SOUTH PACIFIC BOARD

FOR

EDUCATIONAL ASSESSMENT

Pacific Senior Secondary Certificate

CHEMISTRY

Prescription

Form 6

Effective from January 2009

PACIFIC SENIOR SECONDARY CERTIFICATE

Contents **Pages**

CHEMISTRY PRESCRIPTION

This prescription takes effect from January, 2009

RATIONALE

Chemistry continues to have an important place in the senior secondary curriculum of Pacific countries. This revised prescription document is intended to be more user-friendly than previous prescriptions in terms of content and format. The change in format is aimed at improving the readability of the text while at the same time maintain the major components of the prescription.

The content of some topics was reduced to remove areas of duplication and to do away with topics that are redundant as far as the Pacific situation is concerned. The content of the course is modified to describe the expectations in terms of student learning outcomes. This aims to improve the understanding of the combined depth and scope of the specified content, and at the same time focuses more clearly on skills and the application of scientific concepts and principles which should be demonstrated by students who successfully complete the course.

The school-based assessment component of the course is again given tighter controlled through the Common Assessment Task and a more manageable scheme of practical tasks. Further assistance is given to teachers in the form of suggestions for practical activities in each topic area.

The course is intended to provide a sound base for students wishing to continue with studies in chemistry at a higher level as well as students who leave the system at the end of F6.

PREREQUISITES

Students will be expected to have a sound grasp of the chemical principles covered at school certificate level.
The prescription for PSSC Chemistry is built on the assumption that the student has received instruction in the following elementary chemistry:

Metals and their Compounds

A study of some common metals, and some of their compounds to illustrate similarity of physical and chemistry properties and gradation of properties in terms of the activity series.

a) Symbols of common elements - those of the first twenty elements in the periodic table, plus Cr, Mn, Fe, Co, Ni, Cu, Zn, Br, Ag, Ti, Sn, I, Ba, Pb. A simple model of the atom in terms of electrons and the nucleus containing protons and neutrons.

b) Ions - a knowledge of ion formation, and charges on the following simple ions:

K^+, Na^+, NH_4^+, Cl^-, OH^-, NO_3^-, Mg^{2+}, Ca^{2+}, Fe^{2+},

Fe^{3+}, Pb^{2+}, Cu^{2+}, Al^{3+}, O^{2-}, S^{2-}, SO_4^{2-}, CO_3^{2-}, PO_4^{3-}.

c) General chemical and physical properties : reactions of the following metals - Ca, Mg, Al, Zn, Fe, Pb, Cu; with oxygen, water and dilute acids; activity series; the rusting of iron and its prevention.

d) Selected metal compounds - common compounds of K, Na, Mg, Al, Zn, Fe, Pb, Cu. The existence of hydroxides, carbonates, sulfates, chlorides and nitrates. Trends in their solubilities. The effect of heat on calcium and copper carbonates.

e) Oxidation - reduction in simple terms of gain or loss of oxygen. Examples of reduction limited to the extraction of metals from their oxide ores.

Non-metals

a) Sulfur - allotropes and effect of heat on sulfur. The reaction of sulfur with oxygen and with a metal such as iron or copper. The acidic nature of sulfur dioxide and sulfur trioxide as sulfurous and sulfuric acids. Chemical aspects of the manufacture of sulfuric acid (technical details not expected). Effect of sulfur oxides in the atmosphere.

b) Nitrogen - occurrence in the atmosphere and as amino acids in living matter. Lack of chemical reactivity. Reactions with oxygen to form nitrogen oxides which can act as atmospheric pollutants.
Ammonia - preparation, solubility in water, alkalinity and formation of ammonium salts. The nitrogen cycle and the use of ammonia, ammonium salts, urea and nitrates in agriculture. Particular stress made on the importance of nitrogen in nature and agriculture.

c) Carbon - forms of carbon, charcoal - its formation, combustion and uses. The formation of carbon dioxide and its uses. Carbon monoxide as a product of incomplete combustion; its nature and its use as a fuel. The nature and common uses of calcium carbonate, sodium carbonate and sodium hydrogen carbonate. Stress made on the importance of carbon as a fuel and as a reducing agent.

d) Hydrogen – reactions with oxides of nitrogen, sulphur and carbon.

