity in a given context.	1	Che2.1.1.3
6	**calculate** enthalpy changes from appropriate experimental results related to heat capacity/specific heat capacity.	3	Che2.1.3.1
7	**describe** the following enthalpy changes; $\Delta_r H°$, $\Delta_f H°$ and $\Delta_C H°$.	2	Che2.1.2.2
8	**account** for the fact that standard enthalpy of formation ($\Delta_f H°$) equals standard enthalpy of combustion ($\Delta_C H°$) in a given context e.g. $\Delta_f H°$ (H_2O), $\Delta_C H°$ (H_2).	4	Che2.1.4.2
9	**define** lattice energy in a given context.	1	Che2.1.1.4
10	**explain**, in qualitative terms, the effect of ionic charge and of ionic radius on the numerical magnitude of a lattice energy.	3	Che2.1.3.2
11	**calculate** enthalpy change in systems involving either chemical change or phases changes using Hess's Law, for e.g. (i) determining enthalpy changes that cannot be found by direct experiment, e.g. an enthalpy change of formation from enthalpy changes of combustion. (ii) average bond energies.	3	Che2.1.3.3
12	**construct** Born-Haber cycles (including ionisation energy, enthalpy change of atomisation and electron affinity) for ionic compounds and calculate lattice energy.	4	Che2.1.4.3
13	**define** entropy in a given context.	1	Che2.1.1.5

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
14	**describe** spontaneous reactions.	2	Che2.1.2.3
15	**explain** entropy as a measure of the 'disorder' of a system.	3	Che2.1.3.4
16	**explain** the entropy changes that occur: (i) during a change in state e.g. (s) → (l); (l) → (g); (s) → (aq) (ii) during a temperature change (iii) during a reaction in which there is a change in the number of gaseous molecules	3	Che2.1.3.5
17	**predict** whether the entropy change for a given process is positive or negative.	4	Che2.1.4.4
18	**discuss** applications of thermochemical principles to daily lives and the role it plays in the industry or environment.	4	Che2.1.4.5

Substrand 2.2 Chemistry in the Society *(for Internal Assessment Task 1)*

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of chemical principles by presenting an account of how chemistry can advance society in ways that are benign to the environment and sustainable for the future.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**identify** a chemically based current environmental sustainability aspect in the society.	1	Che2.2.1.1
2	**collect** ideas based on current environmental sustainability aspect.	1	Che2.2.1.2
3	**outline** the history or discovery of the environmental sustainability aspect.	2	Che2.2.2.1
4	**explain** the chemical principles involved in the understanding of the environmental sustainability aspect.	3	Che2.2.3.1
5	**discuss** ways in which the chemical principles have improved the understanding of the environmental sustainability.	4	Che2.2.4.1
6	**link** the effect of environmental sustainability aspect on the society and the natural world by relating to the chemical principles.	3	Che2.2.3.2
7	**evaluate** the major controlling factors for the progress in environmental sustainability.	4	Che2.2.4.2

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
8	**analyze/ interpret** data relating to environmental sustainability.	3	Che2.2.3.3
9	**use** referencing to acknowledge sources of information.	2	Che2.2.2.2
10	**order** report comprehensively.	2	Che2.2.2.3
11	**apply** appropriate chemistry language, symbols and equations in writing the report.	3	Che2.2.3.4
12	**evaluate** the impact of environmental sustainability on the society.	4	Che2.2.4.3
13	**discuss** on managing environmental risks and promoting sustainability in the society,	4	Che2.2.4.4
14	**recommend** solutions for the environmental sustainability in a rapidly changing world.	4	Che2.2.4.5

Strand 3: Aqueous Equilibrium Systems

Major Learning Outcome 3

Students are able to demonstrate knowledge application and critical evaluation of chemical equilibrium principles by relating the properties of aqueous solutions to the nature and concentration of dissolved species.

Substrand 3.1 Equilibrium Principles, Acids and Bases (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of equilibrium principles and properties and reactions of acids and bases.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** chemical equilibrium in a given context.	1	Che3.1.1.1
2	**explain** the significance of the magnitude/size of the equilibrium constant (K_c) for a given position of an equilibrium.	3	Che3.1.3.1
3	**define** reversible / irreversible reactions in a given context.	1	Che3.1.1.2
4	**write** equilibrium constants expressions (K_c)for systems in equilibrium e.g reversible/irreversible reactions.	2	Che3.1.2.1
5	**perform** simple / complex calculations of equilibrium constants (K_c) using the (K_c) expressions.	4	Che3.1.4.1
6	**calculate** an equilibrium concentration by using (K_c) of species involved in an equilibrium reaction.	3	Che3.1.3.2
7	**compare and contrast** the equilibrium constant values and the	3	Che3.1.3.3

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
	nature of reactants and products for simple reactions.		
8	**identify/name** a monoprotic acids/basic substances in a given context.	1	Che3.1.1.3
9	**explain** the significance of the magnitude of (K_a) and (K_b)values.	3	Che3.1.3.4
10	**calculate** pH for monoprotic acids, bases, salts and buffers (solutions in which we assume that [HA] = cHA) within a simpler reaction.	3	Che3.1.3.5
11	**perform** calculations of pH for monoprotic acids, bases, salts and buffers (solutions in which we assume that [HA] = cHA) within a more complex reaction.	4	Che3.1.4.2
12	**calculate** the pH, K_a, K_b and K_w of solutions (strong acids and bases / weak acids and bases).	3	Che3.1.3.6
13	**link** the relative equilibrium concentration of dissolved species and relate to K_a, pH or pK_a in a simple situation.	3	Che3.1.3.7
14	**determine** the relative equilibrium concentration of dissolved species related to K_a, pH or pK_a in a more complex situation.	3	Che3.1.3.8
15	**calculate** pH (initial / final) of the solution from titration data.	2	Che3.1.2.2
16	**draw and explain** the titration curve for an acid-base reaction e.g. strong acid-strong base, weak acid – strong base, weak base -strong acid).	4	Che3.1.4.3
17	**analyze/interpret** a titration curve (includes choice of indicators).	3	Che3.1.3.9
18	**describe** the colour of indicators in an acid, base and at the equivalence point (strong acid-strong base, weak acid – strong base, weak base -strong acid).	2	Che3.1.2.3
19	**define** 'buffer solution' in a given context.	1	Che3.1.1.4
20	**identify/state** a feature or example of a buffer solution within a given context.	1	Che3.1.1.5
21	**discuss** the importance of buffer solutions in nature e.g. blood system.	4	Che3.1.4.4
22	**calculate** pH of a buffer solution / affected by dilution within a given context.	3	Che3.1.3.10
23	**discuss** the steps involved in the preparation of buffer solutions.	4	Che3.1.4.5
24	**evaluate** the action of buffer solutions related to the composition of the buffer, including equations for reaction with added acid or base.	4	Che3.1.4.6
25	**define** non-electrolytes in a given context.	1	Che3.1.1.6

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
26	**explain** the pH and conductance (strength of electrolytes) of weak/strong acid/base solutions.	3	Che3.1.3.11
27	**account** for the link between pH and conductance (strength of electrolytes) of weak/strong acid/base solutions with relative concentration and nature of species in solution.	4	Che3.1.4.7
28	**discuss** the pH and conductance (strength of electrolytes) of weak/strong acid/base solutions linked to relative concentration and nature of species in solution and write equations where appropriate.	4	Che3.1.4.8
29	**discuss** the nature and impact of the use of equilibrium systems on everyday applications, evaluating the positive and negative effects.	4	Che3.1.4.9

Substrand 3.2 Solubility (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of the significance of solubility, solubility product of different salts and how solubility is affected by certain factors.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** solubility /solubility product (K_{sp}) common ion effect / complex ion effect in a given context.	1	Che3.2.1.1
2	**explain** the significance of solubility product (K_{sp}).	3	Che3.2.3.1
3	**use** Le Chatelier's principle to explain the effect on solvents at equilibrium.	3	Che3.2.3.2
4	**list** factors that affect solubility.	2	Che3.2.2.1
5	**apply** Le Chatelier's principle to explain the common ion effect.	4	Che3.2.4.1
6	**give** examples of AB, A_2B, AB_2 in a given context.	1	Che3.2.1.2
7	**write** the solubility product expressions for soluble compounds e.g. AB, A_2B, AB_2.	2	Che3.2.2.2
8	**perform** calculations on solubility and K_{sp} values of salts (AB_2, A_2B and AB) in water.	4	Che3.2.4.2
9	**calculate** the solubility product of an ionic solid.	2	Che3.2.2.3
10	**compare and contrast** the relationship between solubility and solubility product.	3	Che3.2.3.3
11	**explain** how temperature affects solubility in an exothermic or endothermic reaction.	3	Che3.2.3.4
12	**account** for pressure affecting solubility of gases using a	4	Che3.2.4.3

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
	combination of Henry's law and Le Chatelier's principle.		
13	**calculate** solubility and K_a values of salts of the type AB_2, A_2B and AB in solutions containing either ion A or ion B.	3	Che3.2.3.5
14	**predict** the occurrence of precipitation with the use of ionic product and K_{sp}.	4	Che3.2.4.4
15	**discuss** the qualitative treatment of common ion effect e.g. $CaSO_4$ and Na_2SO_4.	4	Che3.2.4.5
16	**explain** the effect of pH changes/complex ion formation/common ion on solubility.	3	Che3.2.3.6
17	**discuss** the relevance of solubility with changing conditions e.g. pH or common ion or complex ion formation in real life applications.	4	Che3.2.4.6
18	**discuss** the impact (effect) of solubility product on environment in real life situations.	4	Che3.2.4.7
19	**apply** the concept of solubility (why it is studied) and its uses in daily life / real life.	4	Che3.2.4.8
20	**evaluate** the practical applications solubility has on daily life e.g. purifying water.	4	Che3.2.4.9

Strand 4: Oxidation – Reduction Processes

Major Learning Outcome 4

Students are able to demonstrate knowledge application and critical evaluation of the principles and practical applications oxidation-reduction processes.

