EDUCATIONAL QUALITY AND ASSESSMENT PROGRAMME [EQAP]

SOUTH PACIFIC FORM SEVEN CERTIFICATE [SPFSC]

CHEMISTRY

PRESCRIPTION

GENERAL INFORMATION

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CHEMISTRY

Contents

1. Preamble and Rationale

This prescription defines the requirements for the South Pacific Form Seven Certificate Chemistry examination.

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

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 prescription. Prior knowledge required for each learning objective in this prescription has been included.

This prescription is derived from a revision of the South Pacific Board for Educational Assessment (SPBEA) prescription 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. 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 behaviours 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.

Study in 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
- realise 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. 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. 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. Content Components

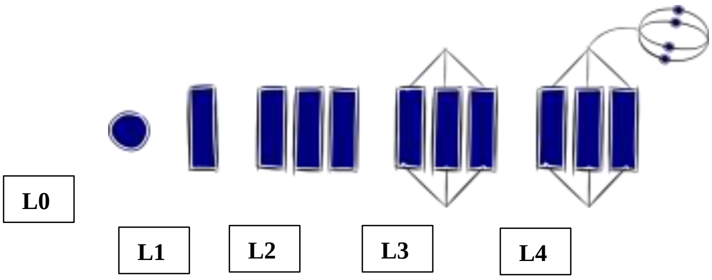
The content of the SPFSC Chemistry course is organised under five strands and a number of sub-strands under each strand. These are outlined below:

Strand Number	Strand Title	Sub strand number	Sub-strand title
1.	Atomic Structure, Bonding and Related Properties	1.1	Atomic Structure and Bonding
		1.2	Nuclear Chemistry
		1.3	Transition Metals
2.	Energy Changes in Chemical and Physical properties	2.1	Thermo-chemical principles and Enthalpy Change
		2.3	Chemistry in the Society
3.	Aqueous Equilibrium systems	3.1	Equilibrium principles
		3.2	Acids And Bases
		3.3	Solubility
4.	Oxidation-Reduction reactions	4.1	Electrochemical cells
5.	Organic Chemistry	5.1	Isomerism and Polymers
		5.2	Reactions
		5.3	Chemistry Problem Solving

6. Unpacking Learning Outcomes

In this prescription, 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 categorisation 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 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 **extended 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, generalisation, 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:

- **define** – to state a basic definition of a concept [Unistructural or L1]
- **describe** – to give the characteristics of, or give an account of, or provide annotated diagrams. [Multistructural or L2]
- **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 L3]
- **discuss** – this means *linking ideas* (descriptions, explanations) to make generalisations or predictions or evaluations. It may involve relating, comparing, analysing, and justifying.

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

7. Learning Outcomes

Strand 1: Atomic Structure, Bonding and Related Properties

Major Learning Outcome

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

Prerequisite:

Students are expected to have knowledge of:

- Basic atomic structure (electron configuration, isotopes, ions) and covalent bond formation.
- Lewis structures and shapes of molecules (up to 4 electron pairs around the central atom)
- Metallic, ionic and covalent bonding and weak intermolecular forces of attraction.
- Complex ions used in inorganic analysis

Sub-strand 1.1 Atomic structure and Bonding

Key Learning Outcome: Students are able to demonstrate understanding of atomic structure and bonding and how these determine intermolecular forces

- write the ground state electron configurations using *s, p* and *d* notation of the first 36 atoms and their monoatomic ions
- relate periodic trends - atomic and ionic radii, 1^{st} ionisation enthalpy and electronegativity - to electron configuration
- draw Lewis structures (up to 6 electron pairs about the central atom, including multiple-bonded species) and determine the shape of simple molecules and polyatomic ions (up to 6 electron pairs)
- determine polarity of simple molecules
- determine the relationship between the polarity of molecules and related intermolecular forces of attraction including instantaneous and permanent dipoles and hydrogen bonding

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**define** electron configuration / monoatomic ion / polarity	1	Che1.1.1.1
2	**write** the ground state electron configurations **using** *s*, *p* and *d* notation of atoms and their monoatomic ions	1	Che1.1.1.2
3	**write** the ground state electron configurations **using** *s*, *p* and *d* notation of atoms and their monoatomic ions	2	Che1.1.2.1
4	**describe** periodic trends in terms of atomic and ionic radii	2	Che1.1.2.2
5	**describe** periodic trends in terms of 1^{st} ionisation enthalpy and electronegativity	2	Che1.1.2.3
6	**describe** periodic trends in terms of electron configuration	2	Che1.1.2.4
7	**explain how** periodic trends - atomic and ionic radii, 1st ionisation enthalpy and electronegativity relate to electron configuration	3	Che1.1.3.1
8	**relate** properties transition metals to their electronic structure.	3	Che1.1.3.2
9	**draw** Lewis structures (up to 6 electron pairs about the central atom, including multiple-bonded species)	3	Che1.1.3.3

10	**identify / state** the shape of a molecule, within a given problem	1	Che1.1.1.3
11	**describe** the shape of simple molecules and polyatomic ions	2	Che1.1.2.5
12	**explain** the shape of simple molecules and polyatomic ions (up to 6 electron pairs) in terms of their electronic structure	3	Che1.1.3.4
13	**determine** the shape of simple molecules and polyatomic ions (up to 6 electron pairs)	2	Che1.1.2.6
14	**explain** how shapes of molecules are determined	3	Che1.1.3.9
15	**describe/determine** the polarity of simple molecules	2	Che1.1.2.7
16	**explain** the polarity of simple molecules in terms of properties that influence this polarity	3	Che1.1.3.5
17	**describe** the polarity of simple molecules	2	Che1.1.2.8
18	**describe** the polarity of covalent bonds	2	Che1.1.2.9
19	**relate** the polarity of covalent bonds to properties that influence it	3	Che1.1.3.6
20	**identify** the intermolecular forces between given molecules in a given diagram/situation	1	Che1.1.1.4
21	**describe** the intermolecular forces between given molecules	2	Che1.1.2.10
22	**describe** the relative strength of intermolecular forces including instantaneous and permanent dipoles and hydrogen bonding linked to melting and boiling points	2	Che1.1.2.11
23	**explain** the relative strength of intermolecular forces including instantaneous and permanent dipoles and hydrogen bonding linked to melting and boiling points	3	Che1.1.3.7
24	**discuss** the relationship between the polarity of molecules and related intermolecular forces of attraction including instantaneous and permanent dipoles and hydrogen bonding and relate to melting and boiling points of molecular compounds	4	Che1.1.4.1

Sub-strand 1.2 Nuclear Chemistry

Key learning Outcome: Students are able to demonstrate understanding of basic ideas of nuclear chemistry

- describe nuclear transformations resulting in alpha, beta and gamma emission using nuclear equations.
- differentiate between fission and fusion reactions
- use radioactive data to carry out calculations involving simple quantitative treatment of half life
- link the properties of radioactive particles with the way they are used

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**define** fission / fusion reactions	1	Che1.2.1.1
2	**identify/state** a feature or example of fission / fusion reactions in a given context	1	Che1.2.1.2
3	**describe** nuclear transformations resulting in alpha, beta and gamma emission using nuclear equations.	2	Che1.2.2.1
	explain how nuclear transformations results in alpha, beta and gamma emission using nuclear equations.	3	Che1.2.3.1
4	**identify/state** a feature or example of alpha / beta / gamma emissions in a given context	1	Che1.2.1.3
5	**describe** properties of alpha / beta / gamma emissions	2	Che1.2.2.2