Carbon Compounds

To highlight the special nature and importance of carbon chemistry in everyday life.

a) The ability of carbon to form linear and branched chains. Simple description of bonding e.g. carbon forms four bonds and hydrogen one.

b) The alkanes, alkenes and alkynes as a family showing gradual changes in physical properties such as melting point and boiling point with increasing molecular size (chain length). Combustion of alkanes to form carbon dioxide and water, and the pollution effects of incomplete combustion.

c) The use of molecular models.

Acids and Bases

a) pH scale and indicators

b) Examples of strong and weak acids, and strong and weak bases

Investigative Skills

Students are expected to have had some experience in carrying out simple scientific investigations.

NB: **Equations are expected to be balanced unless otherwise stated**.

GENERAL AIMS

1. To foster an awareness of the importance of chemistry in the lives of students and to stimulate a continuing interest in chemistry.
2. To provide students with a knowledge of appropriate chemical facts in order to understand important concepts and principles in chemistry.
3. To guide students to apply scientific methods in their study of chemistry (by developing skills in the laboratory) and in the environment in which they live.
4. To develop an awareness of how knowledge of chemical facts and principles can be applied.
5. To develop an ability to communicate chemical ideas and results of investigations/practicals after appropriate experimentation and analysis.
6. To develop skills in time management and planning

COURSE OBJECTIVES

On completing the course of study based on this prescription statement, students should be able to:

1. demonstrate a knowledge of facts related to:
   atomic structure
   quantitative chemistry
   organic chemistry
   inorganic chemistry
   principles of physical chemistry
   oxidation and reduction

2. demonstrate an understanding of important chemical facts and principles by applying them to new situations.

3. show competence in the following scientific skills:
   numeracy: calculate, estimate, understand, analyse and present information in tables and graphs.
   information: gather, process and interpret information; organise, analyse, evaluate and report information.
   problem solving: identify and describe a problem; inquire and research ideas; test hypotheses and make decisions on the evidence then evaluate the outcome.
   physical: develop manipulative skills and the safe and effective use of equipment and chemicals in cooperation with others.
   measurement: accurate use of the following measuring instruments: balance, measuring cylinder, burette, volumetric flask, pipette, stopwatch, thermometer.
   communication: present chemical ideas and experimental findings clearly, logically and precisely, both written and orally; use formulae, equations and models and show the makeup of substances and the changes they undergo during reactions.
   social: work independently as well as cooperatively in groups and where possible with chemists and researchers from the wider community.

4. demonstrate positive attitudes such as curiosity, honesty, flexibility, initiative and open-mindedness on which scientific investigation depends.

MAIN FEATURES OF THE PRESCRIPTION

Based on feedback from the 2008 survey sent out to teachers and the feedback from the review panel, changes have been made to the prescription to be effective in 2009 and beyond. Views of consultants from the region and New Zealand were also sought before the changes were incorporated into the prescription document.

There are minor changes and modifications in the course content, but the major features of the revised prescription are as follows.

1. **Changes to course content**

    * The topic "Chemistry of Water" has been removed.

2. **Changes to the Assessment**

    * **Examination paper** :
        – Multiple Choice is reduced from 30% to 20% and Structured items is increased from 70% to 80%.

    * **Internal Assessment**:
        – Minimum number of practicals is reduced to 8
        – Number of included practicals is reduced to 4
        – Compulsory practicals – of the 4 included practicals, one (1) must be an acid-base titration practical and one (1) must be a qualitative analysis practical.

3. **Content of the prescription:**

    * At the end of each topic a list of practical suggestions is provided
    * At the Advisory Section, a list of possible topics for the Extended Investigative Project and a list of suggested texts and references are provided

4. **Format of the prescription**

    The layout of the document was changed to make it more user-friendly and easier for the teachers to use. As can be seen in the content areas, the topics and outcomes have been separated into two columns. This way, teachers and other users of the prescription can easily identify the outcomes to be assessed in each topic area.