Substrand 4.1 Oxidation – Reduction Reactions *(For IA Task 2)*

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of oxidation-reduction reactions through experiments and relate it to common practical applications.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**explain** oxidation – reduction processes in terms of electron transfer and changes in oxidation number.	3	Che4.1.3.1
2	**construct** oxidation – reduction equations using the relevant half-equations (including acidic or basic solution).	3	Che4.1.3.2

3	**discuss** analytical applications of oxidation – reduction reactions with examples.	4	Che4.1.4.1
4	**perform** oxidation – reduction reaction experiments from given instructions.	4	Che4.1.4.2
5	**record/tabulate** observations and data from oxidation – reduction reaction experiments to enable a valid, reliable conclusion to be made.	2	Che4.1.2.1
6	**analyse/interpret** results from the oxidation – reduction reaction experiments to reach valid conclusions.	3	Che4.1.3.3
7	**infer** appropriate chemical equations for the oxidation – reduction reactions that would have occurred in the experiment.	3	Che4.1.3.4
8	**evaluate** findings of oxidation – reduction reaction experiments in relation to the purpose of the experiment, highlighting limitations and sources of errors, and suggest modifications or improvements.	4	Che4.1.4.3
9	**discuss** the findings of the oxidation – reduction reaction experiment in relation to everyday application of the results.	4	Che4.1.4.4
10	**report** scientifically on findings of oxidation – reduction reaction experiments using chemistry vocabulary, symbols, and conventions.	2	Che4.1.2.2

Substrand 4.2 Electrode Potentials and Electrochemical Cells

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of electrode potentials as a measure of reactivity in redox reactions and relate its application to electrochemical cells.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** redox couple/ electrode potential in a given context.	1	Che4.2.1.1
2	**define** electrode/ half-cell/electrode reduction potential in a given context.	1	Che4.2.1.2
3	**list/describe** the factors that can affect the electrode reduction potential.	2	Che4.2.2.1
4	**describe** the standard hydrogen electrode (SHE).	2	Che4.2.2.2
5	**define** standard electrode potential/ standard reduction potential/ standard cell potential in a given context.	1	Che4.2.1.3
6	**describe** methods used to measure the standard electrode potentials of metals or non-metals in contact with their ions in aqueous solution (e.g. non-metal with aqueous ions: $Cl_{2\,(g)}$, $Cl^-_{(aq)}$ / inert electrode (Pt or C)).	2	Che4.2.2.3
7	**describe** methods used to measure the standard electrode potentials of ions of the same element in different oxidation states (e.g. two types of aqueous ions: $M^{2+}_{(aq)}$, $M^+_{(aq)}$ / inert electrode (Pt or C)).	2	Che4.2.2.4

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
8	**deduce** from E^o values the relative reactivity of elements, compounds and ions as oxidizing agents or as reducing agents.	3	Che4.2.3.1
9	**apply** oxidation and reduction processes to the electrolysis of some common electrolytes (molten or aqueous).	3	Che4.2.3.2
10	**predict** the identity of the substance liberated during electrolysis from the state of electrolyte (molten or aqueous), position in the redox series (electrode potential) and concentration.	4	Che4.2.4.1
11	**calculate** the mass and/or volume of substance liberated during electrolysis of some common electrolytes (molten or aqueous).	3	Che4.2.3.3
12	**justify** the industrial applications of electrolysis with specific examples.	4	Che4.2.4.2
13	**define** electrochemical cell/ galvanic (or voltaic) cell in a given context.	1	Che4.2.1.4
14	**define** standard cell potential/electromotive force (EMF) in a given context.	1	Che4.2.1.5
15	**describe** the features and functions of the various components of simple galvanic and electrolytic cells.	2	Che4.2.2.5
16	**explain** the workings of a galvanic cell.	3	Che4.2.3.4
17	**describe** half-cells/ electrochemical cells using the IUPAC notation.	2	Che4.2.2.6
18	**sketch** the diagram of a galvanic cell and label its components (anode, cathode, and directions of ion and electron movement).	3	Che4.2.3.5
19	**construct** a galvanic cell from its given components.	4	Che4.2.4.3
20	**calculate** a standard cell potential by combining two standard electrode potentials.	3	Che4.2.3.6
21	**explain/deduce** the polarity or each electrode and direction of electron flow in a simple cell using standard cell potentials.	3	Che4.2.3.7
22	**predict** the spontaneity/feasibility of a reaction using standard cell potentials (i.e. reactants and products are present in their standard states (under standard conditions)).	4	Che4.2.4.4
23	**compare** and **contrast** between a galvanic cell and an electrolytic cell.	3	Che4.2.3.8
24	**generalize** principles of oxidation and reduction reactions to settings commonly found in society and the environment (e.g. batteries of vehicles; corrosion of metals in vehicles, buildings and bridges; oxidation of foods; galvanic protection with sacrificial corrosion; fuels; breathalyzer test).	4	Che4.2.4.5
25	**discuss** the possible advantages of developing other types of electrochemical cell, e.g. the H_2/O_2 fuel cell and the nickel-metal hydride and lithium-ion rechargeable batteries.	4	Che4.2.4.6

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
26	**evaluate** the impact (benefits and risks) of electrochemical cell applications on everyday life and environmental sustainability.	4	Che4.2.4.7

Strand 5: Organic Chemistry

Major Learning Outcome 5

Students are able to demonstrate knowledge application and critical evaluation of principles and applications of organic chemistry.

Substrand 5.1 Structure and Isomerism in Organic Chemistry (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critical evaluation of functional groups and isomerism in organic compounds through systematic nomenclature and interpretation of chemical structures.

SLO No.	Specific Learning Outcomes: ***Students are able to***	Skill level	SLO code
1	**recognize** the names, formulae and structures of arenes, halogenoarenes, phenols, amines, amides and acyl chlorides in a given context.	1	Che5.1.1.1
2	**draw** the structural, displayed, and skeletal formulae of arenes, halogenoarenes, phenols, amines, amides and acyl chlorides.	3	Che5.1.3.1
3	**apply** systematic nomenclature (IUPAC) to simple aliphatic organic molecules with up to 6 carbon atoms for functional groups alkanes, alkenes, halogenoalkanes, alcohols (including primary, secondary and tertiary), aldehydes, ketones, carboxylic acids, esters (six + six, straight chains only), acyl chlorides, amines (primary only) and amides (six + six, straight chains only).	3	Che5.1.3.2
4	**apply** systematic nomenclature (IUPAC) to name simple aromatic molecules with one benzene ring and two simple and same substituents, for example 1,2-dichlorobenzene.	3	Che5.1.3.3
5	**define** stereoisomerism /optical isomerism/ enantiomerism/chiral center in a given context.	1	Che5.1.1.2
6	**describe** structural isomerism and its division into chain, positional and functional group isomerism.	2	Che5.1.2.1
7	**describe** stereoisomerism and its division into geometrical (cis-trans) and optical isomerism.	2	Che5.1.2.2
8	**explain** a chiral centre in an molecule and its relation to optical isomerism (restricted to one chiral centre).	3	Che5.1.3.4
9	**identify** chiral centres and geometrical (cis-trans) isomerism in a	1	Che5.1.1.3

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
	molecule of given structural formula in a given context.		
10	**deduce/draw** the possible isomers (structural and stereoisomers) for an organic molecule of known molecular formula.	3	Che5.1.3.5
11	**discuss** the importance of isomerism in the way they are applied to everyday situations with given examples (e.g. drug manufacturing or extraction from natural sources).	4	Che5.1.4.1

Substrand 5.2 Reactions in Organic Chemistry (EA)

Key Learning Outcome:

Students are able to demonstrate knowledge application and critically evaluate, elaborate, justify, relate, evaluate or compare and contrast the links between the structure, functional groups, physical properties and/or reactivity of organic compounds.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**define** oxidation / reduction / substitution / elimination / hydrolysis reaction in a given context.	1	Che5.2.1.1
2	**identify/state** a feature of oxidation / reduction / substitution / elimination / hydrolysis reaction in a given context.	1	Che5.2.1.2
3	**define** electrophile/nucleophile in a given context.	1	Che5.2.1.3
4	**identify/state** a feature of electrophilic substitution reaction/ nucleophilic substitution reaction in a given context.	1	Che5.2.1.4
5	**describe** the substitution reactions of alcohols to halogenoalkanes including reaction products and conditions.	2	Che5.2.2.1
6	**describe** the elimination reactions of alcohols to alkenes including reaction products and conditions.	2	Che5.2.2.2
7	**describe** the esterification reactions between alcohol and acyl chlorides using ethyl ethanoate as an example.	2	Che5.2.2.3
8	**describe** the reaction of phenol with bases including reaction products and conditions.	2	Che5.2.2.4
9	**explain** the relative acidities of water and ethanol.	3	Che5.2.3.1
10	**suggest** characteristic distinguishing reactions for primary, secondary and tertiary alcohols, e.g. mild oxidation.	4	Che5.2.4.1
11	**discuss** the application of reactions of alcohols in real life situations using named examples.	4	Che5.2.4.2
12	**describe** the nucleophilic substitution reaction of haloalkane including reaction products and conditions.	2	Che5.2.2.5
13	**describe** the elimination reaction of haloalkane including reaction products and conditions.	2	Che5.2.2.6

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
14	**compare** the reactions of primary, secondary and tertiary haloalkanes in terms of reaction products, conditions, and type of reaction.	3	Che5.2.3.2
15	**interpret** the different reactivities of halogenoalkanes (with reference to hydrolysis and to the relative strengths of the C–Hal bonds).	3	Che5.2.3.3
16	**explain** the uses of fluoroalkanes and fluorohalogenoalkanes in terms of their relative chemical inertness.	3	Che5.2.3.4
17	**discuss** the application of reactions of haloalkane in real life situations using named examples.	4	Che5.2.4.3
18	**describe** the reduction reaction of aldehydes and ketones including reaction products and conditions e.g. using $NaBH_4$ or $LiAlH_4$.	2	Che5.2.2.7
19	**deduce** the nature (aldehyde or ketone) of an unknown carbonyl compound from the results of simple tests (Fehling's and Tollens' reagents; ease of oxidation).	3	Che5.2.3.5
20	**discuss** the application of reactions of aldehydes in real life situations using named examples.	4	Che5.2.4.4
21	**describe** the oxidation reaction of carboxylic acids (methanoic acid) including reaction products and conditions.	2	Che5.2.2.8
22	**describe** the substitution reaction of carboxylic acids to acyl chlorides including reaction products and conditions.	2	Che5.2.2.9
23	**describe** the reduction reaction of carboxylic acids to alcohols including reaction products and conditions e.g. using $LiAlH_4$.	2	Che5.2.2.10
24	**explain** the relative acidities of carboxylic acids and alcohols.	3	Che5.2.3.6
25	**explain** the acidities of chlorine-substituted ethanoic acids using the concept of electronegativity.	3	Che5.2.3.7
26	**describe** the hydrolysis of acyl chlorides including reaction products and conditions.	2	Che5.2.2.11
27	**describe** the reactions of acyl chlorides with alcohols, ammonia, and primary amines including reaction products and conditions.	2	Che5.2.2.12
28	**explain** the relative ease of hydrolysis of acyl chlorides and alkyl chlorides.	3	Che5.2.3.8
29	**describe** the acid and base hydrolysis of esters.	2	Che5.2.2.13
30	**compare** the reactions of carboxylic acid and carboxylic acid derivatives in terms of reaction products, conditions and type of reaction.	3	Che5.2.3.9

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
31	**describe** the formation of alkyl amines such as ethylamine (by the reaction of ammonia with halogenoalkanes or the reduction of amides with $LiAlH_4$).	2	Che5.2.2.14
32	**explain** the basicity of amines.	3	Che5.2.3.10
33	**explain** the relative basicity's of ammonia and ethylamine in terms of their structures.	3	Che5.2.3.11
34	**discuss** the application of reactions of amines in real life situations using named examples.	4	Che5.2.4.5
35	**describe** the formation of amides from the reaction between NH_3 or RNH_2 and R'COCl.	2	Che5.2.2.15
36	**describe** amide hydrolysis on treatment with aqueous alkali or acid.	2	Che5.2.2.16
37	**describe** the substitution reactions of benzene including reaction products and conditions e.g. halogenation, alkylation, acylation, nitration.	2	Che5.2.2.17
38	**predict** whether halogenation will occur in the side-chain or in the aromatic ring in arenes depending on reaction conditions.	4	Che5.2.4.6
39	**identify/state** a feature of condensation polymers (e.g. polyester – Terylene; e.g. polyamides - polypeptides, proteins, nylon 6, nylon 6,6 and Kevlar) in a given context.	1	Che5.2.1.5
40	**describe** the formation of polyesters and polyamides.	2	Che5.2.2.18
41	**deduce** the repeat unit of a condensation polymer obtained from a given monomer or pair of monomers.	3	Che5.2.3.12
42	**predict** the type of polymerization reaction and structure of polymer for a given monomer or pair of monomers.	4	Che5.2.4.7
43	**discuss** the properties and structure of polymers based on their methods of formation (addition or condensation).	4	Che5.2.4.8
44	**discuss** the effect of presence of side-chains and intermolecular forces on the properties of polymeric materials.	4	Che5.2.4.9
45	**compare** condensation polymers with addition polymers in terms of formation and physical properties.	3	Che5.2.3.13
46	**define** degradable/biodegradable polymers in a given context.	1	Che5.2.1.6
47	**identify** chemically inert/difficult to biodegrade polymers e.g. poly(alkenes) and degradable polymers in a given context.	1	Che5.2.1.7
48	**identify** polymers biodegradable by hydrolysis e.g. polyesters and polyamides in a given context.	1	Che5.2.1.8
49	**describe** the hydrolysis of proteins.	2	Che5.2.2.19
50	**identify** organic functional groups for an organic molecule	1	Che5.2.1.9

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
	containing several functional groups in a given context.		
51	**predict** properties and reactions for an organic molecule containing several functional groups.	4	Che5.2.4.10
52	**devise** multi-stage synthetic routes for preparing organic molecules using the reactions in the syllabus.	4	Che5.2.4.11
53	**analyze** a given synthetic route in terms of type of reaction and reagents used for each step of it, and possible by-products.	4	Che5.2.4.12

Substrand 5.3 Problem Solving in Organic Chemistry *(For IA Task 3)*

Key Learning Outcome:

Students are able to demonstrate knowledge application and critically evaluate, plan, analyse, evaluate and conclude practical investigations to solve problems in organic chemistry.