6	**differentiate** between fission and fusion reactions	3	Che1.2.3.2
7	**use** radioactive data to carry out calculations involving simple quantitative treatment of half life	3	Che1.2.3.3
8	**describe** the properties of radioactive particles	2	Che1.2.2.3
9	**link** the properties of radioactive particles with the way they are used	3	Che1.2.3.4
10	**discuss** the nature and impact of the use of nuclear chemistry an everyday applications evaluating the positive and negative effects of this application	4	Che1.2.4.1

Sub-strand 1.3 Transition Metals

Key learning Outcome: Students are able to demonstrate understanding of properties and reactions of transition metals

- describe the characteristic properties (variable oxidation state, colour and formation of complex ions) of transition metals
- relate properties of transition metals to their electronic structure.
- name the following complex ions and write chemical equations for their formation: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**Identify/Name** transition metals	1	Che1.3.1.1
2	**list** the characteristic properties of transition metals (variable oxidation state, colour and formation of complex ions)	2	Che1.3.2.1
3	**list** the factors that contribute to the properties of transition metals	2	Che1.3.2.2
4	**explain** how these factors influence the characteristic properties (variable oxidation state, colour and formation of complex ions) of transition metals	3	Che1.3.3.1
5	**identify/name** the following complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$	1	Che1.3.1.2
6	**identify/name** the following complex ions: - restricted to $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$	1	Che1.3.1.3
7	**identify/name** the following complex ions: - restricted to $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	1	Che1.3.1.4
8	**write** chemical equations and observations for the formation of complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$	2	Che1.3.2.3
9	**write** chemical equations and observations for the formation of complex ions: - restricted to $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$	2	Che1.3.2.4
10	**write** chemical equations and observations for the formation of complex ions: - restricted to $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	2	Che1.3.2.5
11	**describe** observations for the formation of complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$	2	Che1.3.2.6
12	**describe** observations for the formation of complex ions: - restricted to $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$	2	Che1.3.2.7
13	**describe** observations for the formation of complex ions: - restricted to $^+$, $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	2	Che1.3.2.8
14	**relate** chemical equations and observations for the formation of complex ions: - restricted to $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^+$	3	Che1.3.3.2
15	**relate** chemical equations and observations for the formation of complex ions: - restricted to $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$	3	Che1.3.3.3
16	**relate** chemical equations and observations for the formation of complex ions: - restricted to $[Zn(OH)_4]^{2-}$ and $[FeSCN]^{2+}$	3	Che1.3.3.4

Strand 2: Energy Changes in Chemical and Physical Processes

Major Learning Outcome 2 Students are able to demonstrate understanding of chemical principles by using thermochemical data to determine energy changes involved in chemical and physical processes.

Sub-strand 2.1 Thermo-chemical principles and Enthalpy Change

Key learning Outcome: Students are able to demonstrate understanding of thermo-chemical principles

- differentiate between endothermic and exothermic reactions related to bond making and bond breaking processes.
- define the following terms; $\Delta_f H°$, $\Delta_c H°$, $\Delta_r H°$, $\Delta_{vap} H°$ and $\Delta_{fus} H°$ including writing thermochemical equations
- calculate enthalpy change in systems involving either chemical change or phases changes using the following:

  $\Delta_r H° = \Sigma\ \Delta_f H°$ (products) - $\Sigma\ \Delta_f H°$ (reactants). ○ Hess's Law.
  Average bond enthalpies (energies)
- Use specific heat capacity

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**define** Ionisation Enthalpy	1	Che2.1.1.1
2	**identify** ionisation enthalpy in a given context	1	Che2.1.1.2
3	**describe** endothermic and exothermic reactions	2	Che2.1.2.1
4	Describe the process of energy release during bond making and/or bond breaking.	2	Che2.1.2.2
5	**explain** how endothermic reactions relate to bond making and bond breaking processes.	3	Che2.1.3.5
6	**explain** how exothermic reactions relate to bond making and bond breaking processes.	3	Che2.1.3.1
7	**define/name** the following enthalpy changes; $\Delta_f H°$, $\Delta_c H°$, $\Delta_r H°$, $\Delta_{vap} H°$ and $\Delta_{fus} H°$	1	Che2.1.1.3
8	**describe** the features of the following enthalpy changes; $\Delta_f H°$, $\Delta_c H°$, $\Delta_r H°$, $\Delta_{vap} H°$ and $\Delta_{fus} H°$	2	Che2.1.2.3
9	**write** thermochemical equations of simpler reactions	2	Che2.1.2.4
10	**write** thermochemical equations of a more complex nature	3	Che2.1.3.2
11	**calculate** enthalpy change in simpler systems involving either chemical change or phases changes using the following: o $\Delta rH° = \Sigma\ \Delta fH°$ (products) - $\Sigma\ \Delta fH°$ (reactants). o Hess's Law. o Average bond enthalpies (energies)	3	Che2.1.3.3
12	**calculate** enthalpy change in complex systems involving either chemical change or phases changes using the following: o $\Delta rH° = \Sigma\ \Delta fH°$ (products) - $\Sigma\ \Delta fH°$ (reactants). o Hess's Law. o Average bond enthalpies (energies)	4	Che2.1.4.1

13	**use** specific heat capacity to calculate enthalpy changes in simple chemical reactions	2	Che2.1.2.5
14	**use** specific heat capacity to calculate enthalpy changes in complex chemical reactions	3	Che2.1.3.4

Sub-strand 2.2: Chemistry in the Society

(for Internal Assessment Task 1)

Key Learning Outcome: Demonstrate understanding of chemical principles by presenting an account of how chemistry explains aspects of the natural world or is used in society to meet needs, resolve issues, and develop new technologies.

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**name/identify** chemical product that are used in the community	1	Che2.2.1.1
2	**create** an account of the historical development or discovery of the chemical product or process as well as its current use	4	Che2.2.4.1
3	**outline** the chemical principles involved in the use of a chemical product and/or the historical development of a chemical product	2	Che2.2.2.1
4	**describe** the stages of the chemical process involved in the use of a chemical process and/or the historical development of a chemical process	2	Che2.2.2.2
5	**link** the use of a chemical product in the community or the natural world to the related chemical principles	3	Che2.2.3.1
6	**evaluate** issues related to the production or development and/or use of the chemical product or process	4	Che2.2.4.2
7	**describe** sources from which **i**nformation was gathered	2	Che2.2.2.3
8	**tabulate** data relating to the use of chemical product and/or process	2	Che2.2.2.4
9	**Interpret** tabulated data	3	Che2.2.3.2
10	**use** referencing to acknowledge sources of information	2	Che2.2.2.5
11	**organise** report coherently	2	Che2.2.2.6
12	**use** appropriate chemistry language, symbols and equations in the report	2	Che2.2.2.7
13	**Discuss** the impact of the use of the chemical product and processes on the environment and predict the consequences of current trends in usage	4	Che2.2.4.3

Strand 3: Aqueous Equilibrium Systems

Major Learning Outcome 3

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

Prerequisite:

Students will be expected to have knowledge of:

- Equilibrium reactions, equilibrium constants, Le Chateliers' principle
- Acids as proton donors, bases as proton acceptors, pH calculations (strong and weak acids and bases), pK_w, pH scale,

Sub-strand 3.1 Equilibrium principles, Acids and Bases

Key Learning Outcome: Students are able to demonstrate understanding of equilibrium principles and properties and reactions of acids and bases.