CONTENT AREAS

I. ATOMIC STRUCTURE AND BONDING	
Topic	**Outcomes**
1. PERIODIC TABLE	a) write the electron configurations for the first 20 elements and their respective ions in terms of principle energy levels and *s,p,d,f* notations. b) use the principle energy levels to identify atoms in the same Period c) use valence electrons to identify elements in the same Group d) relate the charge on monatomic ions to their positions on the periodic table e) define the following terms: (i) first ionization energy (ii) atomic radii (iii) ionic radii (iv) electronegativity f) explain the trends in (i) – (iv) above, across Periods 2 and 3 and within Groups. g) use the trends in the periodic table to explain the properties of atoms and ions. h) use the trends in electronegativity to determine probable types of bond.
2. BONDING	
a) Ionic Bonding	(i) describe ionic bonding in terms of electron transfer. (ii) describe the properties of ionic substances: electrical conductivity, solubility, boiling/melting points, brittleness (iii) relate the physical properties of ionic substances to their structures and bonding.
b) Covalent Bonding	(i) describe a covalent bond as a shared pair of electrons. (ii) distinguish between polar and non-polar covalent bonds. (iii) describe the continuum in the distribution of electrons moving from non-polar through polar to ionic bonding (iv) describe the polarity of the water molecule and the process of hydration of ionic substances. (v) describe the physical properties of discrete molecular substances and infinitely extended covalent networks. Physical properties to be limited to: electrical conductivity, melting point/boiling point, solubility, hardness. (vi) relate these physical properties to their structures and bonding (vii) describe the types of inter-molecular forces (viii) relate the inter-molecular forces to the physical properties of discrete molecular substances (ix) compare the strength of inter-molecular and intra-molecular forces and the role played by the hydrogen bond.
c) Metallic Bonding	(i) describe the metallic bond as a lattice of positive ions and de-localised electrons. (ii) describe the physical properties of metallic substances. Physical properties to be limited to : electrical conductivity, melting point, boiling point, malleability, ductility, lustre (iii) relate these properties to their structures and bonding.

I. ATOMIC STRUCTURE AND BONDING	
Topic	**Outcomes**
3. SHAPES OF MOLECULES	a) draw Lewis structures for simple covalent molecules and ions. Limit to four valence electron pairs. b) deduce the shape of simple covalent molecules using electron pair repulsion theory. c) name and draw molecules with the following shapes: (i) linear e.g. HCl (ii) bent (v-shaped) e.g. H_2O (iii) trigonal (triangular) pyramid e.g. NH_3 (iv) tetrahedral e.g. CH_4 d) use the molecular shape and electron distribution to determine whether the molecules are polar or non-polar.
Practical Suggestions 1. Solubility and Bonding 2. Electrical Conductivity 3. Melting points and Boiling points 4. Forces between particles 5. Shapes of Molecules	

II. QUANTITATIVE CHEMISTRY	
Topic	**Outcomes**
1. MOLE AND MOLAR MASS	Carry out simple calculations involving mass (grams), molar mass (g/mol), amount (moles), Avogadro's Number and chemical formulae using: moles (n), Avogadro's Number, relative atomic mass (A_r), molar mass (M), relative molecular mass (M_r)
2. EMPIRICAL AND MOLECULAR FORMULAE	a) distinguish between an empirical formula and a molecular formula. b) calculate (i) percentage composition e.g. • water of crystallisation • elements in a compound. (ii) empirical formula of a compound given its percentage composition (and vice versa). (iii) molecular formula from empirical formula and molar mass (and vice versa). c) explain the process of gravimetric analysis e.g water of crystallisation
3. STOICHIOMETRY IN CHEMICAL REACTIONS	a) write balanced equations given the reactants and/or products. b) use the symbols to describe states of molecules in chemical equations [(g) gas, (l) liquid, (s) solid, (aq) aqueous solution] c) carry out stoichiometric calculations based on mass, number of moles, concentration and volume. $c = \frac{n}{V}$, $n = \frac{m}{M}$, $c = \frac{m}{V}$