SLO No.	Specific Learning Outcomes: *Students are able to*	Skill level	SLO code
1	**state** the problem under investigation.	1	Che5.3.1.1
2	**describe** the hypothesis of the investigation.	2	Che5.3.2.1
3	**plan/design** a procedure for the investigation.	3	Che5.3.3.1
4	**record/tabulate** data from the investigation.	2	Che5.3.2.2
5	**analyze** primary data to draw appropriate conclusions.	3	Che5.3.3.2
6	**analyse** secondary data/provided data/other published data to reach appropriate conclusions.	3	Che5.3.3.3
7	**evaluate** data and provided information to determine the confidence with which conclusions may be drawn.	4	Che5.3.4.1
8	**judge** the reliability of the investigation and the trustworthiness of its outcomes.	4	Che5.3.4.2
9	**draw** conclusions from the investigation with respect to the hypothesis and make further predictions.	4	Che5.3.4.3
10	**suggest** ways the investigation may be improved in order to increase the confidence in drawing conclusions.	4	Che5.3.4.4
11	**discuss** the findings of the investigation in relation to real-life applications.	4	Che5.3.4.5
12	**report** scientifically on the investigation and findings using chemistry vocabulary, symbols, and conventions.	2	Che5.3.2.3

8.0 Assessment

The assessment of the syllabus is in two parts (External and Internal assessment).

1. External assessment (EA) : 70%
2. Internal assessment (IA) : 30%

The Principal, or his/her nominee, will certify that the syllabus requirements have been fulfilled.

8.1 Suggested Teaching Times and Weighting

Strand	Outcomes	External / internal	Suggested Time	Approximate Weighting
1	**Atomic Structure and Bonding and Properties**	External	5.5 weeks	20%
2	**Thermochemistry and Chemistry in the Society**	External	5.0 weeks	8%
		Internal		10%
3	**Aqueous Equilibrium Systems**	External	5.5 weeks	20%
4	**Oxidation-Reduction Processes**	External	4 weeks	5%
		Internal		10%
5	**Organic Chemistry**	External	8 weeks	17 %
		Internal		10%
	Total		**28 weeks**	**100%**

8.2 External Assessment

This syllabus will be examined by a **three-hour written paper**. The weightings given to each topic within the examination paper will be approximately:

Strand 1: Atomic Structure, Bonding and Related Properties	20%
Strand 2: Thermochemistry and Chemistry in the Society	8%
Strand 3: Aqueous Equilibrium Systems	20%
Strand 4: Oxidation-Reduction Processes	5%
Strand 5: Organic Chemistry	17%

Candidates are required to apply knowledge, understanding, and acquired skills to unfamiliar situations in the examination. Where required information lies outside the prescribed content areas, this information will be provided as resource material in the examination paper. At least 60% of the paper will require explanations, application of knowledge and higher order thinking skills. A copy of the periodic table giving element symbols, atomic numbers and molar masses will be included with the examination paper. Symbols, nomenclature, spelling, and formatting will follow current IUPAC conventions as detailed in the Appendix.

8.3 Assessment Blueprint

The blueprint below is to guide the Internal and External Assessment allocations for Chemistry.

The allocation of 10%, 20%, 30% and 40% for levels 1, 2, 3 and 4 respectively is common across all subjects in SPFSC.

Strand	Total Weight	IA or EA	Level 1	Level 2	Level 3	Level 4	Total skill score allocation (%)
Strand 1: Atomic Structure, Bonding and Related properties	20	EA					20
Strand 2: Thermochemistry and Chemistry in the Society	18	EA					8
		IA	1	1	1	1	10
Strand 3: Aqueous Equilibrium Systems	20	EA					20
Strand 4: Oxidation – Reduction Processes	15	EA					5
		IA			2	1	10
Strand 5: Organic Chemistry	27	EA					17
		IA		1		2	10
Number of items	40		**10**	**10**	**10**	**10**	**100**
TOTAL	100		**10**	**20**	**30**	**40**	

8.4 Internal Assessment Tasks (30%)

There are three Internal Assessment tasks in this course:

1. An individual research project on Chemistry in the Society (10%)
2. A group practical skills assessment involving oxidation-reduction reactions (10%)
3. An individual written practical skills assessment involving organic analysis (10%)

The learning outcomes that are assessed in Tasks 1, 2 and 3 can be found in Sub-strands 2.2, 4.1 and 5.3, respectively.

8.4.1 Task 1: Individual Research Project (10%)

Students are able to demonstrate knowledge application in chemical principles by presenting an account of how chemistry can advance society in ways that are benign to the environment and sustainable for the future.
The learning outcomes assessed in this task are found in Sub-Strand 2.2: Chemistry in the Society. In this task students are to:

1	Discuss with their teacher a chemically based current environmental sustainability aspect in the society that they wish to research.
2	Students are to research into one aspect and its impacts only. Some possible topics are given below: ▪ Mitigation of climate change, ▪ Maintaining or Improving Environmental quality (air, land, sea), ▪ Waste Management, ▪ Use of renewable feedstocks, ▪ Sustainable chemical synthesis, ▪ Reducing and reusing food waste, ▪ Remediation of pollutants, ▪ Renewable energy production and storage,
3	Research into the chosen aspect will cover a range of areas of chemistry including environmental chemistry, consumer chemistry, food chemistry, electrochemistry, thermochemistry, organic chemistry and analytical chemistry.
4	The purpose of this task is to assess the student's ability to research into an area of chemistry through which they connect their learning in chemistry with the chemistry processes that are part of their everyday lives. Students will also be able to recognize that environmental sustainability and processes are chemical, and to understand them, understanding the basic chemistry involved is necessary. This includes an understanding of the history behind the aspect. This integrated approach should be modelled by the teacher when they link their lessons to everyday contexts. e.g. when teaching about thermochemistry, they could introduce this topic by discussing sustainable energy (renewable energy sources) aspects including its history and future.
5	This task also assesses student's independent research skills so it is not necessary that they would have covered a specific topic in order to be able to complete the research. Their research becomes the source of their learning.
6	The communication skills required have two outcomes – good communication in English and communication that demonstrates chemical literacy. Chemical literacy is demonstrated when descriptions of chemical phenomena are supported by appropriate formulae and equations.
7	After identifying with the teacher, the chemically based current environmental sustainability aspect to be researched, the students are to complete the following: • Gather relevant information by reading widely. • Gathering information from actual site visits (e.g. waste disposal sites, saltwater intrusion sites, chemical application in agriculture/mining etc.) and talking with or interviewing staff

members is a definite advantage. However, it is not a compulsory requirement.

- Keep a portfolio of draft findings. This portfolio will be checked by the teacher. The portfolio is a compulsory part of this assessment task.

Compile the research report, ensuring that the following are addressed in the report:

- Research aim/s are stated
- Research methods are described
- Sources of information are acknowledged
- The aspect is described, together with its history
- Chemical principles behind the environmental aspect are described, including how these have improved understanding of the aspect.
- Data/Findings are analyzed /interpreted – linking the improved understanding of the environmental aspect to the chemical principles
- Chemical names, formulas, equations are used
- Environmental or societal impacts of the aspect and recommendation of possible solutions.

Students who are working towards excellence level are expected to be able to evaluate the current environmental sustainability aspect based upon chemical principles and relate it to the impacts on the society. Teachers should guide the students' choice of topic to ensure that there is a reasonable opportunity to evaluate possible issues and impact.

It is expected that students will spend about 5 hours of class time writing the report. The compiling of resources into the portfolio is to be done using students' own time. The report should be between 1000 and 1500 words (4 - 5 ×A4 pages). Both the report and the portfolio are to be submitted to the teacher by the due date.

The scoring criteria/rubric for this task is provided (refer to pages 33- 35). Teachers are to use the scoring criteria very closely for the scoring of student research reports. Scored student reports are to be kept in the school for later reference. The student skill scores for each item will be recorded on the marksheet that will be provided from EQAP. The score sheet with highlighted skill levels and comments are to be provided to students.

The School Principal is to follow up to ensure the valid and reliable completion of this task.

8.4.2 Task 2: CAT - Practical Skills – Laboratory-based assessment (10%)

Quantitative and/or Qualitative Analysis using Oxidation-Reduction reactions	
The learning outcomes assessed in this CAT are taken from Strand 4. Teachers are advised to prepare students for the CAT by ensuring that they practice experimental skills during their course of study.	
Explanatory Notes	
1	Task 2 is a common assessment task (CAT). The task instructions will be provided to schools at the appropriate time. Teachers are to note the CAT date in the Assessment Schedule provided in the CD Information pack. The common assessment task (CAT) will be provided for the laboratory-based practical on experimental skills dealing with measuring, recording, presenting, analyzing, concluding and evaluating findings. Laboratory facilities will be required for this task. Students will carry out experimental analyses in groups, however, discuss the results and submit their laboratory report individually
2	A generic task and a scoring rubric will be provided (See page 36).
3	Basically, students will be required to carry out experiments on oxidation-reduction reactions leading to quantitative and/or qualitative analysis of known and/or unknown substances**.** Candidates will be expected to perform experiments, record and present their observations and data, analyse their results, discuss the findings, provide suggestions/recommendations and draw appropriate conclusions.
4	Finally, students will submit a laboratory report.

8.4.3 Task 3: CAT - Practical Skills – Written Assessment (10%)

Problem Solving in Chemistry: Analysis of Unknown Organic Compounds	
The learning outcomes that are assessed in this task can be found in Sub-Strand 5.3. Teachers are advised to prepare students for the CAT by ensuring that they practice experimental skills during their course of study.	
Explanatory Notes	
1	Task 3 is a common assessment task (CAT). The task instructions will be provided to schools at the appropriate time. Teachers are to note the CAT date in the Assessment Schedule provided in the CD Information pack. The common assessment task (CAT) will be provided for the written assessment on higher-order experimental skills dealing with planning, analysis, conclusions and evaluation. Laboratory facilities are not required for this task. A generic task and a scoring rubric will be provided (See page 38-4).
2	Basically, students will be required to design an experimental investigation of a given problem. There will be activities in which students will be given some experimental data and will be required to analyse, evaluate and draw conclusions from them.