- relate equilibrium constants to the position of an equilibrium
- discuss factors which change equilibrium position
- carry out simple calculations of equilibrium concentrations using equilibrium constant expressions
- calculate pH for monoprotic acids, bases, salts and buffers (solutions in which the we assume that [HA] = c_{HA})
- determine the relative equilibrium concentration of dissolved species related to Ka, pH or pKa
- describe the action of buffer solutions related to the composition of the buffer (acid and conjugate base), including equations for reaction with added acid or base
- discuss / compare 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.
- Titration curves as a context for calculations, understanding of changing pH as nature of species in solution changes, choice of indicators for titrations. (IA)

SLO#	**Specific Learning Outcomes:** *Students are able to*	**Skill level**	**SLO code**
1	**identify** equilibrium constants for a given position of an equilibrium	1	Che3.1.1.1
2	**list** factors which change equilibrium position	2	Che3.1.2.1
3	**explain** how a factor changes the equilibrium position	3	Che3.1.3.1
4	**carry** out simple calculations of equilibrium concentrations using equilibrium constant expressions	2	Che3.1.2.2
5	**carry** out more calculations of equilibrium concentrations using equilibrium constant expressions	3	Che3.1.3.2
6	**identify/name** a monoprotic acid	1	Che3.1.1.2
7	**calculate** pH for monoprotic acids, bases, salts and buffers (solutions in which the we assume that [HA] = c_{HA}) within a simpler reaction	2	Che3.1.2.3
8	**calculate** pH for monoprotic acids, bases, salts and buffers (solutions in which the we assume that [HA] = c_{HA}) within a more complex reaction	3	Che3.1.3.3
9	**determine** the relative equilibrium concentration of dissolved species related to Ka, pH or pKa in a simple situation	2	Che3.1.2.4
10	**determine** the relative equilibrium concentration of dissolved species related to Ka, pH or pKa in a more complex situation	3	Che3.1.3.4
11	**define** 'buffer solution'	1	Che3.1.1.3
12	**identify/state** a feature or example of a buffer solution within a given context	1	Che3.1.1.4
13	**describe** the actions of buffer solutions in a reaction	2	Che3.1.2.5
14	**explain** the action of buffer solutions related to the composition of the buffer, including equations for reaction with added acid or base	3	Che3.1.3.5
15	**describe** the pH and conductance (strength of electrolytes) of weak/strong acid/base solutions	2	Che3.1.2.6
16	**explain** the link between pH and conductance (strength of electrolytes) of weak/strong acid/base solutions with relative concentration and nature of species in solution	3	Che3.1.3.6

17	**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	Che3.1.4.1

Sub-strand 3.2 Solubility

Key Learning Outcomes: Students are able to demonstrate understanding of solubility and how solubility is affected by certain factors

a. calculate solubility of salts of the type AB_2, A_2B and AB in water and in solutions containing either ion A or ion B.
b. discuss / compare of solubility with changing conditions e.g. pH or common ion or complex ion formation
c. determine whether precipitation will occur with mixtures of solutions (compare K_s with Q)

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**define** solubility / common ion effect / complex ion effect	1	Che3.2.1.1
2	**state** Le Chaterlier's principle on solvents at equilibrium	1	Che3.2.1.2
3	**list** factors that affect solubility	2	Che3.2.2.1
4	**use** Le Chaterlier's principle to explain the common ion effect, using an example	3	Che3.2.3.1
5	**calculate** solubility of salts of the type AB_2, A_2B and AB in water	2	Che3.2.2.2
6	**explain** how temperature affects solubility in an exothermic or endothermic reaction	3	Che3.2.3.2
7	**explain** how pressure affects solubility of gases using a combination of Henry's law and Le Chaterlier's principle	3	Che3.2.3.3
8	**calculate** solubility of salts of the type AB_2, A_2B and AB in solutions containing either ion A or ion B.	2	Che3.2.2.3
9	**compare** the solubility with changing conditions e.g. pH or common ion or complex ion formation	3	Che3.2.3.4
10	**discuss** the relevance of solubility with changing conditions e.g. pH or common ion or complex ion formation in real life applications	4	Che3.2.4.1
11	**determine** whether precipitation will occur with simple mixtures of solutions (compare K_s with Q)	2	Che3.2.2.4
12	**determine** whether precipitation will occur with complex mixtures of solutions (compare K_s with Q)	2	Che3.2.2.5

Strand 4: Oxidation – Reduction Reactions

Major Learning Outcome 4

Students are able to demonstrate understanding of chemical principles by applying oxidation-reduction principles to electrochemical cells and using the concept of electromotive force to compare the relative strength of oxidants and reductants and to deduce the direction of spontaneous reactions.

Prerequisite:

Students will be expected to have knowledge of:

- oxidation numbers (state) used to determine redox processes and to identify oxidants and reductants
- oxidation and reduction processes as transfer of electrons

- ion-electron method for balancing half-equations and balanced overall equations for redox reactions (including acidic conditions)
- observable changes that take place when common oxidants and reductants are used e.g.
    - oxidants: O_2, Cl_2, dilute acids (H^+), Br_2, H_2O_2, MnO_4^-, $Cr_2O_7^{2-}$, Cu^{2+}, Fe^{3+}, I_2.
    - reductants: Zn, Mg, Fe and Cu metals, C, CO, SO_2, Fe^{2+}, SO_3^{2-}, Cl^-, I

Sub-strand 4.1: Electrochemical Cells

Key Learning Outcome: Students are able to demonstrate understanding of electrochemical cells

- describe electrochemical (galvanic) cells in terms of electrodes (anode and cathode), electrolytes (anions and cations), a salt bridge, half-cells, redox couples, hald cell reactions and an overall equation
- represent electrochemical cells using the IUPAC notation.
- calculate E^o for an electrochemical cell and use this to determine the spontaneity of a given redox reaction
- use E^o_{cell} values to compare strength of oxidants and reductants (including halogens (group 17) elements).
- describe the differences between an electrochemical cell and an electrolytic cell
- apply principles of electrochemistry to explain the operation of some commercial 'batteries' (dry cell and lead acid batteries)

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**define** galvanic (or voltaic) cell / anions / cations	1	Che4.1.1.1
2	**identify/state** a feature or example of galvanic (or voltaic) cell / anions / cations	1	Che4.1.1.2
3	**describe** how electrochemical (galvanic) cells works	2	Che4.1.2.1
4	**explain** electrochemical (galvanic) cells in terms of electrodes (anode and cathode), electrolytes (anions and cations), a salt bridge, half-cells, redox couples, half-cell reactions and an overall equations	3	Che4.1.3.1
5	**compare** electrochemical (galvanic) cells in terms of electrodes (anode and cathode), electrolytes (anions and cations), a salt bridge, half-cells, redox couples, half-cell reactions and an overall equations	3	Che4.1.3.2
6	**represent** electrochemical cells using the IUPAC notation.	2	Che4.1.2.2
7	**outline** the features of oxidation-reduction reactions	2	Che4.1.2.3
8	**calculate** E^o for an electrochemical cell or use E^o to **determine** the spontaneity of a given redox reaction	3	Che4.1.3.3
9	**use** E^o_{cell} values to **compare** strength of oxidants and reductants (including halogens (group 17) elements).	3	Che4.1.3.4
10	**describe** the differences between an electrochemical cell and an electrolytic cell	2	Che4.1.2.4
11	use principles of electrochemistry to **discuss** the applications of some commercial 'batteries' (dry cell and lead acid batteries) in industries	4	Che4.1.4.1

Strand 5: Organic Chemistry

Major Learning Outcome 5

Students are able to demonstrate understanding of chemical principles by using information about the structure and reactions of organic molecules to solve problems in organic chemistry

Prerequisites

Students will be expected to have knowledge of:

- the following terms: organic compound, hydrocarbon, saturated, unsaturated, alkyl group, homologous series, functional group.
- structure and reaction of organic compounds containing the following functional groups: alkenes, alkynes, alcohols (alkanols), alkyl halides (haloalkanes), carboxylic acids, esters, and alkanes.
- IUPAC rules for naming organic molecules containing up to six carbon atoms and the functional groups above.
- isomerism including structural and geometric (*cis-trans*) for organic molecules containing up to six carbon atoms and the functional groups listed above.