II. QUANTITATIVE CHEMISTRY	
Topic	**Outcomes**
4. ACID-BASE TITRATION	a) use stoichiometric equations in calculations b) define standard solution, titre, aliquot, equivalency point, end point. c) calculate (i) concentration to specified dilutions in terms of gL^{-1} and mol L^{-1}. (ii) mass required to make a standard solution given the size of volumetric flask and molar mass. (iii) unknown concentration based on titration data. d) identify and use all the equipment used for volumetric analysis e) prepare a standard solution, f) carry out a titration and dilution. g) describe the colour changes of common indicators, methyl orange and phenolphthalein, when the end point is reached
<u>Practical Suggestions</u>: 1. The mole 2. The molar mass 3. Water of Crystallisation 4. Empirical Formula 5. Prepare of standard solution 6. Standardisation of hydrochloric acid solution 7. Standardisation of sodium hydroxide solution 8. Analysis of vinegar 9. Analysis of ammonia cleaner 10. Analysis of aspirin tablet 11. Colorimetric analysis of iron in food 12. Gravimetric determination of sulfate in fertilizer	

III. ORGANIC CHEMISTRY	
Topic	**Outcomes**
1. ALKANES, ALKENES and ALKYNES	a) (i) use the general formula to determine the molecular formulae and structural formulae of alkanes C_{1-8}, alkenes C_{2-5}, and alkynes C_{2-5}. (ii) apply the concept of 'structural isomerism' to alkanes and alkenes. (iii) apply the concept of 'geometrical isomerism' to alkenes (iv) use the IUPAC rules to name simple hydrocarbons. b) identify the functional groups of alkanes, alkenes and alkynes. c) distinguish the meaning of *saturation* and *unsaturation*. d) recognise and write equations for: (i) substitution reactions of alkanes with halogens (ii) addition reactions of alkenes and alkynes with halogens, hydrohalides, water (H_2O) and hydrogen (H_2) **<u>Note</u>**: The mechanism of electron transfer will **NOT** be examined. e) describe and use the bromine and $KMnO_4$ tests for unsaturated compou f) describe the laboratory preparation of ethene (by steam cracking and by dehydration), and ethyne (from calcium carbide), and write balanced equations for each.

III. ORGANIC CHEMISTRY	
Topic	**Outcomes**
2.POLYMERISATION	a) explain using structural formulae, the production of polythene and PVC b) give examples of the use of PVC and polythene. c) describe the environmental problems caused by PVC and polythene products.
3. ALKYL HALIDES	a) name simple primary alkyl halides b) write balanced equations for the formation of simple primary alky halides from a reaction between hydrogen halides and alkenes.
4. ALCOHOLS, KETONES and ALDEHYDES	a) (i) use the general formulae to determine the molecular formula of C_1 - C_5 alcohols. (ii) identify the functional groups for alcohols, ketones and aldehydes. (iii) use the IUPAC rules to name C_1 - C_5 alcohols, ketones and aldehydes and give examples of each. b) (i) identify and name the three types of alcohol (primary, secondary, tertiary) and give examples of each. (ii) deduce the products formed from the oxidation of the three types of alcohol. (iii) carry out tests for ketones and aldehydes.
5. CARBOXYLIC ACIDS	a) recognise the functional group. b) use the general formula to determine the molecular formula and structural formula of C_1 - C_5 carboxylic acids and use the IUPAC rules to name them. c) describe the acidic behaviour of ethanoic acid d) write equations to show the reaction of ethanoic acid with aqueous sodium hydroxide. e) carry out the laboratory preparation of an ester f) write the equation for the formation of esters. g) state the common physical properties of esters.
6. FATS AND OILS	a) recognise the general structure of fats and oils as esters. **Note**: structure of glycerol is required. b) draw the structures of tri-glycerides given the formulae of the constituer fatty (carboxylic) acids. c) relate the trend of rising melting points with increasing saturation fats/oils. d) describe the extraction of fats/oils from their respective sources. e) describe how fats and oils are refined using alkali to remove free fatty acids and steam distillation to remove the undesirable volatile products. f) describe the effects of hydrogenation on fats and oils. g) compare butter with margarine in terms of chain length, degree of unsaturation of fatty acids, melting points h) (i) describe and write the structural formula for a soap. (ii) describe the process of soap manufacturing. (iii) describe how the chemical nature of soap promotes its role as a cleaning agent.
7. CARBOHYDRATES	a) draw the open and cyclic structures of glucose and be aware of their inter-conversion. b) use Fehlings or Benedicts reagent to test for the presence of the aldehyde group in an open glucose structure. c) recognise the differences in structure and property of two types of st (linear and branched).