General Explanatory notes

Course work requirements, the assessment tasks and weightings given to each task should be clearly explained to students at the beginning of the year's course. Results must be clearly recorded and maintained by teachers so that accurate information on each student's progress is readily available.

At the start of the year students should be given a copy of the assessment statement to be used. The assessment statement and copies of all assessment tasks and assessment schedules used, as well as a sample of student responses to all internal assessment work undertaken, must be available for verification on request until 30 November of the year of the examination. The moderation of Internal Assessment will be done in accordance with EQAP policies pertaining to the SPFSC qualification as specified from time to time.

More information on Tasks plus other explanatory notes are provided in Appendix 1.

8.5 Scoring Rubrics

8.5.1 IA Task 1 Scoring Rubric (10%)

Task item, level & SLO code	Level 1	Level 2	Level 3	Level 4
1. **identify** a chemically based current environmentally sustainable aspect (L1) (Che2.2.1.1)	Correct aspect is identified			
2. **collect** ideas based on current environmental sustainability aspect (L1) (Che2.2.1.2)	Correct Ideas collected based on the topic.			
3. **outline** the historical /discovery of the aspect. (L2) Che2.2.2.1	One correct idea on historical account	More than one perspective is provided		
4. **explain** the chemical principles involved in the aspect(L3) Che2.2.3.1	One correct chemical principle is explained briefly	More than one correct chemical principle explained	More than two chemical principles explained with examples.	
5. **discuss** ways in which chemical principles have improved understanding (L4) Che2.2.4.1	One correct idea is given.	At least two correct ideas are given but not linked.	At least two correct ideas are given, which are properly linked.	Further discussion with relation to the aspect /extension of ideas.

6. **link** the effect of the aspect to chemical principles (L3) Che2.2.3.2	One correct use or one principle is provided	Effect and principle are provided but not linked	Effect and principle are provided and related well	
7. **evaluate** factors (L4) Che2.2.4.2	One correct factor is stated	At least two correct factors are given but not linked.	At least two correct factors are related to their control on the aspect	Factors are related and examples given, shows extension of ideas
8. **analyze / interpret** data (L3) Che2.2.3.3	Data pieces correctly tabulated with one description	More than one correct description of trends provided /tabulated	Data trends are correctly related to possible causes	
9. **use** sources of Information / referencing (L2) Che2.2.2.2	One correct source / reference is provided	Two or more sources are listed /referencing used correctly in two or more places.		
10. **order** report comprehensively (L2) Che2.2.2.3	Very basic reporting	Organization / sequencing is linked		
11. **apply** chemistry language (L3) Che2.2.3.4	Chemistry language is very basic (uses vocabulary)	Chemistry language is general (uses vocabulary without linkage)	High level Chemistry language is used (laws/ theories related to sustainability.	
12. **evaluate** the impact of the aspect (L4) Che2.2.4.3	One correct impact is listed	More than one correct impact is listed	Listed impacts are linked.	Related impacts are extended to other fields using good examples.
13. **discussion** on managing / promoting sustainability (L4) Che 2.2.4.4	One correct idea is briefly discussed.	Two or more correct ideas discussed with examples.	Two or more correct ideas discussed and linked to sustainability	Two or more correct ideas discussed and related to e.g./ sustainability/ chemical principles.

14. **recommend** solutions (L4) Che 2.2.4.5	One correct solution stated.	Two or more correct solutions discussed without linking ideas.	Two or more correct solutions discussed linked to sustainability	Two or more correct solutions discussed linked / related to sustainability and to the changing world.

Name of student: _____

Signature of Teacher_____**Date:** _____

8.5.2 IA Task 2 Scoring Rubric (10%)

Task item, level & SLO code	Level 1	Level 2	Level 3	Level 4
1. **explain** oxidation – reduction processes in terms of electron transfer and changes in oxidation number L3 Che4.1.3.1	Basic definition of oxidation – reduction reaction is given.	Oxidation – reduction processes are described electron transfer reactions.	The ideas of electron transfer and changes in oxidation number are linked to describe oxidation – reduction processes.	
2. **construct oxidation** – reduction equations using the relevant half-equations (including acidic or basic solution) L3 Che4.1.3.2	At least one correct balanced half equation is provided.	Both correct balanced half equations are provided.	Correct net balanced equation is provided in acidic or basic solution.	
3. **discuss** analytical applications of oxidation – reduction reactions with examples L4 Che4.1.4.1	One analytical application example is stated.	Two or more analytical applications example are listed.	At least one analytical example is given, justified with the relevant oxidation-reductions reactions and reactions.	At least one analytical example is given, justified with the relevant oxidation-reductions reactions and how the principles of oxidation-reductions are applied in that context.
4. **perform** oxidation – reduction reaction experiments from given instructions L4 Che4.1.4.2	Experimental steps are followed but not completed.	Experimental steps are correctly followed but not completed in the required order.	Experimental steps are completed in the correct order, with linking evident between the steps.	The whole experiment is completed correctly and within the stipulated timeframe.
5. **record/tabulate** observations and data from oxidation – reduction reaction experiments to enable a valid, reliable conclusion to be made L2 Che4.1.2.1	All data or observations are presented as a single table of results.	Data or observations are presented in a series of well laid out tables.		
6. **analyse/interpret** results from the oxidation – reduction reaction experiments to	One calculation is shown.	Working in calculations are shown, and the key steps in reasoning/deduction	The key patterns and trends shown by data in tables and graph are described and interpreted.	

reach valid conclusions L3 Che4.1.3.3		is shown.		
7. **infer** appropriate chemical equations for the oxidation – reduction reactions that would have occurred in the experiment L3 Che4.1.3.4	One reaction equation is given.	All balanced reaction equations relevant to the experiment are provided.	Reaction equations are provided and justified from experimental data/observations.	
8. **evaluate** findings of oxidation – reduction reaction experiments in relation to the purpose of the experiment, highlighting limitations and sources of errors, and suggest modifications or improvements L4 Che4.1.4.3	Systematic error or random error is identified.	The most significant sources of error in the experiment are identified/listed.	The uncertainty in the measurement is estimated and expressed quantitatively.	The effectiveness of the experimental procedure in regards to accuracy and precision is discussed with possible limitations, and suggested modifications.
9. **discuss** the findings of the oxidation – reduction reaction experiment in relation to everyday application of the results L4 Che4.1.4.4	One conclusion is stated.	Conclusions from an experiment give an outline description of the main features of the data.	Conclusions are drawn from the experiment and whether the findings supports the given hypothesis is considered.	Conclusions are drawn from the experiment, and further ways are suggested in which the experiment can be extended to answer a new question.
10. **report** scientifically on findings of oxidation – reduction reaction experiments using chemistry vocabulary, symbols, and conventions L2 Che4.1.2.2	A written report is submitted.	The submitted report is organized and includes accepted scientific conventions.		

Name of student: _____

Signature of Teacher:_____ **Date:** _____

8.5.3 IA Task 3 Scoring Rubric (10%)

Task item, level & SLO code	Level 1	Level 2	Level 3	Level 4
1. **state** the problem under investigation L1 Che5.3.1.1	A problem statement is given.			
2. **describe** the hypothesis of the investigation L2 Che5.3.2.1	A possible outcome of the investigation is stated.	A precise, testable statement of outcome of the investigation is given in terms of a prediction.		
3. **plan/design** a procedure for the investigation L3 Che5.3.3.1	Steps necessary to carry out the procedure is identified.	Steps necessary to carry out the procedure is identified, including the variables to be studied.	A procedure is provided that incorporates suitable apparatus, chemicals, experimental steps, experimental variables and risk assessment of the proposed experiment.	
4. **record/tabulate** data from the investigation L2 Che5.3.2.2	Data is recorded in a single format.	Data is recorded in different formats i.e. according to the type of data collected.		
5. **analyse** primary data to draw appropriate conclusions L3 Che5.3.3.2	Use of calculations to enable simplification or explanation of data.	Use of tables and graphs to draw attention to the key points in data.	Use of calculations, tables and graphs to show patterns and trends in data, including the variability of data.	
6. **analyse** secondary data/provided data/other published data to reach appropriate conclusions L3 Che5.3.3.3	Reference to secondary data is made.	Different sources and types of secondary data is used to support primary data.	Linking of primary and secondary data is done to enable appropriate conclusions.	

7. **evaluate** data and provided information to determine the confidence with which conclusions may be drawn L4 Che5.3.4.1	Data that has been replicated or need to be replicated is identified.	The adequacy of the range of data provided is described.	The extent to which data has been adequately replicated or not is explained.	Advantages of replication of data, and the practical limitations is suggested.
8. **judge** the reliability of the investigation and the trustworthiness of its outcomes L4 Che5.3.4.2	A weakness/limitation of the experimental procedure used is identified.	Weaknesses/ limitations of the experimental procedure used is described.	Weaknesses/ limitations of the experimental procedure used to the quality of data obtained is related.	Suggestion on how changes in the variables and/or conditions used for the experiment might have an effect on the results obtained, is made.
9. **draw** conclusions from the investigation with respect to the hypothesis and make further predictions L4 Che5.3.4.3	A key feature of data is identified.	A detailed description of the key features of the data and analyses is provided.	A consideration is made on whether experimental data supports the conclusions reached.	Analysis is made on whether data is of sufficient quality and can/cannot be used successfully to test the prediction.
10. **suggest** how the investigation may be improved in order to increase the confidence in drawing conclusions	Anomalous values in data is identified.	Anomalous values in data and the corresponding experimental steps are identified.	Justification of anomalous data with respect to theory is given.	Possible explanations for anomalous data and appropriate strategies for dealing with such anomalies within familiar contexts are suggested.

L4 Che5.3.4.4				
11. **discuss** the findings of the investigation in relation to real-life applications L4 Che5.3.4.5	One experimental finding is stated.	An outline description of the main features of the data from the experiment is given.	Conclusions are drawn from the experiment data.	Conclusions are drawn from the experiment data, and further ways are suggested in which the experiment can be extended to answer a new question.
12. **report** scientifically on the investigation and findings using chemistry vocabulary, symbols, and conventions L2 Che5.3.2.3	A written report is submitted.	The submitted report is organized and includes accepted scientific conventions.		

Name of student: _____

Signature of Teacher:_____ **Date:** _____

9.0 Appendices

9.1 Appendix 1: More Information on IA tasks

CHEMISTRY IN THE SOCIETY

Internal assessment resource - GENERIC TASK

Research, evaluate and link to chemically based current environmental sustainability aspect in the society.

Student Instructions Sheet

Introduction:

Many environmental aspects and processes are chemical, and to understand them, understanding the basic chemistry involved is necessary. These current environmental sustainability aspect impact humans, animals and the society as a whole. Over the last few decades, the exploitation and degradation of our environment have increased significantly. More understanding of the environmental sustainability aspect and actions are needed in favour of protecting the planet earth than ever before.

You are to prepare a report about an environmental sustainability aspect that has impacted the society in some way. Your report will link the aspect identified to your understanding of chemistry phenomena. This means that you will explain the Chemistry involved in the understanding and addressing of issue based on the Chemistry you have learned in Year 12 and Year 13. Your report should be easy for a Year 12 Chemistry student to follow.