Sub-strand 5.1 Isomerism and Polymers

Key Learning Outcome: Students are able to demonstrate understanding of structures, isomerism and polymers

Structure, isomerism and polymers

- structure and isomerism of organic molecules containing the functional groups: alcohols, aldehyde, ketone, ester, carboxylic acid, acyl chloride, primary amide, amine, haloalkane
- Use IUPAC rules for naming isomers containing the functional groups above with up to 8 carbons
- describe formation of condensation polymers containing ester and amide functional groups (including proteins from amino acids)
- relate the properties of polymers to their structure and bonding

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**define** isomerism / polymers / constitutional isomers / stereo isomers / enantiomer	1	Che5.1.1.1
2	**list** the subgroups of constitutional isomers	2	Che5.1.2.1
3	**describe** the structure of each subgroup	2	Che5.1.2.2
4	**list** the subgroups of stereoisomers	2	Che5.1.2.3
5	**describe** the structure of each subgroup	2	Che5.1.2.4
6	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: alcohols	3	Che5.1.3.1
7	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: aldehyde	3	Che5.1.3.2
8	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: ketone	3	Che5.1.3.3

9	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: ester	3	Che5.1.3.4
10	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: carboxylic acid	3	Che5.1.3.5
11	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: acyl chloride	3	Che5.1.3.6
12	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: primary amide	3	Che5.1.3.7
13	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: amine	3	Che5.1.3.8
14	**describe** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: haloalkane	3	Che5.1.3.9
15	**compare and contrast** the structure and isomerism [constitutional and stereoisomers] of organic molecules containing the functional groups: alcohols, aldehyde, ketone, ester, carboxylic acid, acyl chloride, primary amide, amine, haloalkane	3	Che5.1.3.10
16	**use** IUPAC rules for naming isomers containing the functional groups with up to 4 carbons	2	Che5.1.2.5
17	**use** IUPAC rules for naming isomers containing the functional groups with 4 – 8 carbons	3	Che5.1.3.11
18	**outline the** formation of condensation polymers containing ester and amide functional groups (including proteins from amino acids)	2	Che5.1.2.6
19	**define** condensation polymers / addition polymers	1	Che5.1.1.2
20	**identify/state** a feature of example of condensation polymers / addition polymers in a given context	1	Che5.1.1.3
21	**compare** condensation polymers with addition polymers	3	Che5.1.3.12
22	**explain** the relationships between stages in the formation of condensation polymers containing ester and amide functional groups (including proteins from amino acids)	3	Che5.1.3.13
23	**describe** the properties of polymers	2	Che5.1.2.7
24	**relate** the properties of polymers to their structure and bonding	3	Che5.1.3.14
25	**integrate** information about structure and reactions to determine the identity of unknown molecules	3	Che5.1.3.15
26	**discuss** the importance of isomerism, especially enantiomers, in the way they are applied to everyday situations giving examples	4	Che5.1.4.1

Sub-strand 5.2: Reactions

Key Learning Outcome: Students are able to demonstrate understanding of reactions of hydrocarbons and factors that affect these reactions

- alcohols - oxidation with $Cr_2O_7^{2-}/H^+$ or MnO_4^-/H^+
    - substitution with PCl_3, PCl_5, $SOCl_2$ or HCl
    - elimination with concentrated sulfuric acid
- haloalkane - substitution and elimination reactions with OH^-
- amines - reactions as bases, substation reactions with acid chlorides
- aldehydes - oxidation of aldehydes with Fehlings (Benedicts) and Tollens' reagent aldehydes and ketones - reduction by $LiAlH_4$
- carboxylic acids - substitution to form esters and acyl chlorides
- carboxylic acid derivatives – acid chlorides reaction with water, amine and alcohol ester hydrolysis with acid and base

SLO#	**Specific Learning Outcomes:** *Students are able to*	**Skill level**	**SLO code**
1	**define** oxidation / substitution / elimination reaction	1	Che5.2.1.1
2	**identify/state a feature or example of** oxidation / substitution / elimination reaction in a given context	1	Che5.2.1.2
3	**describe** the oxidation reactions of alcohols including reaction products and conditions	2	Che5.2.2.1
4	**describe** the substitution reactions of alcohols including reaction products and conditions	2	Che5.2.2.2
5	**describe** the elimination reactions of alcohols including reaction products and conditions	2	Che5.2.2.3
6	**compare** the three types of reactions of alcohols in terms of reaction products, conditions, and type of reaction	3	Che5.2.3.1
7	**discuss** the application of reactions of alcohols in real life situations using named examples	4	Che5.2.4.1
8	**describe** the substitution reaction of haloalkane including reaction products and conditions	2	Che5.2.2.4
9	**describe** the elimination reaction of haloalkane including reaction products and conditions	2	Che5.2.2.5
10	**compare** the different reactions of haloalkane in terms of reaction products, conditions, and type of reaction	3	Che5.2.3.2
11	**discuss** the application of reactions of haloalkane in real life situations using named examples	4	Che5.2.4.2
12	**describe** the oxidation reaction of aldehydes including reaction products and conditions	2	Che5.2.2.6
13	**describe** the reduction reaction of ketones including reaction products and conditions	2	Che5.2.2.7
14	**describe** the substitution reaction of carboxylic acids including reaction products and conditions	2	Che5.2.2.8
15	**describe** the reactions of amines in terms of reaction products, conditions, and type of reaction	3	Che5.2.3.3
16	**discuss** the application of reactions of amines in real life situations using named examples	4	Che5.2.4.3
17	**compare** the reactions of aldehydes and ketones in terms of reaction products, conditions, and type of reaction	3	Che5.2.3.4
18	**discuss** the application of reactions of aldehydes in real life situations using named examples	4	Che5.2.4.4
19	**describe** the reactions of carboxylic acids in terms of reaction products, conditions, and type of reaction	2	Che5.2.2.9
20	**describe** the reactions of carboxylic acid derivatives in terms of reaction products, conditions, and type of reaction	2	Che5.2.2.10
21	**compare** the reactions of carboxylic acid and carboxylic acid derivatives in terms of reaction products, conditions, and type of reaction	3	Che5.2.3.5

Sub-strand 5.3: Solving problems in organic chemistry
(for Internal Assessment Task 2)

Key Learning Outcome: Students are able to demonstrate understanding of chemical principles by carrying out practical tasks to collect data, analysing both primary and secondary data and evaluating data and methods of data collection.

- integrate information about structure and reactions to determine the identity of unknown molecules
- carry out practical tests to identify functional groups in organic molecules

SLO#	**Specific Learning Outcomes:** *Students are able to*	Skill level	SLO code
1	**plan/design** a procedure to determine the identity of a range of inorganic or organic unknowns	2	Che5.3.2.1
2	**observe** and record observations to enable a valid, reliable conclusion to be made.	2	Che5.3.2.2
3	**interpret** results accurately to reach a valid conclusion for at least four unknowns	3	Che5.3.3.1
4	**write** appropriate equations that suit the reactions occurring in the titration	3	Che5.3.3.2
5	**discuss** findings in relation to the purpose of the experiment, highlighting sources of errors	4	Che5.3.4.1
6	**tabulate** readings from the experiment	2	Che5.3.2.3
7	**calculate** appropriate pH for given titration data	2	Che5.3.2.4
8	**plot** a titration curve (includes choice of indicators)	3	Che5.3.3.3
9	**analyse/interpret** a titration curve (includes choice of indicators)	3	Che5.3.3.4
10	**identify** functional groups in organic molecules	2	Che5.3.2.5
11	**organise** practical report coherently	2	Che5.3.2.6
12	**carry** out practical tests to identify functional groups in organic molecules	3	Che5.3.3.5

8. Assessment

The assessment of the prescription 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 prescription requirements have been fulfilled.