III. ORGANIC CHEMISTRY	
Topic	**Outcomes**
Practical Suggestions: 1. Data and its applications 2. Properties of alkanes, alkenes and alkynes 3. Oxidations of alcohols 4. Preparation of esters 5. Investigation of ethene gas 6. Preparation of soaps 7. Properties of vinegar (acetic acid) 8. Models of organic compounds 9. Cracking of paraffin oil 10. Fermentation of ethanol	

IV. INORGANIC CHEMISTRY	
Topic	**Outcomes**
1. PROPERTIES OF SELECTED PERIOD 3 COMPOUNDS	a) Oxides (illustrated by Na_2O, MgO, Al_2O_3, SiO_2, SO_3) (i) explain the ratio of the atoms in the oxide as it relates to the position of the element in the periodic table. (ii) relate the ionic and covalent oxides to their position in the periodic table. (iii) describe the trend from basic oxides to acidic oxides. (iv) write balanced equations which demonstrate the acidic, amphoteric or basic property of an oxide. b) Chlorides (as illustrated by NaCl, $MgCl_2$, $AlCl_3$, PCl_3, HCl) (i) explain the ratio of the atoms in the chlorides in relation to the position of the element in the period from Na - P. (ii) relate the melting points and the electrical conductivities of chlorides to their structure and bonding. (iii) write balanced equations which demonstrate the reaction of chlorides with water.
2. TESTING FOR UNKNOWN IONIC SPECIES	a) carry out practicals to determine the solubilities of nitrates, sulfates, chlorides, carbonates, hydroxides, salts of Group I metals and ammonium salts. b) apply the formulae and recognise the appearance of the following complex ions: $[Cu(NH_3)_4]^{2+}$, $[Ag(NH_3)_2]^{+}$, $[Fe\,CNS]^{2+}$, $[Al(OH)_4]^{-}$, $[Zn(OH)_4]^{2-}$ c) apply knowledge of solubilities and complex ions to carry out tests for the presence of Mg^{2+}, Ag^{+}, Fe^{2+}, Fe^{3+}, Cu^{2+}, Al^{3+}, CO_3^{2-}, Cl^{-}, SO_4^{2-}, Zn^{2+}, Pb^{2+}, I^{-}, OH^{-} and describe the observations made. d) write balanced ionic equations to represent the reactions which occur during the test in c) above. **(Equations involving the formation of complex ions will NOT be examined.)**
Practical Suggestions 1. Solubility and precipitations 2. Test for ions in solutions 3. Analysis of ions in solutions 4. test for ions in different types of water	

V. PRINCIPLES OF PHYSICAL CHEMISTRY	
Topic	**Outcomes**
1. ENERGY CHANGES	a) describe enthalpy change (ΔH) b) define exothermic and endothermic reactions c) recognise exothermic and endothermic reactions in terms of the qualitative treatment of energy changes in a chemical reaction. d) relate amount (n) to energy change (ΔH) in a thermochemical equation ΔH reaction = $\Sigma\Delta H$ products - $\Sigma\Delta H$ reactants. e) construct and interpret energy profile diagrams in terms of: - activation energy. - energy change in a reaction (ΔH). - catalysed pathways. f) apply Hess' Law to calculate the energy change for a chemical reaction
2. RATE OF REACTION	a) state the factors affecting rate of reaction (temperature, concentration, catalyst, and particle size) b) explain the effects of these factors in terms of simple collision theory. c) explain the role of a catalyst in a chemical reaction.
3. EQUILIBRIUM	a) define dynamic equilibrium using equations of the type: $A + B \rightleftharpoons C + D$ b) (i) recognise a closed and an open system. (ii) infer that equilibrium can only occur in a closed system. c) use Le Chatelier's principle to explain the qualitative effects of changing (i) temperature (ii) total pressure (reduction in volume results in an increase in pressure.) (iii) concentration. d) describe the effect of catalysts on equilibrium systems. e) explain how Le Chatelier's principle is applied in the Haber process (ammonia production) and Contact process (sulfur trioxide) as commercial examples of equilibrium reactions.
4. ACIDS AND BASES	a) define acids as proton donors and bases as proton acceptors. b) identify acid-base conjugate pairs c) describe the behaviour of strong and weak acids and bases in terms of H^+ and OH^- ions. d) determine the strength of an acid or base using universal indicator. (use HCl, HNO_3, H_2SO_4, CH_3COOH, NaOH, Na_2CO_3, NH_3 as examples.) e) describe the basic properties of hydroxides and write equations to indicate such properties. f) use equations to show that water can behave as an acid and as a base (amphiprotic). g) describe the <u>equilibrium reaction</u> for water and its ionic product (K_w) represented by $[H_3O^+]\,[OH^-] = K_w = 10^{-14}$ h) use pH + pOH = 14 to deduce pOH or pH i) calculate pH and pOH given the hydrogen ion and hydroxide ion concentrations (and vice versa). j) use the pH scale to differentiate acidic, neutral and basic pH ranges.