Conditions:

Research - 3-4 class periods are available for you to research the material

Presentation – 2 class periods are available for you to write up your report.

a. Topic

The context will be prescribed. You will choose your own topic within the given context.
For example, if the context is mitigation of climate change you might choose to write your report about how to reduce or prevent emission of greenhouse gases, how it has changed the climate and the resulting impacts on the society.

b. Research

1. **Research** your topic. You will need to find out about the *discovery, efforts and impacts* of the environmental sustainability aspect AND the *chemistry* related to the *discovery, effects and impacts*. For example:
   - The environmental situation that resulted in the discovery of the aspect
   - How the aspect was investigated and researched to understand it better

- Important chemistry concepts and principles involved in the discovery, investigation and understanding of the aspect.
- Any factors that are important to the management of the aspect
- Any further trends/consequences if the aspect is managed/not managed

These statements are starting points only, to indicate the kind of evidence you will need to produce a report in Part C below.

2. Produce a folder of researched material that includes photocopies or originals of written resources and other resources (e.g. pamphlets, notes from a video, photos). All material included must have information that identifies the source. This may include author, year, title, publisher, place published; or URL and date accessed; or name and contact details of people and organisations approached.

Produce a **reference list**. This will be attached to your completed report.

c. Presentation

Produce a presentation written in your **own words** to integrate information and data that you have researched from a range of different sources to **discuss**:

- The environmental situation that resulted in the discovery of the aspect
- How the aspect was investigated and researched to understand it better
- Important chemistry concepts and principles involved in the discovery, investigation and understanding of the aspect
- Any factors that are important to the management of the aspect
- Any further trends/consequences if the aspect is managed/not managed

NOTE:

i. The presentation will be mostly assessed on your understanding of the way an environmental sustainability aspect has been discovered and actions related to the investigation and management of the aspect. However, some scores will be given for the quality of your presentation – it should be free of spelling and grammatical errors and correctly incorporate chemistry formulae and appropriate equations. It should be appropriate for use with Year 12 Chemistry students.

ii. To ensure all data/quotes/graphs/diagrams/maps, etc. that you used can be checked and authenticated, any references used as information sources should be acknowledged with them in the body of the report. A small amount of information or facts can be copied but it must be written in quote marks and have the reference beside it in the body of the presentation.

iii. If you have collected actual data yourself, record the following information with the presented data: date of collection, name and position of the persons interviewed.

iv. Include a reference list of sources used, recorded in a way that the source can be located.

v. Your portfolio of data should be handed in with your report.

Quantitative and/or Qualitative Analysis Using Oxidation-Reduction Reactions

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Student Instructions Sheet

Instructions:

1. This task involves assessment of practical skills through a series of experiments. You will carry out the experiments in groups and submit the report individually.
2. You need to work closely with your laboratory instructor for guidance and feedback throughout the duration of this task. You are to only proceed with any experimental work after getting approval by the laboratory instructor. Any modifications to the approved methodology must also be approved by the laboratory instructor before proceeding with its practical aspect in the laboratory.
3. Finally, you have to submit a report. Please refer to the guide provided in your Study Guide for the write-up of your report.

CAUTION

Always use caution in the laboratory. Many chemicals are potentially harmful. Ensure that you are well acquainted with all the safety aspects of the Chemistry laboratory. You must be supervised by a staff member during any experimental work in the laboratory. Pay special attention to the precautions given in the experiments required for Task and ensure that they are taken to avoid exposure of chemicals by the principal routes, that is, contact with skin and eyes, inhalation, and ingestion. Follow safety precautions given for all reagents used in this experiment. Avoid ingesting any of the reagents. Where necessary, your laboratory instructor will also provide additional instructions on the safety precautions needed e.g. wearing of appropriate personal protective devices such as, laboratory coats, gloves and goggles when performing the experiments.

Activity: Volumetric Analysis Using Redox Titration

Introduction:

An oxidation-reduction (redox) reaction is a type of chemical reaction that involves a transfer of electrons between two species. Titrations which utilize redox reactions can be used accurately to determine the concentration of an unknown solution by titrating it against a solution of known concentration (standardized solution). A common example is the redox titration of a solution of iron (II) salt against a solution of potassium permanganate. Potassium permanganate solution is widely used in redox titrations because it can act as its own indicator. In this example potassium permanganate solution is bright purple, while the iron (II) salt solution is colorless. The endpoint of the titration is identified easily because the solution will remain slightly purple from the unreacted potassium permanganate.

Experiment

You are required to carry out the standardization of a potassium permanganate solution. You will perform the experiment in groups however, process data, make interpretations about the results, discuss findings and submit the report individually.

Apparatus/Equipment required

100 mL conical flask, 20 or 25 ml pipette, pipette filler, burette, retort stand, wash bottle

Reagents required

Sulphuric acid, 2 mol L^{-1}

Potassium permanganate solution (approximate concentration of 0.02 mol L^{-1})

Iron (II) ammonium sulfate solution (accurate concentration of 0.1 mol L^{-1})

CAUTION - Sulfuric acid (H_2SO_4) is corrosive, toxic and oxidizing. Use a fume hood when working with H_2SO_4. Wear gloves and goggles when performing the experiment.

Procedure to be performed (Che4.1.4.2)

1. Fill the burette with the potassium permanganate solution.
2. Pipette 20 mL (or 25 mL) of iron (II) ammonium sulfate solution into a conical flask.
3. Add potassium permanganate solution from the burette into the flask and mix the solution in the flask well.
4. Continue addition of the potassium permanganate solution until a pink colour first persists.
5. Note the volume of potassium permanganate solution and record the data.
6. Repeat titrations until concordant results are obtained and note the volume of potassium permanganate solution used.

Post-Lab Activity

1. Tabulate data from the experiment. (Che4.1.2.1)
2. Explain the oxidation – reduction processes taking place in the experiment in terms of electron transfer and changes in oxidation number. (Che4.1.3.1)
3. Infer appropriate chemical equations for the oxidation – reduction reaction that would have occurred in the experiment. (Che4.1.3.4)
4. Construct oxidation – reduction equations using the relevant half-equations to obtain the overall redox reaction. (Che4.1.3.2)
5. Analyse data to determine the concentration of potassium permanganate solution. (Che4.1.3.3)
6. Evaluate findings in relation to the purpose of the experiment, highlighting limitations and sources of errors, and suggest modifications or improvements. (Che4.1.4.3)
7. Discuss the findings of the oxidation – reduction reaction experiment in relation to everyday application of the results. (Che4.1.4.4)
8. Write and submit a laboratory report. (Che4.1.2.2)

Internal assessment resource - EXAMPLE OF STUDENT TASK

Problem Solving in Chemistry: Investigation on the Identities of Unknown Organic Compounds

Student Instructions Sheet

1.0 Introduction

The functional groups present in unknown organic compounds can be identified through a two-step process involving selective solubility tests and selective functional group tests. The analysis depends on having a scheme of confirmatory tests that progressively and systematically eliminates or identifies possible functional groups in organic compounds. In the first step, solubility tests can suggest the size and polarity of an unknown compound and the presence of basic or acidic functional groups. In the second step, chemical tests transform an unknown into a different compound with an accompanying change in appearance. These tests are often called classification tests because they identify the possible functional groups present.

2.0 Activity

Your laboratory instructor gives you three bottles only labeled as 1, 2 and 3. All bottles contain different organic compounds (an alkene, a alcohol or a carboxylic acid). The instructor then asks you to use your knowledge of organic chemistry reactions to investigate and identify the type of organic compound present in each bottle. Use the following guideline to complete this task:

1. State the problem under investigation. (Che5.3.1.1)
2. Describe the hypothesis of the investigation. (Che5.3.2.1)
3. Plan/design an experimental procedure for the investigation. Indicate all the reagents, reactions conditions and apparatus you would use. (Che5.3.3.1)
4. Tabulate the type of data that would be obtained from the experiments. (Che5.3.2.2)
5. Analyse the data to draw appropriate conclusions about the possible identities of each compound. (Che5.3.3.2)
6. Analyse other provided data/ published data to reach appropriate conclusions about the possible identities of each compound. (Che5.3.3.3)
7. Evaluate findings of the investigation with respect to the level of confidence with which the possible identity of each compound is concluded. (Che5.3.4.2)
8. Judge the reliability of the investigation and the trustworthiness of its outcomes. (Che5.3.4.3)
9. Draw conclusions from the investigation with respect to the hypothesis and make further predictions. (Che5.3.4.4)
10. Suggest how the investigation may be improved in order to increase the confidence in drawing conclusions on the possible identities of each compound. (Che5.3.4.5)
11. Discuss the findings of the investigation in relation to real-life applications. (Che5.3.4.6)
12. Write and submit a report on the investigation and its outcomes. (Che5.3.2.3)

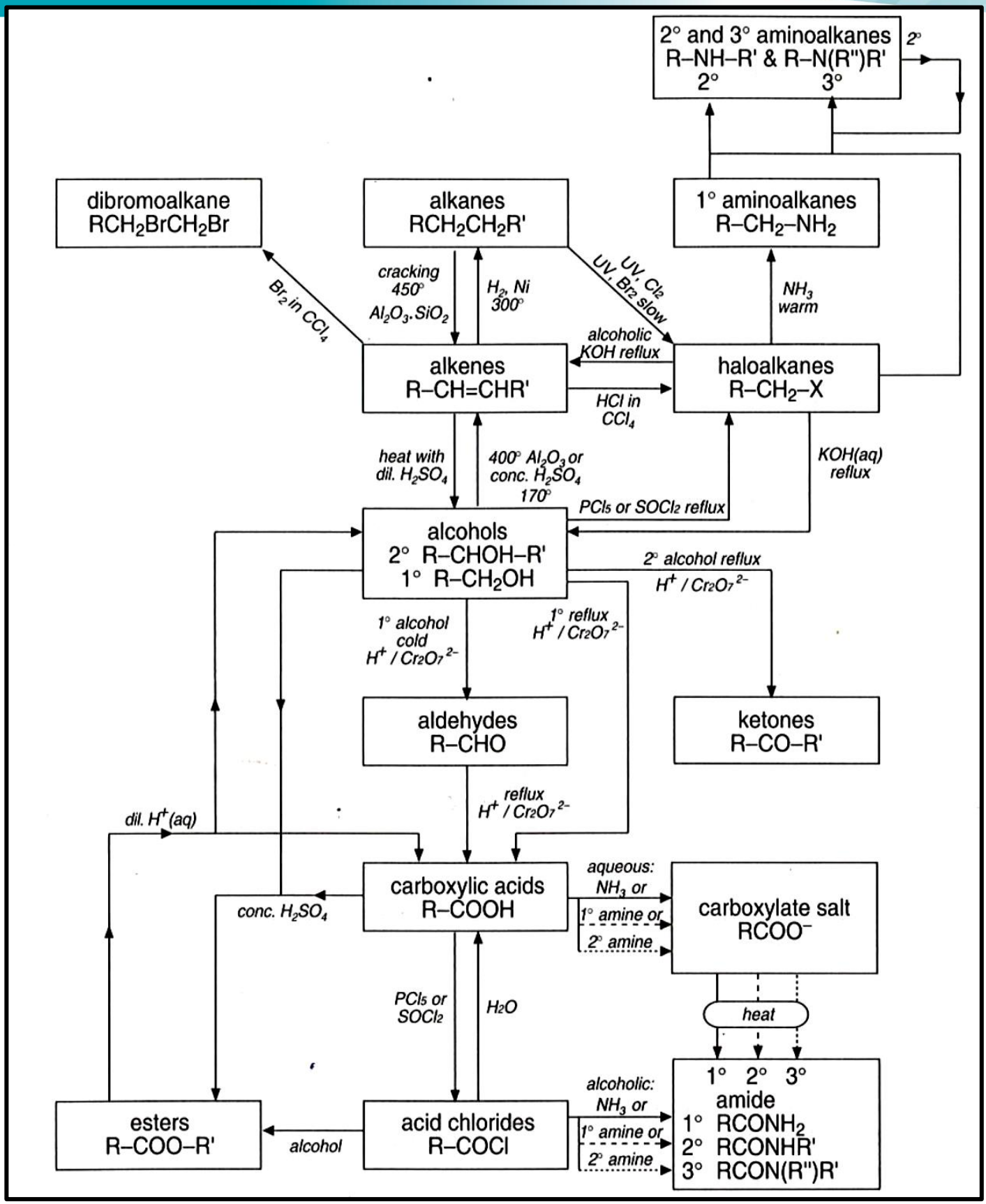


Figure: Summary of reactions of organic compounds. Image copyright: ESA Publications (NZ) Ltd.