Suggested Teaching Times and Weighting

Strand	Outcomes	External / internal	Suggested Time	Approximate Weighting
1	**Atomic Structure and Bonding and Properties**	*External*	*7 weeks*	*25%*
2	**Energy Changes in Chemical and Physical properties**	*External*	*7 weeks*	*11%*
		Internal		*15%*
3	**Aqueous Equilibrium Systems**	*External*	*3 weeks*	*10%*
4	**Oxidation-Reduction Reactions**	*External*	*2 weeks*	*9%*

5	**Organic Chemistry**	*External*	*9 weeks*	*15 %*
		Internal		*15%*
	Total		**28 weeks**	**100%**

External Assessment (70%)

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

Strand 1: Atomic structure, bonding and related properties	25%
Strand 2: Energy changes in chemical and physical processes	11%
Strand 3: Aqueous Equilibrium Systems	10%
Strand 4: Oxidation-reduction reactions	9%
Strand 5: Organic chemistry	15%

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 40% 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.

Assessment Blueprint

The blueprint below is to guide the internal and external assessment allocations for Chemistry.

The allocation of 20%, 30%, 30% and 20% for levels 1, 2 3 and 4 respectively is common across all subjects at the SPFSC level.

Strand	IA or EA	Level 1	Level 2	Level 3	Level 4	Total skill score allocation (%)
Strand 1: Atomic Structure, Bonding and Related properties	EA					25
Strand 2: Energy Changes in Chemical and Physical Reactions	EA					11
	IA					15
Strand 3: Aqueous Equilibrium Systems	EA					10
Strand 4: Oxidation - Reduction	EA					9
Strand 5: Organic Chemistry	EA					15
	IA					15
Number of items		**20**	**15**	**10**	**5**	**100**
TOTAL		**20**	**30**	**30**	**20**	

Internal Assessment Task Guidelines (30%)

There are two Internal Assessment tasks in this course:

1. An individual research project on Chemistry in the Community (15%)
2. An individual practical skills assessment involving Titration (15%)

The learning outcomes that are assessed in Task 1 can be found in sub-strand 2.2.

The learning outcomes to be assessed in Task 2 are found in sub-strand 5.3.

Task 1: Chemistry in the Community

A research into the use of chemistry products and processes in the society

In this task students are to:

1. Discuss with their teacher the chemical product that is used in the society that they wish to research about. Students are to research into one product and its processes only. A list of possible products is given below.
   a Fuel and fuel products
   b Soap and soap products
   c Medicine/drugs
   d Textile products
   e Food products
   f Plastics
2. Research into these products will cover a range of areas of chemistry including environmental chemistry, consumer chemistry, food chemistry, oxidation-reduction processes including electrochemistry, and thermochemistry.
3. 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 products or processes that are part of their everyday lives. This process should be modelled by the teacher when they link their lessons to everyday contexts e.g. when teaching about hydrocarbons they could introduce this topic by discussing the fuels that are in common use in the community.
4. This task 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.
5. 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. For example a discussion about the use of baking soda in making a cake to rise will include the chemical name and formula for baking soda and a reaction for the release of carbon dioxide when baking soda is heated or reacted with acid.
6. After identifying with the teacher the chemical product to be researched, the students are to complete the following:

   a Gather relevant information by reading widely.

   b Gathering information from actual site visits (e.g. pharmacy or chemist for drugs or medicine, food processing factory for food products etc) and talking with or interviewing staff members is a definite advantage. However, it is not a compulsory requirement.

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

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

- i Research aim/s are stated
- ii Research methods are described
- iii Sources of information are acknowledged
- iv Chemical process for manufacture of the product is described
- v Data/findings are tabulated
- vi Findings are interpreted – linking the use of the chemical product to the environment and the chemical processes
- vii Chemical names, formulas, equations are used
- viii Environmental or societal impacts of the use of the product and manufacturing processes are evaluated and recommendations are provided

Students who are working towards excellence level are expected to be able to evaluate issues associated with the use of development of the product or process. Teachers should guide the students' choice of topic to ensure that there is a reasonable opportunity to evaluate possible issues.
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 appended as Appendix 1. 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.

Task 2: CAT on Practical Skills

Problem Solving in Chemistry: a titration

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 assessment of practical skills (titrations) and the analysis and evaluation of quantitative data. Students will carry out a redox titration individually and process their own data. They will sit a written test in which they are required to process and evaluate secondary data. This contributes 15% of the internal assessment.

2. The oxidation-reduction titration will be carried out individually. A balanced equation will be provided. Answer will be in mol L^{-1} or g L^{-1}.
3. Secondary data and experimental procedures could relate to aspects of thermochemistry, oxidation-reduction chemistry or atomic structure and bonding
4. A generic task and a marking template will be provided (See Appendix 2) for the chemical analysis.
5. Equations for organic analyses will give the structure of reactants and products-
6. For the titration curves each student will have a unique set of titration data to analyse.
7. Basically, each student is required to carry out a series of calculations that link pH values and indicators to a titration curve. Each candidate will have a unique titration curve or set of data to analyse (related to weak acid / strong base titration). Unique data relates to the pK_a and concentration of the acid and base and the availability of indicators. This contributes 5% of the internal assessment.

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 3 and 4.

Appendices

Appendix 1: Scoring Rubric for Internal Assessment Task 1

Task item, level & SLO code	Level 1	Level 2	Level 3	Level 4
1. Name chemical product in the community (L1) (Che2.2.1.1)	Product is named correctly			
2. Account of historical development (L4) Che2.2.4.1	One correct historical account	More than one perspective is provided	Historical perspectives are linked	Historical account is comprehensive
3. Outline of chemical principles (L2) Che2.2.2.1	One chemical principle is provided	More than one chemical principle is provided		
4. Describe chemical processes (L2) Che2.2.2.2	One feature only given in the description	More than one feature given in the description		
5. Link the use of chemical product (L3) Che2.2.3.1	One use or one principle is provided	Use and principle are provided but not linked	Use and principle are provided and related well	
6. Evaluate issues (L4) Che2.2.4.2	One issue about production or use is stated	More than one issue about production or use are stated	Issues are related to their impacts on the community	Issues are related and examples given show extension of ideas
7. Describe sources of information (L2) Che2.2.2.3	One source is provided	More than one source is listed		
8. Tabulate data (L2) Che2.2.4	Data pieces provided but not tabulated or incomplete	Data pieces are tabulated and labelled appropriately		
9. Interpret data (L3) Che2.2.3.2	Data pieces tabulated with one description	More than one description of trends provided	Data trends are well related to possible causes	
10. Use referencing (L2) Che2.2.2.5	One correct referencing used	Referencing used correctly in more than one places		
11. Organise report coherently (L2) Che2.2.2.6	Basic organisation	Coherent organisation		
12. Use of chemistry language (L2) Che2.2.2.7	Chem language is very basic	Chem language is detailed		
13. Discussion of impact (L4) Che2.2.4.3	One impact is listed	More than one impact are listed	Listed impacts are related	Related impacts are extended to other fields using good examples

Name of student: ____

Total skill score value: _________________ **Out of a possible skill score of 33**