V. PRINCIPLES OF PHYSICAL CHEMISTRY	
Topic	**Outcomes**
Practical Suggestions: 1. Energy changes 2. Heats of reaction 3. Effect of concentration on the rate of reaction 4. Effect of temperature on the rate of reaction 5. Effect of surface area on the rate of reaction 6. Activation energy 7. Catalysis 8. Equilibrium game 9. Chemical equilibrium 10. Equilibrium systems 11. Strength of acids and bases 12. Acidity of household substances 13. Testing soil pH 14. Preparation of indicators	

VI. OXIDATION AND REDUCTION	
Topic	**Outcomes**
1. DEFINITIONS	Define oxidation as loss of electrons and reduction as gain of electrons
2. OXIDATION STATE	a) determine the oxidation state (number) of each atom in a given element, molecule or ion. b) recognise and explain oxidation and reduction reactions in terms of changes in oxidation states (numbers):
3. OXIDANTS AND REDUCTANTS	a) define oxidant and reductant b) recognise oxidant and reductant in a chemical reaction. c) identify the common oxidising agents (oxygen, chlorine, metals with dilute acids, hydrogen peroxide, permanganate, dichromate). d) identify the colours of permanganate and dichromate in their different forms under acidic conditions e) identify the common reducing agents: metals e.g. zinc, magnesium and iron; carbon, sulfur dioxide, carbon monoxide. f) formulate and balance half equations for a given reaction using the ion-electron method. [Redox reaction in aqueous solution will be restricted to those in acid solution.] g) combine half equations and write fully balanced equations for the redox reactions.
3. APPLICATIONS	a) apply oxidation and reduction processes to the electrolysis of some common ionic solutions e.g. NaCl (aq) and molten ionic compounds e.g. NaCl (l). b) predict and describe observations made at the electrodes (anode and cathode) during electrolysis. c) recognise and interpret instances of oxidation and reduction in 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 electrodes; fuels; breathalyser test.
Practical Suggestions: 1. Electron transfer in oxidation-reduction 2. Reactivity of metals 3. Oxidising agents 4. Halides ions as Reducing agents 5. Electrolysis of copper chloride 6. Rusting 7. Oxidation of foods 8. Electrolysis of water 9. Electro-chemical cells 10. Electric currents generated by redox reactions	

ASSESSMENT

Assessment will be by an external examination (60%) and by internal assessment (40%).

1. The assessment of this prescription will test the following skills:

   - Recognising and communicating chemical principles and concepts.
   - Applying chemical knowledge to new situations.
   - Using experimental techniques.
   - Recall of knowledge.
   - Drawing chemical diagrams, including flow diagrams.

   These skills are not regarded as being of equal weighting.

2. **THE EXAMINATION**

   a) The six (6) sections of the prescription will be examined by a written paper in approximately the following weighting:

TOPIC	WEIGHT (%)
Atomic Structure	15
Quantitative Chemistry	20
Organic Chemistry	28
Inorganic Chemistry	10
Principles of Physical Chemistry	17
Oxidation and Reduction	10
TOTAL	**100**

   b) There will be one three-hour paper set.

   c) The examination will comprise of two sections:

   Section A: Multiple-choice type questions 20%
   Section B: Structured items 80%

- A copy of the Periodic Table, (in which the main Groups are labelled I [H, Li, ...] through VIII [He, Ne, ...], the Periods labelled 1, 2, ..., and which gives the element symbols and their atomic numbers only) will be provided.
- The use of silent, hand-held electronic calculators will be permitted. Pre-programmed calculators and recording devices including all types of cellular phones will not be allowed into the examination room.