Chemistry examinations will use the following information, which has been based on International Union of Pure and Applied Chemistry (IUPAC) recommendations. Candidates should be encouraged to use this IUPAC terminology, but those who use other terminology will not be penalized if their answers indicate a clear understanding of the chemistry involved.

General Chemistry

Symbols for the physical quantities, ***M***, ***V***, ***H***, ***K***, are written in italics (sloping letters). Any following subscripts will be in upright type.

Units in Symbols / Expressions	Common use
M, molar mass is the mass of one mole of a defined substance and will be used for elements and compounds.	g mol^{-1}
V, volume A looped l is not used in these abbreviations.	L and mL
n, amount of substance, expressed in moles. It is incorrect to use the term 'number of moles'. (See Details under 'Amount of Substance' below.)	mol
c, amount concentration, is expressed as moles per litre, also denoted by the format [ ].	mol L^{-1}
Concentrations may also be written as *mass concentration*, expressed as grams per litre. *Composition of a mixture, commonly expressed as % w/V, % w/w and % V/V, will be used only after giving a clear definition of their meaning (eg grams per 100 mL, grams per 100 g, mL per 100 mL respectively).*	g L^{-1}
s *(italic s)*, solubility, units as for concentration.	mol L^{-1}

Amount of Substance

This is a physical quantity, symbol *n (italic n)*, measured in a unit called the mole, which has the abbreviation mol.
The term, 'number of moles' is to be avoided. The term, 'amount of substance in moles' is preferred. In the same manner, the size of an object can be described in terms of its 'length in metres', rather than its 'number of metres'.

Graph Axes and Table Headings
Labelled as: quantity / unit, e.g. c / mol L^{-1}.
Only values will then be written on the axes or in a table.

Enthalpy changes, ΔH

Units commonly used kJ mol^{-1}

$\Delta_r H°$, standard enthalpy of reaction when reactants and products are in their standard state (usually the state at 25°C). For example:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta_r H°$ (H_2O, l) = –570 kJ mol^{-1}

The term mol^{-1} means per mole of reaction, which is determined by the chemical equation; i.e. 2 mol of H_2 reacting with 1 mol of O_2 to give 2 mol of H_2O.

$\Delta_f H°$, standard enthalpy of formation, per mole of product. For example, the standard enthalpy of formation of liquid water:

$H_2(g) + ½O_2(g) \rightarrow H_2O(l)$ $\Delta_f H°$ (H_2O, l) = –285 kJ mol^{-1}

$\Delta_c H°$, standard enthalpy of combustion, per mole of substance burnt. For example, the standard enthalpy of combustion of hydrogen gas to give liquid water:

$H_2(g) + ½O_2(g) \rightarrow H_2O(l)$ $\Delta_c H°$ (H_2, g) = –285 kJ mol^{-1}

Note (i) The superscript ° denotes a defined standard state.
(ii) The alternative superscript $^{\theta}$ (plimsol) is acceptable.
(iii) A space is always left between any value and its unit, as well as between units for composite units.

- $\Delta_{fus}H$, enthalpy of fusion (melting)
- $\Delta_{vap}H$, enthalpy of vaporization
- $\Delta_{sub}H$, enthalpy of sublimation

Standard Electrode Potential
Electrode potentials are defined as standard electrode potentials, $E°$.
Units are volts, symbol V.

e.g.	**Redox couple**	$E°$ / V	
		Zn^{2+} / Zn	–0.76
		Fe^{3+} / Fe^{2+}	+0.77

A half-cell is an electrode and the couple it is in contact with. When the oxidant and reductant are in different phases, a vertical line in the cell diagram is used to represent the phase boundary. For

example:

$Zn(s)$ | $Zn^{2+}(aq)$ Oxidant and reductant are in different phases. Metal electrode is part of redox couple.

OR

$Fe^{3+}(aq)$, $Fe^{2+}(aq)$ | Pt Oxidant and reductant are in the same phase. An inert electrode is used. The vertical line represents a phase boundary.

Equilibrium Constant, K

Constants will be dimensionless, ie have no units, in keeping with current IUPAC conventions. They will include:

- K_c General equilibrium constant in which the equilibrium composition is expressed in terms of concentration of species
- K_a Acid association constant or acidity constant
- K_w Dissociation constant of water

p notation will be restricted to: pK_a for $-\log_{10}K_a$ and **pH** for $-\log_{10}[H_3O^+]$

Chemical Formulae

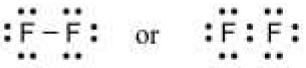
These denote entities composed of more than one atom (molecules, simple and complex ions, groups of atoms, etc).

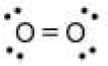
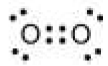
e.g. **Formula**	**Information conveyed**
H_2O	one water molecule or one mole of water
$\frac{1}{2}O_2$	half a mole of oxygen molecules
$Zn_3(PO_4)_2$	one mole of zinc phosphate comprising zinc and phosphate ions in a 3:2 ratio
$2\ MgSO_4$	two moles of magnesium sulfate
$\frac{1}{5}KMnO_4$	one-fifth of a mole of potassium permanganate (manganate VII)

Lewis Structures

These show the arrangement of valence electrons in molecules. Bonding electrons may be represented using

: or –

For F_2  or

For O_2  or 

Equations for Chemical Reactions

$H_2(g)$	+	$Br_2(g)$	→	$2HBr(g)$	forward reaction
$H_2(g)$	+	$Br_2(g)$	⇌	$2HBr(g)$	equilibrium

States of Aggregation

These are written in parentheses printed in *italic* type, immediately after the formula or substance and on the same line as chemical formula symbols.

e.g. ***s*** solid, ***l*** liquid, ***g*** gas or vapour
aq aqueous solution (dissolved in water)
HCl*(g)* hydrogen chloride in the gaseous state

Temperature
Celsius temperature °C

Pressure
Units are pascals (Pa), or more commonly kPa. Standard pressure is 10^5 Pa.

IUPAC Approved Spelling
Spelling of the element with atomic number 16 is the IUPAC recommended spelling of **sulfur**.
Derived ions have consistent spelling: e.g. sulfide, sulfate, sulfite, thiosulfate

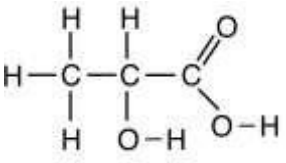
Organic Chemical Formulae *(Information conveyed as an example: lactic acid, $C_3H_6O_3$)*

Empirical formula Stoichiometric proportions of atoms only (simplest ratio formula) CH_2O

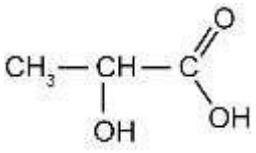
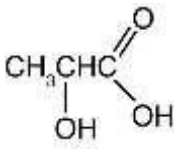
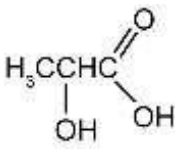
Molecular Formula Formula of the actual molecule $C_3H_6O_3$

Structural formula Shows how atoms are connected in a molecule.
It may be drawn in different ways, as shown below:

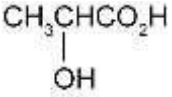
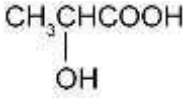
(a) All atoms and bonds are shown:



(b) Bonds to hydrogen are not shown:

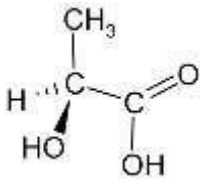

OR

OR


OR only bonds to substituents are shown:


OR


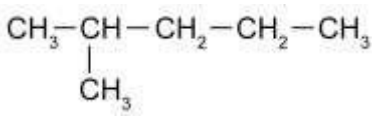
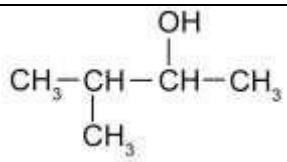
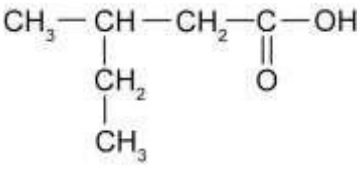
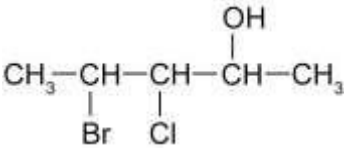
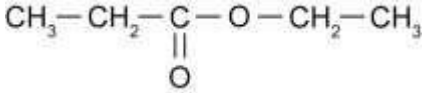
The structural formulae in (b) are referred to as condensed structural formulae.

(c) Stereochemistry (3-D arrangement of atoms) is shown:

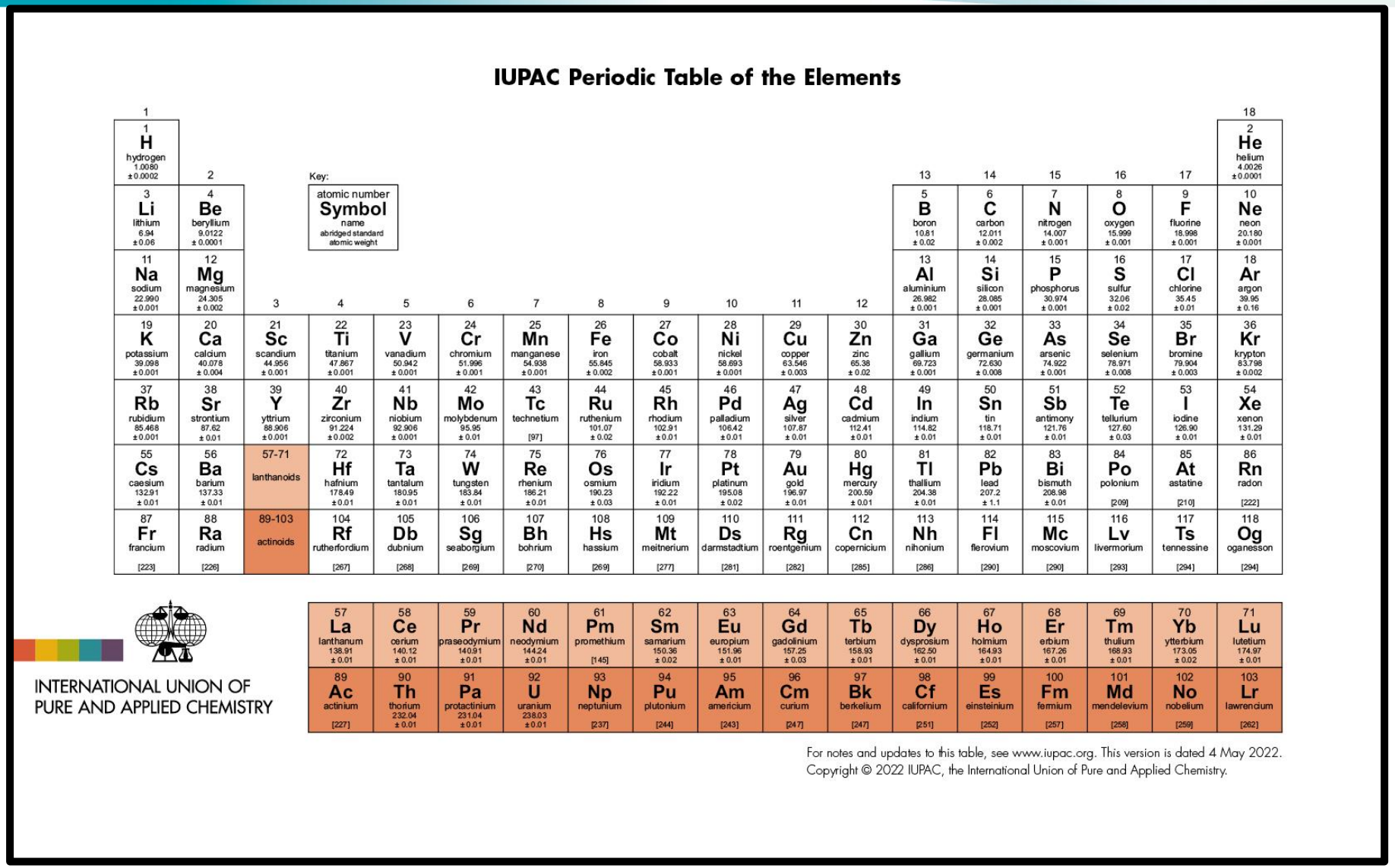


Organic Chemical Nomenclature

IUPAC conventions will be followed. There is ongoing discussion on some of the following naming. Candidates will be given full credit for alternative naming if an unambiguous structure is implied. Some examples are:

Structure	*IUPAC name*
	2−methylpentane
	3-methylbutan−2−ol
	3−methylpentanoic acid
	4−bromo−3−chloropentan−2−ol
	ethyl propanoate

9.2 Appendix 2: Periodic Table



IUPAC Periodic Table of the Elements

1																	18
1 H hydrogen 1.0080 ± 0.0002	2		Key: atomic number **Symbol** name abridged standard atomic weight									13	14	15	16	17	2 He helium 4.0026 ± 0.0001
3 Li lithium 6.94 ± 0.06	4 Be beryllium 9.0122 ± 0.0001											5 B boron 10.81 ± 0.02	6 C carbon 12.011 ± 0.002	7 N nitrogen 14.007 ± 0.001	8 O oxygen 15.999 ± 0.001	9 F fluorine 18.998 ± 0.001	10 Ne neon 20.180 ± 0.001
11 Na sodium 22.990 ± 0.001	12 Mg magnesium 24.305 ± 0.002	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 26.982 ± 0.001	14 Si silicon 28.085 ± 0.001	15 P phosphorus 30.974 ± 0.001	16 S sulfur 32.06 ± 0.02	17 Cl chlorine 35.45 ± 0.01	18 Ar argon 39.95 ± 0.16
19 K potassium 39.098 ± 0.001	20 Ca calcium 40.078 ± 0.004	21 Sc scandium 44.956 ± 0.001	22 Ti titanium 47.867 ± 0.001	23 V vanadium 50.942 ± 0.001	24 Cr chromium 51.996 ± 0.001	25 Mn manganese 54.938 ± 0.001	26 Fe iron 55.845 ± 0.002	27 Co cobalt 58.933 ± 0.001	28 Ni nickel 58.693 ± 0.001	29 Cu copper 63.546 ± 0.003	30 Zn zinc 65.38 ± 0.02	31 Ga gallium 69.723 ± 0.001	32 Ge germanium 72.630 ± 0.008	33 As arsenic 74.922 ± 0.001	34 Se selenium 78.971 ± 0.008	35 Br bromine 79.904 ± 0.003	36 Kr krypton 83.798 ± 0.002
37 Rb rubidium 85.468 ± 0.001	38 Sr strontium 87.62 ± 0.01	39 Y yttrium 88.906 ± 0.001	40 Zr zirconium 91.224 ± 0.002	41 Nb niobium 92.906 ± 0.001	42 Mo molybdenum 95.95 ± 0.01	43 Tc technetium [97]	44 Ru ruthenium 101.07 ± 0.02	45 Rh rhodium 102.91 ± 0.01	46 Pd palladium 106.42 ± 0.01	47 Ag silver 107.87 ± 0.01	48 Cd cadmium 112.41 ± 0.01	49 In indium 114.82 ± 0.01	50 Sn tin 118.71 ± 0.01	51 Sb antimony 121.76 ± 0.01	52 Te tellurium 127.60 ± 0.03	53 I iodine 126.90 ± 0.01	54 Xe xenon 131.29 ± 0.01
55 Cs caesium 132.91 ± 0.01	56 Ba barium 137.33 ± 0.01	57-71 lanthanoids	72 Hf hafnium 178.49 ± 0.01	73 Ta tantalum 180.95 ± 0.01	74 W tungsten 183.84 ± 0.01	75 Re rhenium 186.21 ± 0.01	76 Os osmium 190.23 ± 0.03	77 Ir iridium 192.22 ± 0.01	78 Pt platinum 195.08 ± 0.02	79 Au gold 196.97 ± 0.01	80 Hg mercury 200.59 ± 0.01	81 Tl thallium 204.38 ± 0.01	82 Pb lead 207.2 ± 1.1	83 Bi bismuth 208.98 ± 0.01	84 Po polonium [209]	85 At astatine [210]	86 Rn radon [222]
87 Fr francium [223]	88 Ra radium [226]	89-103 actinoids	104 Rf rutherfordium [267]	105 Db dubnium [268]	106 Sg seaborgium [269]	107 Bh bohrium [270]	108 Hs hassium [269]	109 Mt meitnerium [277]	110 Ds darmstadtium [281]	111 Rg roentgenium [282]	112 Cn copernicium [285]	113 Nh nihonium [286]	114 Fl flerovium [290]	115 Mc moscovium [290]	116 Lv livermorium [293]	117 Ts tennessine [294]	118 Og oganesson [294]

57 La lanthanum 138.91 ± 0.01	58 Ce cerium 140.12 ± 0.01	59 Pr praseodymium 140.91 ± 0.01	60 Nd neodymium 144.24 ± 0.01	61 Pm promethium [145]	62 Sm samarium 150.36 ± 0.02	63 Eu europium 151.96 ± 0.01	64 Gd gadolinium 157.25 ± 0.03	65 Tb terbium 158.93 ± 0.01	66 Dy dysprosium 162.50 ± 0.01	67 Ho holmium 164.93 ± 0.01	68 Er erbium 167.26 ± 0.01	69 Tm thulium 168.93 ± 0.01	70 Yb ytterbium 173.05 ± 0.02	71 Lu lutetium 174.97 ± 0.01
89 Ac actinium [227]	90 Th thorium 232.04 ± 0.01	91 Pa protactinium 231.04 ± 0.01	92 U uranium 238.03 ± 0.01	93 Np neptunium [237]	94 Pu plutonium [244]	95 Am americium [243]	96 Cm curium [247]	97 Bk berkelium [247]	98 Cf californium [251]	99 Es einsteinium [252]	100 Fm fermium [257]	101 Md mendelevium [258]	102 No nobelium [259]	103 Lr lawrencium [262]

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 4 May 2022.

9.3 Appendix 3: IA Summary Form

South Pacific Form Seven Certificate

IA Summary Form 2023

School Logo

CHEMISTRY

COUNTRY	
SCHOOL	

Task	Brief Description of Tasks	Start Date	End Date	Date to EQAP	Weighting
1. Research Project					10%
2. CAT - Practical Skills – Laboratory-Based Assessment					7%
3. CAT - Practical Skills – Written Assessment					13%
TOTAL					**30%**

Note:
1. Be specific about dates, not just Week 3 Term 1, etc.
2. Assessment Schedules/Scoring Rubrics for the tasks will be provided by EQAP. Teachers must use these when scoring students' work.
3. All IA Score Capture Sheets will be provided by EQAP to schools.

Verification and Endorsement of IA Program

Principal's Name	Teachers Name	School Stamp
Signature	Signature	
Date	Date	

A full IA program is to be submitted together with this IA Summary Form.

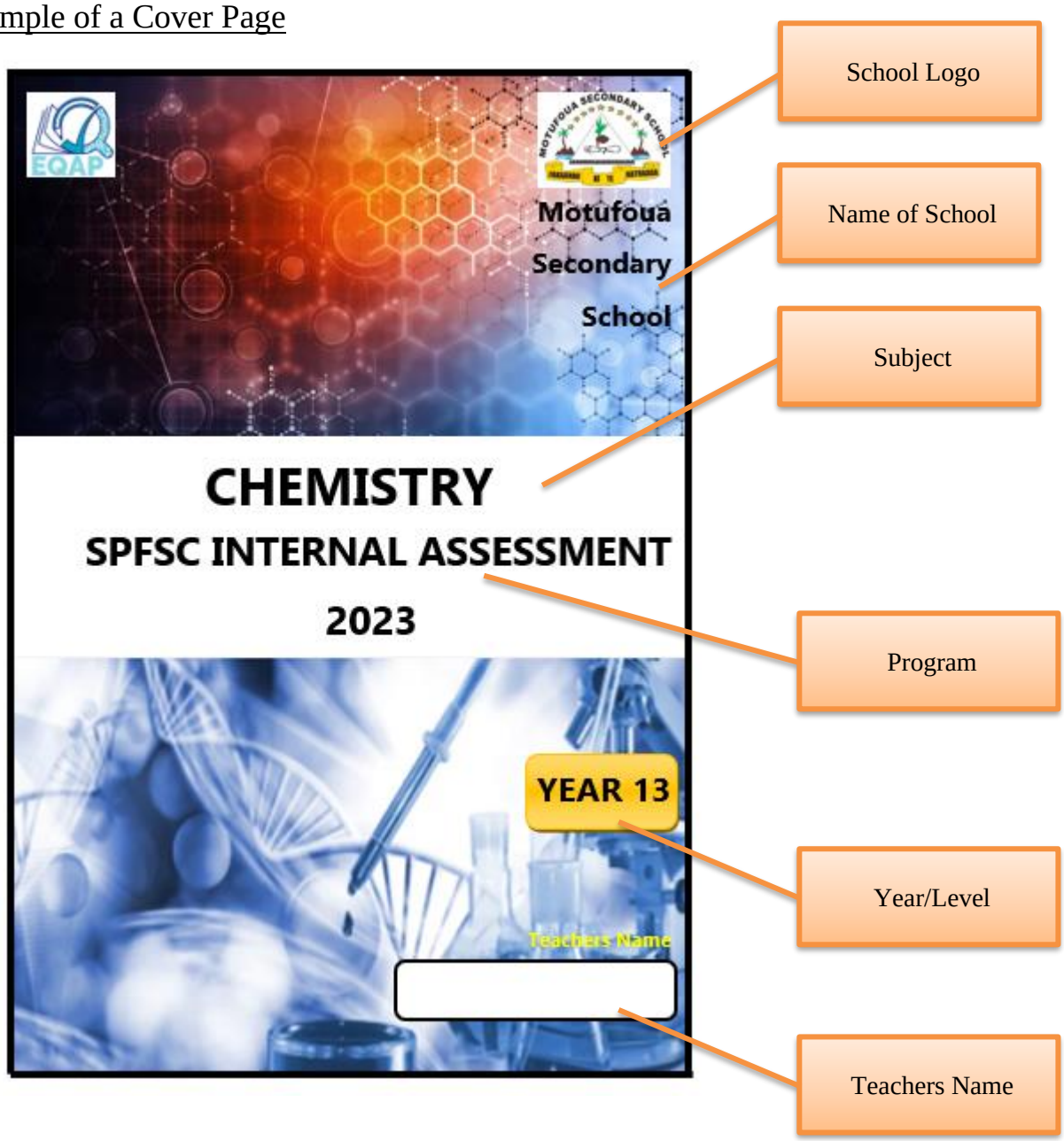
9.4 Appendix 4: IA Program Proposal Template