Signature of Teacher ___________________________ Date: ________________________

Appendix 2: Scoring Rubric for Internal Assessment Task 2

Task item, level & SLO code	Level 1	Level 2	Level 3	Level 4
1. Design a procedure (L2) Che5.3.2.1	Procedure is not complete	Procedure is complete		
2. Record observations (L2) Che5.3.2.2	One correct observations	Observations are mostly correct		
3. Interpret data (L3) Che5.3.3.1	Data pieces tabulated with one description	More than one description of trends provided	Data trends are well related to possible causes	
4. Write appropriate equations processes (L3) Che5.3.3.2	One appropriate equation is given in the description, but may have a minor slip	One correct equation is given in the description with both sides balanced	More than one correct (fully balanced) equations are provided	
5. Discuss findings (L4) Che5.3.4.1	Findings are listed only	More than one findings are listed	Listed findings are related logically	Related findings are extended to other fields using good examples
6. Tabulate data (L2) Che5.3.2.3	Data pieces provided but not tabulated or incomplete	Data pieces are tabulated and labelled appropriately		
7. Calculate pH values (L2) Che5.3.2.4	One correct calculation	More than one correct calculation provided		
8. Plot of titration curve (L3) Che5.3.3.3	Plot is basic	Plot has a number of correct details	Plot is well structured and labelled	
9. Interpret titration curves (L3) Che5.3.3.4	One idea listed	A number of ideas are listed but not related	Ideas are linked in interpreting titration curves	
10. Identify functional groups (L2) Che5.3.2.5	One functional group is correctly identified	More than one functional group is correctly identified		
11. Report organisation (L2) Che5.3.2.6	Organisation is basic	Organisation is coherent		

Name of student: ____

Total skill score value: _________________ **Out of a possible skill score of 31**

Signature of Teacher: ____________________________ **Date: ___________________**

Appendix 3: More Information on IA tasks

CHEMISTRY IN THE COMMUNITY

Internal assessment resource - GENERIC TASK

Research, evaluate and link to chemical principles the use and /or development of a chemical compound or process used in the community.

Student Instructions Sheet

Introduction:

Chemical process and the products of chemical reactions are important in our daily lives. Chemical processes are an important part of biology and help us to understand how living systems work as well as being central to our understanding of reactions in the non-living world such as geological processes. New materials have been developed by chemists especially in the last 100 years that meet needs and help solve problems in society and lead to a better life style for many. You are to prepare a report about a chemical process or a chemical compound that has been used to benefit society in some way. Your report will link the process of compound to your understanding of chemistry phenomena. This means that you will explain the chemistry involved in the development of use of the compound or process based on the chemistry you have learned in form 6 and form 7. Your report should be easy for a Form 6 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 pharmaceuticals you might choose to write your report about the discovery, development and use of aspirin or another common drug.

B. Research

1. **Research** your topic. You will need to find out about the *discovery, development and use* of the chemical compound or process AND the *chemistry* related to the discovery, development and use. For example:
   - The human needs, demands or issues that resulted in the development of the compound or process
   - How the compound or process is used or was developed to meet the human needs, demands or issues

- Important chemistry concepts and principles involved in use, development or discovery
- Any factors that are important to the use or development or discovery
- Any issue that result from the use development or discovery

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 human needs, demands or issues that lead to the development or discovery of the chemical compound or process.
- the development or discovery of the chemical compound or process.
- important chemical concepts or principles in the development or discovery of the chemical compound or process.
- an evaluation of any issues that have arisen in the use or development of the chemical compound or process

NOTE:

1. The presentation will be mostly assessed on your understanding of the way the chemical compound or process has met a human need, demand or issue and the chemical ideas, concepts and processes related to the use, development or discovery of the compound or process. However, some marks 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 form 6 chemistry students.
2. 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.
3. 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.
4. Include a reference list of sources used, recorded in a way that the source can be located.
5. Your portfolio of data should be handed in with your report.

INORGANIC ANALYSIS

Internal assessment resource - EXAMPLE OF STUDENT TASK

Identify unknown solids by qualitative analysis

Student Instructions Sheet

Introduction:

Qualitative analysis involves identifying the ions present in unknown samples using observable physical and chemical properties unique to each chemical species. The acid–base behaviour of anions can be deduced from pK_a and this information is used to verify the presence of a particular anion in a sample. Solubility information is also useful in determining the identity of anions and cations.

The analysis depends on having a scheme that progressively eliminates possible anion identities.

Acid–base properties

A strong acid completely dissociates in water. A weak acid only partially dissociates – equilibrium is often reached when only up to 5% of the acid molecules have dissociated.

$$HA + H_2O \rightleftharpoons A^- + H_3O^+$$

The strength of the weak acid is measured by its acid dissociation constant K_a. where

$$K_a = \frac{[A^-][H_3O^+]}{[HA]} \quad \text{and } pK_a = -\log K_a$$

e.g. For strong acids such as HCl, HBr, HNO_3 pK_a < 0 – these are all strong acids

For weak acids:

Acid	K_a	pK_a
CH_3COOH	1.74×10^{-5}	4.76
HF	6.76×10^{-4}	3.16
NH_4^+	5.75×10^{-5}	9.24

As the strength of acids decreases then:

- K_a decreases
- pK_a increases

- the strengths (i.e. ability to accept protons) of the conjugate bases of the acids increase. So HF is a stronger acid than CH_3COOH which is stronger than NH_4^+, while NH_3 is a stronger base than CH_3COO^- and F^-.

Note: If an anion has no hydrogen and its conjugate acid is strong then the anion will be neutral

Solubility Rules

Inorganic cations and anions can also be identified from differences in the solubility of their salts and their ability to form complex ions. The following solubility rules may be helpful

1. All sodium, potassium and ammonium compounds are soluble
2. All nitrates are soluble
3. All chlorides, bromides and iodides are soluble except for Ag^+, Pb^{2+} and Hg_2^{2+} salts
4. All sulfates are soluble except for $BaSO_4$, $PbSO_4$, $CaSO_4$, $SrSO_4$ and Hg_2SO_4
5. All carbonates and hydroxides are insoluble except for when Rule 1 applies

Quantities, Units, Symbols and Nomenclature used SPFSC Chemistry Examination Papers

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 penalised 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.

Symbols / Expressions	**Units in 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. g L^{-1}

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).

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}

$\Delta_r H^{o}$, 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.

$\Delta_f H^{o}$, 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}

$\Delta_c H^{o}$ 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 vaporisation
- $\Delta_{sub}H$, enthalpy of sublimation

Standard Electrode Potential

Electrode potentials are defined as standard electrode potentials, $\boldsymbol{E}°$.
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: **p*K*a** for –log10*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).

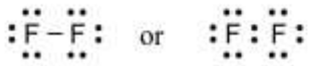
eg

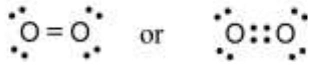
Formula	**Information conveyed**
H_2O	one water molecule or one mole of water
$^1/_2\ O_2$	half a mole of oxygen molecules
$Zn_3(PO_4)_2$	one mole of zinc phosphate comprising zinc and phosphate ions in a 3:2 ratio
2 $MgSO_4$	two moles of magnesium sulfate
$^1/_5\ KMnO_4$	one-fifth of a mole of potassium permanganate (manganate VII)

Lewis Structures

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

: or −

For F_2 

For O_2 

Equations for Chemical Reactions

$H_2(g)$ + $Br_2(g)$ $\rightarrow$ $2HBr(g)$ forward reaction

$H_2(g)$ + $Br_2(g)$ $\rightleftharpoons$ $2HBr(g)$ 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.

eg ***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

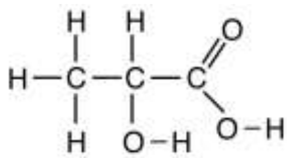
Pressure

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



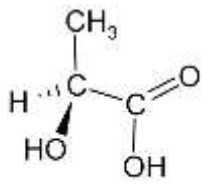
Organic Chemical Formulae

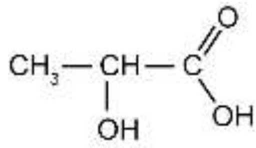
Information conveyed Example: lactic acid

empirical formula Stoichiometric proportions of atoms only. Simplest ratio formula. CH2O

molecular formula Formula of the actual molecule. C3H6O3

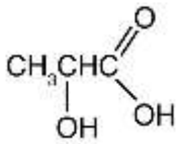
structural formula Shows how atoms are connected. It may be drawn in different ways.



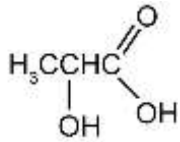


(a) All atoms and bonds are shown.

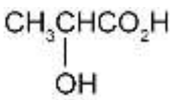
(b) Bonds to hydrogen are not shown



OR

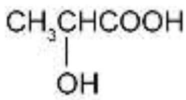


OR



OR

Only bonds to substituents are shown.

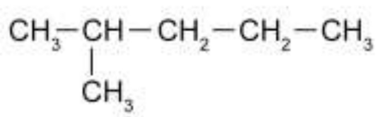
OR 

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

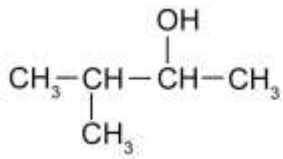
The structural formulae in (b) are referred to as condensed structural formulae.

Organic Chemical Nomenclature

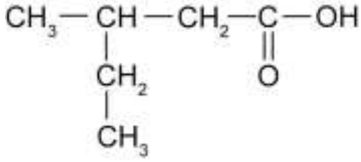
IUPAC conventions will be followed. There is ongoing discussion on some of the following naming. Candidates will be given full credit for alternative naming if an unambiguous structure is implied. Some examples are:



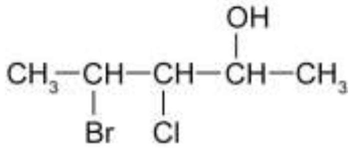
Structure	*IUPAC name*
(structure above)	2−methylpentane



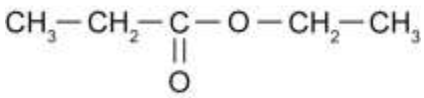
3−methylbutan−2−ol



3−methylpentanoic acid



4−bromo−3−chloropentan−2−ol



ethyl propanoate

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hydrogen 1 **H** 1.008																	2 **He** 4.003
Lithium 3 **Li** 6.943	Beryllium 4 **Be** 9.012											Boron 5 **B** 10.81	Carbon 6 **C** 12.01	Nitrogen 7 **N** 14.01	Oxygen 8 **O** 16.00	Fluorine 9 **F** 19.00	Neon 10 **Ne** 20.18
Sodium 11 **Na** 22.99	Magnesium 12 **Mg** 24.31											Aluminium 13 **Al** 26.98	Silicon 14 **Si** 28.09	Phosphorus 15 **P** 30.97	Sulfur 16 **S** 32.07	Chlorine 17 **Cl** 35.45	Argon 18 **Ar** 39.95
Potassium 19 **K** 39.10	Calcium 20 **Ca** 40.08	Scandium 21 **Sc** 44.96	Titanium 22 **Ti** 47.88	Vanadium 23 **V** 50.94	Chromium 24 **Cr** 52.00	Manganese 25 **Mn** 54.94	Iron 26 **Fe** 55.85	Cobalt 27 **Co** 58.93	Nickel 28 **Ni** 58.69	Copper 29 **Cu** 63.55	Zinc 30 **Zn** 65.39	Gallium 31 **Ga** 69.72	Germanium 32 **Ge** 72.59	Arsenic 33 **As** 74.92	Selenium 34 **Se** 78.96	Bromine 35 **Br** 79.90	Krypton 36 **Kr** 83.80
Rubidium 37 **Rb** 85.47	Strontium 38 **Sr** 87.62	Yttrium 39 **Y** 88.98	Zirconium 40 **Zr** 91.22	Niobium 41 **Nb** 92.91	Molybdenum 42 **Mo** 95.94	Technetium 43 **Tc** (98)	Ruthenium 44 **Ru** 101.1	Rhodium 45 **Rh** 102.9	Palladium 46 **Pd** 106.4	Silver 47 **Ag** 107.9	Cadmium 48 **Cd** 112.4	Indium 49 **In** 114.8	Tin 50 **Sn** 118.7	Antimony 51 **Sb** 121.8	Tellurium 52 **Te** 127.6	Iodine 53 **I** 126.9	Xenon 54 **Xe** 131.3
Caesium 55 **Cs** 132.9	Barium 56 **Ba** 137.3	Lanthanum 57 **La**† 138.9	Hafnium 72 **Hf** 178.5	Tantalum 73 **Ta** 180.9	Tungsten 74 **W** 183.9	Rhenium 75 **Re** 186.2	Osmium 76 **Os** 190.2	Iridium 77 **Ir** 192.2	Platinum 78 **Pt** 195.1	Gold 79 **Au** 198.0	Mercury 80 **Hg** 200.6	Thallium 81 **Tl** 204.4	Lead 82 **Pb** 207.2	Bismuth 83 **Bi** 209.0	Polonium 84 **Po** (209)	Astatine 85 **At** (210)	Radon 86 **Rn** (222)
Francium 87 **Fr** (223)	Radium 88 **Ra** 226.0	Actinium 89 **Ac**‡ 227.0	Rutherfordium 104 **Rf** (261)	Dubnium 105 **Db** (262)	Seaborgium 106 **Sg** (263)	Bohrium 107 **Bh** (264)	Hassium 108 **Hs** (265)	Meitnerium 109 **Mt** (266)	Darmstadtium 110 **Ds** (271)	Roentgenium 111 **Rg** (272)	Copernicium 112 **Cn** (277)		114 (289)		116 (289)		

Cerium 58 **Ce** 140.1	Praseodymium 59 **Pr** 140.9	Neodymium 60 **Nd** 144.2	Promethium 61 **Pm** (145)	Samarium 62 **Sm** 150.4	Europium 63 **Eu** 152.0	Gadolinium 64 **Gd** 157.3	Terbium 65 **Tb** 158.9	Dysprosium 66 **Dy** 162.5	Holmium 67 **Ho** 164.9	Erbium 68 **Er** 167.3	Thulium 69 **Tm** 168.9	Ytterbium 70 **Yb** 173.0	Lutetium 71 **Lu** 175.0
Thorium 90 **Th** 232.0	Protactinium 91 **Pa** 231.0	Uranium 92 **U** 238.0	Neptunium 93 **Np** 237.0	Plutonium 94 **Pu** (244)	Americium 95 **Am** (243)	Curium 96 **Cm** (247)	Berkelium 97 **Bk** (247)	Californium 98 **Cf** (251)	Einsteinium 99 **Es** (252)	Fermium 100 **Fm** (257)	Mendelevium 101 **Md** (258)	Nobelium 102 **No** (259)	Lawrencium 103 **Lr** (260)

Appendix 4: IA Summary Form

SOUTH PACIFIC FORM SEVEN CERTIFICATE
Internal Assessment Summary Form

CHEMISTRY

Country: ____________________ School: ____________________________________

Task	Brief Description	Start Date	End Date	Weighting
1. Chemistry in our Community				15%
2. Practical Skills CAT				15%

Note: 1. Be specific about dates, not just Week 3 Term 1, etc.

2. Assessment schedule for Task 1 is provided in the prescription while the assessment schedule for Task 2 will be sent later by EQAP. Teachers must use these when scoring students' work.