Page 1 : Cover Page

The Cover Page will have the name of the:

- School
- Subject : FULL IA PROGRAM
- Teachers Name:

An Example of a Cover Page



Page 2: **INSERT IA SUMMARY FORM HERE**

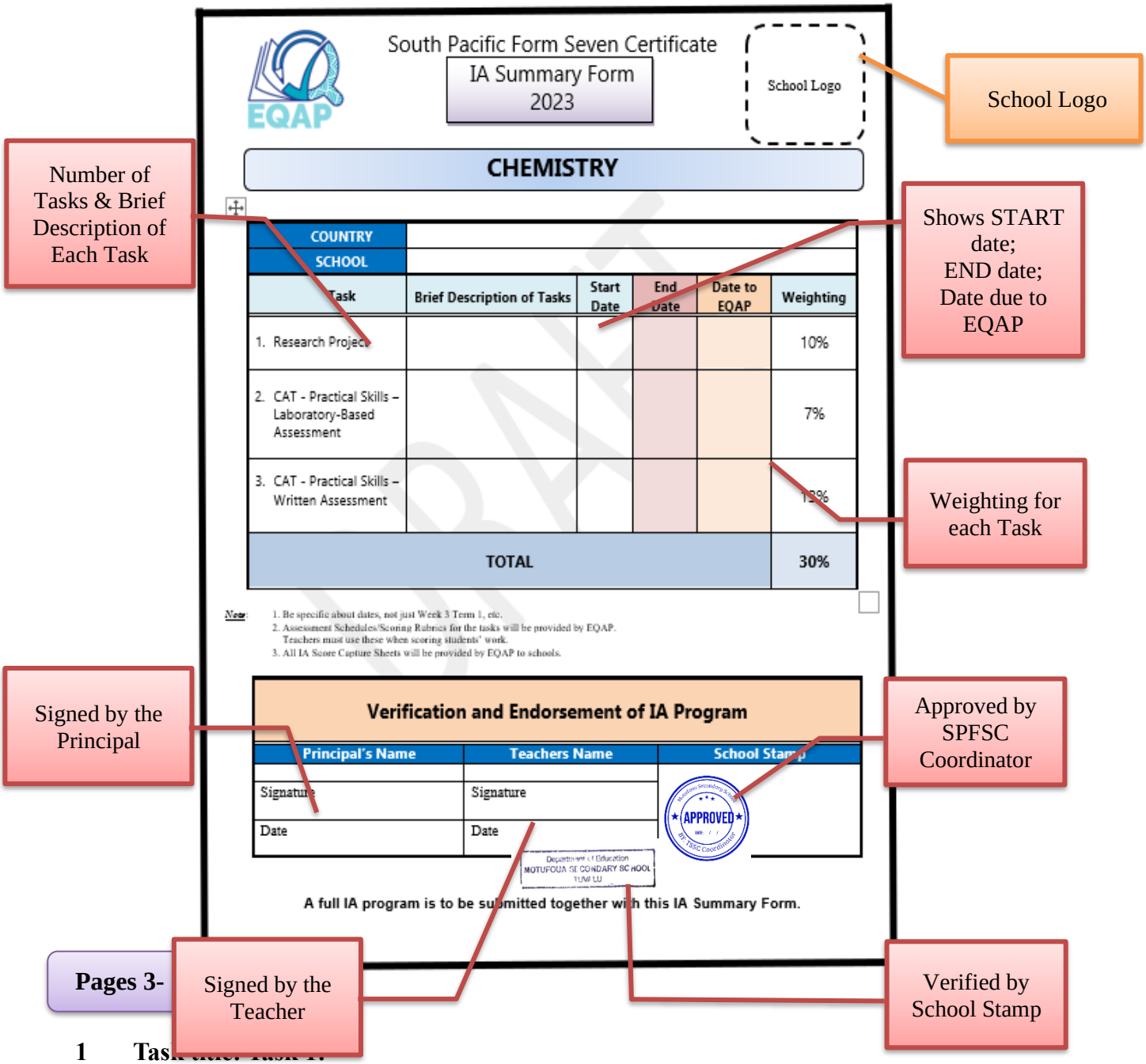
The IA Summary Form must have the following:

- Number of Tasks
- Brief Description of the Tasks

- Start and End Dates
- Signature of Principal and Teacher
- School Stamp/Date

(To be completed, signed by both the teacher and the School Principal of his/her Nominee/school stamped/scan/insert)

An Example of an IA Summary Form



School Logo

Number of Tasks & Brief Description of Each Task

Shows START date; END date; Date due to EQAP

Weighting for each Task

Signed by the Principal

Approved by SPFSC Coordinator

Signed by the Teacher

Verified by School Stamp

The title should be brief and include a reference to the particular syllabus topic or skill which is being assessed by the task.

Example: *"Research Topic – Investigation of a Social Issue."*

2 Learning Outcomes: List the Specific Learning Outcomes (SLOs) to be assessed by the task

These are found in the syllabus and need to be identified before the tasks are constructed.

Example: *Describe a feature of ….*

(Copy and paste directly from the aligned Syllabus: it must show strand, sub strand and SLOs)

3. Assessment/Task:

Describe the task as a form of assessment to measure student achievements of the above learning outcomes at different stages of the lesson/task implementation.

(Think of what the best types of assessment for the above LOs are so that your students can demonstrate they have achieved the learning outcomes. Also include how you will pre-assess their knowledge at the beginning of the lesson and how you will continuously assess them throughout the strand/topic to monitor their learning progress. The summative assessments are the final IA tasks.)

e.g. Diagnostic: *(can be oral questions/short tests/ surveys/questionnaires to find out what students already know before the lesson)*

Formative: 1. This is the formative use of the summative assessment such as the drafts submitted, self-assessment, peer assessment, teacher assessment of the drafts and specific feedback provided to improve the task. 2. For CATs – this can be similar items prepared by teachers using the SLOs and given to students for practice. After scoring, the feedback needs to be given to improve learning. If majority students not doing well then re-teach using another strategy, assess and monitor learning.

Summative: (these are the final IA tasks or the CATs to measure how much the students have learnt/achieved after the learning period)

4 Resources: List materials required for completing the task (for learning & demonstrating the achievement for the SLOs.

This must specify any material items such as books, documents, maps, stimulus material, equipment required by the task, including use of technology.

5 Guidelines for the teacher on advance preparation requirements

a) **time required** by the student for task completion (monitoring progress)
b) recommended dates/date range for task completion
c) organization of room and hardware to facilitate task completion (learning assessment).

(After the task has been completed and scored, teachers will need an IA score capture sheet to record the performance of all students in the class.)

6 Guidelines for the teacher on task completion and task control

This must specify:

- the role of the teacher during the period of task completion
- instructions that are to be given by the teacher to the students
- actions that are required of the teacher during task completion

7 Preparation by the students beforehand

If students are required to prepare in advance of the task date, preparatory notes must indicate the requirements. For example, students may need to collect support materials for a task that is supervised in a classroom.

8 Task outline for the student

This outline is a brief description of the task that the student is to complete. It is a general description without specific detail.

Example: *Your task is to focus on an important social issue. After investigating that issue, you need to process information collected and suggest possible courses of action that authorities could take.*

9 Task detail for the student

This must provide a detailed description of the task in the sequence that the student would be expected to follow during task completion. This must clearly state:

- what the student is expected to do
- what the student is expected to record and present for assessment.

10. Feedback & Support

Allocate time for:

i. Student's self-assessment and correction
ii. Peer assessment, feedback, and time for improvement
iii. Teacher assessment, feedback, and time for time improvement

(NB: State how this will be carried out)

11. Final submission & scoring

State when the final task is due and how it will be assessed. State how the school (HOD/SPFSC Coordinator) will monitor the scoring of the tasks.

12 Scoring Rubric

Copy and paste directly from the aligned Syllabus the relevant scoring rubrics.

13 Assessment score capture sheet for the task

This will be provided by EQAP.

(Repeat 1-13 for other tasks)

SOUTH PACIFIC FORM SEVEN CERTIFICATE CHEMISTRY IA SCORE CAPTURE FORM

(Task 1: Chemistry in the Society)

The IA score capture form will be provided from EQAP. The IA scores will be captured electronically on to EXCEL sheets and the Excel sheets returned to EQAP.

SOUTH PACIFIC FORM SEVEN CERTIFICATE CHEMISTRY IA SCORE CAPTURE FORM

(Task 2: Practical Skills - Laboratory-based Assessment)

The IA score capture form will be provided from EQAP. The IA scores will be captured electronically on to EXCEL sheets and the Excel sheets returned to EQAP.

SOUTH PACIFIC FORM SEVEN CERTIFICATE CHEMISTRY IA SCORE CAPTURE FORM

(Task 3: Practical Skills - Written Assessment)

The IA score capture form will be provided from EQAP. The IA scores will be captured electronically on to EXCEL sheets and the Excel sheets returned to EQAP.

9.5 Appendix 5: Advisory Section: Timeline for Form 7 Chemistry

Week	**Term 1**	**Term 2**	**Term 3**
1	Jan 26 – 30 Staff/student planning & orientation	May 18 Thermochemistry and Chemistry in the Society	Oct 5 Organic chemistry
2	Feb 2 – 6		
3	Feb 9 Atomic structure, bonding and related properties	June 5	
4		June 8	
5		Practical Skills - Laboratory-Based Assessment (IA)	
6		June 26	Oct 12
7		Mid-Year Exam	Practical Skills - Written Assessment (IA)
8		Mid-Year Exam	End of Year Exam
9		July 13 Aqueous Equilibrium	
10	Oxidation – reduction processes		
11			Oct 26 **SPFSC Exams**
12		Aug 7	
13	Chemistry in the Society (IA)	Aug 10	
14		Aug 17	
	Term Break		

9.6 Appendix 6: Chemistry References and Resources

Textbooks, Workbooks and Laboratory Manuals:

1. NCEA Level 3 Chemistry - Barnes-Graham, Boniface and Giffney - ESA Publications
2. Year 13 Chemistry Student Notes - Anne Wignall and Terry Wales - Pearson Education New Zealand
3. Year 13 Chemistry - Practical Workbook – ABA Books
4. Core Practicals for Year 13 - Howarth, Rendel and Wooff – Longman
5. OpenStax College Chemistry (http://cnx.org/content/col26069/1.5)
6. South Pacific Form Seven Certificate – Chemistry Laboratory Manual
7. South Pacific Form Seven Certificate – Chemistry Study Guide

Other useful references:

1. Chemistry - A Senior Course - Woof, Howarth, Oughton and Rendle
2. Year 13 Chemistry - Croucher – Pathfinder Series
3. Khan Academy | Free Online Courses, Lessons & Practice (https://www.khanacademy.org)
4. Chemguide: helping you to understand Chemistry (https://www.chemguide.co.uk/)
5. LibreTexts - Free The Textbook (https://chem.libretexts.org/)
6. Chemistry - BBC Bitesize (https://www.bbc.co.uk/bitesize/subjects/zmf3cdm)