3. All IA Score Capture Sheets will be provided by EQAP to schools.

Teacher's Name and Signature: ………………………………………………………………………

Principal's Name and Signature: …………………………………………………………

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

SOUTH PACIFIC FORM SEVEN CERTIFICATE CHEMISTRY IA SCORE CAPTURE FORM

(Task 1: Chemistry in the Community)

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)

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.

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 Energy changes in chemical and physical processes	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 CAT	
6		June 26	Oct 12
7		Mid Year Exam	Analysis of Unknowns (IA)
8		Mid Year Exam	End of Year Exam
9		July 13 Aqueous Equilibrium	
10	Oxidation – reduction		
11			Nov 16 **SPFSC Exams**
12		Aug 7	
13	Chemistry on the Community	Aug 10	
14		Aug 17 Titration Curve (IA)	
	Term Break		

Chemistry References

Textbooks and Workbooks:

1. 13 Chemistry Student Notes (Wales and Wignall)
2. Year 13 Chemistry - Practical Workbook – ABA Books
3. Core Practicals for Year 13 Howarth, Rendel and Wooff – Longman
4. NCEA Level 3 Chemistry Barnes-Graham, Boniface and Giffney ESA Publications

Other useful references are:

1. Chemistry - A Senior Course Woof, Howarth, Oughton and Rendle
2. Year 13 Chemistry Croucher – Pathfinder Series
3. Chemistry Videos – Classroom videos in Australia (e.g. I came I saw I redoxed, Atom Bond – the atom with golden e^-, Atoms and their e^-s) – on Water from VEA in Australia

SOUTH PACIFIC FORM SEVEN CERTIFICATE CHEMISTRY –

SUMMARY of EXTERNAL CONTENT

STRUCTURE, BONDING and RADIOACTIVITY

* compare and contrast fission and fusion reactions
* discuss α, β and γ emission
* write balanced nuclear equations
* carry out half-life calculations
* discuss typical uses of radioactivity
* write electron configurations for the first 36 elements using *s, p, d* notation
* describe trends across a period and down a group for I.E., atomic and ionic radii, electronegativity and give reasons for these trends
* review of year 12 ideas – ionic, metallic and covalent bonds
* draw Lewis diagrams for simple covalent molecules of 2-6 valence electron pairs
* predict the shape of these molecules
* use the shape to predict the polarity of molecules
* describe weak intermolecular arising from instantaneous and permanent dipoles including hydrogen bonding
* relate bonding / intermolecular forces to the physical properties of substances
* describe the characteristic properties of transition metals and their relationship to atomic structure
* give examples of transition metals with variable oxidation state, coloured ions, catalysts, and complex ions.
* name and write equations for the formation of given complex ions

ENERGY

* summarise changes of state on heating a solid from zero K including $\Delta_{fus}H$ and $\Delta_{vap}H$

* describe reactions as endothermic and exothermic
* define $\Delta_f H$, $\Delta_c H$, $\Delta_r H$ and write the relevant equations
* calculate $\Delta_r H$ from given data including $\Delta_f H$, $\Delta_c H$
* calculate $\Delta_r H$ from bond enthalpy data

AQUEOUS CHEMISTRY

* equilibrium principles including K_c calculations
* define K_s and use it to calculate solubility
* use ionic product to predict precipitation
* predict the effect of a common ion on solubility
* discuss changes in solubility with addition of acids, bases and formation of complex ions
* define acids, bases, conjugate acid, conjugate base, amphiprotic, amphoteric, stong/ weak acid/base
* calculate the pH of strong acids and bases
* calculate the pH of weak acids, weak bases, acidic and basic salts * define and use K_a, K_w, pK_a and pH
* define buffers and write equations for buffer action
* know how to prepare buffer solutions
* calculate the pH of buffer solutions and the acid/base ratio at given pH values
* state the relative concentrations of species in given aqueous solutions
* discuss the properties of aqueous solutions in relation to the species present i.e. conductance, pH

OXIDATION-REDUCTION

* recall from Form 6:use oxidation numbers to recognise redox reactions, how to write half equations for a range of oxidising and reducing agents, how to write balanced equations for redox reactions
* identify the species involved in a redox reaction by observation
* construct simple electrochemical cells from cell diagrams and identify the anode and cathode reactions
* calculate the electrode potential of a cell
* use E° values to predict the spontaneity of a reaction and relative strength of oxidants and reductants
* relate electrochemical cells to everyday use of batteries
* Compare electrochemical and electrolytic cells

ORGANIC CHEMISTRY

* recognise the prescribed functional groups
* apply naming rules to draw structures and vice versa
* recognise structural, geometrical and optical isomers
* recognise substitution, elimination addition and condensation reactions
* recall Form 6 properties and reactions of alkanes, alkenes and alkynes, and describe addition polymerisation
* name and classify 1°, 2° and 3° alcohols
* describe the physical properties of alcohols
* write equations for combustion, substitution (by Cl), elimination and oxidation reactions of alcohols.
* describe condensation reactions of alcohols with carboxylic acids.
* name aldehydes and ketones and describe their preparation from alcohols
* use reactions with mild oxidising agents to identify aldehydes
* name haloalkanes and classify as 1°, 2° and 3°
* describe preparation of haloalkanes
* describe the substitution and elimination reactions of haloalkanes
* classify 1°, 2° and 3°amines
* name 1° amines
* describe amine reactions as bases and as ligands (with Cu^{2+})
* name and give examples of carboxylic acids

* recall physical properties of carboxylic acids
* discuss reactions of carboxylic acids - as acids and in the preparation of esters, acid chlorides and amines
* name and give examples of acid chlorides, amides, esters
* describe physical properties of acid chlorides, amides, esters
* describe the common reactions of acid chlorides, amides, esters including hydolysis
* summarise methods of preparation of acid chlorides, amides, esters
* give the general formula for amino acids and the structures of glycine and alanine
* discuss the reason for optical isomerism in most amino acids
* know how amino acids combine to form proteins
* recognise peptide links
* know the difference between condensation polymers and addition polymers
* write equations for the formation of polyesters and polyamides and the hydrolysis of polyesters and polyamides
* discuss polymerisation in proteins and bonding between the strands

Teacher Guidelines for Chemistry in the Community - Written Report

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment for the written task.

Context/setting:
The context will be prescribed by SPBEA and the student or the teacher will select the topic within this context for the report.

Conditions:
This is to be an individual activity. Students may use the same resource material but must write individual reports. It is suggested that the students spend 3 class periods (up to 3 hours collecting and processing the information to a rough draft of their report. They will then have 1 -2 hours of class time which need not be continuous, to write their report. This will be done under exam conditions. They may bring their resources and rough draft from which to write the report. All of this will be handed in with the finished report

Resource requirements:
Students will need access to a range of resources related to the context/task. Some of these may be provided by the teacher. Students may use their own resources along with those provided by the teacher or teachers may require students to find all their own resources. This will depend on the availability of and access to resources.

Additional information:
The assessment schedule should be available to students. A generic written task for students is also available

Teacher Guidelines f**or Practical Skills:**

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment for the practical skills.

Context/setting:
The unknown solution for the titration will be prescribed in the CAT. The teacher must also determine the oxidation reduction reaction and hence the titration to be carried out to determine the concentration of the unknown oxidant or reductant.

Conditions:
This is to be an individual practical activity. If it is necessary, students may share equipment and/or solution, but they must collect and process only their own data. The suggested time is 12 hours, which need not be continuous, provided both the practical work and the processing of data are carried out under supervised conditions.

Resource requirements:
Students should be familiar with the titration techniques prior to the assessment. Standard titration equipment. Standard solutions and required reagents and the unknown solution.

Additional information:
Teachers should carry out the given procedure prior to the student practical assessment to determine the expected outcome for the solution used. Students must not use the data collected for this activity for the extended practical investigation