3. INTERNAL ASSESSMENT

1. The major purpose of a PSSC internal assessment programme is to measure subject-related skills and abilities that cannot easily be measured by pencil-and-paper tests, i.e. practical skills, long-term research and investigative skills.

   This should be kept in mind when designing internal assessment programmes for submission to SPBEA.

2. The Internal Assessment component will make up 40% of the total assessment.

3. At least **eight (8)** practical activities directly related to course objectives and content, as described in this prescription, **must** be carried out by each student. Students must also write a report on each of these activities. **At least one of these must be based on each of the prescribed topics**. Four (4) practical activities will be counted towards students' final assessment. Of these four practicals, one **must** be an acid-base titration practical and one **must** be a qualitative analysis practical.

4. There are four (4) areas on which the internal assessment will be based.

TASK	WEIGHT (%)	
	Total Assessment	**IA Component**
Common Assessment Task (CAT) Manipulative Skills test	8	20
Extended Investigative Project	16	40
*****Practical Reports (Four (4) included practicals)	12	30
Other Tasks (Assignments, tests, quiz etc.)	4	10
TOTAL	**40**	**100**

* Practical reports will be based on the four (4) included practical activities. The same four practicals will be assessed for each student in the school

* One (1) of the four included practicals must be an acid-base titration practical, and one (1) must be a qualitative analysis practical

5. Other Tasks - these are three (3) teacher designed tasks (TDT) based on any assessment activity decided by the teacher. The total mark for each task is up to the teacher to decide, but the three tasks must have a combined weight of 10%. Teachers are required to do all the computations and report the final TDT mark out of 10. The mark capture form will reflect this.

6. Although certain student attitudes and behaviours may be desirable (e.g. co-operativeness, perseverance, politeness, etc.) they should not be included as skills to be assessed when recorded through the marking schemes in the PSSC Internal Assessment programme submitted by any school. Attempts to quantify and report such qualities should be done as a separate school activity.

7. Schools must submit a mark for each of the four assessment components. These marks will be reflected in the Mark Capture Sheet provided by SPBEA for these purposes.

   Practical Activities(out of 40) [4 practs. @ **10 marks** each]
   Investigative Study(out of 60) [see marking criteria]
   Other Tasks (out of 10) [teachers to convert total OT marks to out of 10]
   CAT [SPBEA will specify when CAT is ready]

   Note : (i) the mark for Extended Investigative Project (60) is the mark specified in the marking criteria in this prescription. This mark will be reflected in the Mark Capture Sheet provided by SPBEA for these purposes.
   (ii) CAT - SPBEA will advise schools of the total mark once the CAT is ready.

8. Schools that intend to enrol students in PSSC Chemistry must submit a completed "**PSSC Internal Assessment Summary Form"** by March 31st in the year of enrolment. These forms will be provided by the SPBEA. Several forms may be necessary to document a school's Internal Assessment programme. Further information must also be attached to these forms. This information should include details of procedures, the marking of separate teacher-designed tasks, and descriptions of intra-school moderation of internal assessments if a school has more than one class taking PSSC Chemistry.

9. Schools are required to submit all IA marks using the specially prepared mark capture forms provided by SPBEA.

10. Clear records and documentation regarding the school's approved PSSC Internal Assessment programme must be kept. Furthermore, all students' work that has been assessed under this programme (tests, essays, practical reports, projects, etc.) must be available for verification by SPBEA officers during any one school year.

11. Students who will be enrolled in PSSC Chemistry must be given a copy of the school's PSSC Internal Assessment programme for the subject. Each student must also be informed of when assessment tasks are to be given, and be notified of his or her assessment result for each task as soon as it is marked.

12. Chemistry teachers and school principals will be required to sign the "PSSC School Agreement" form to confirm that the above PSSC Internal Assessment programme procedures will be followed.

APPENDICES

APPENDIX 1

Nomenclature Conventions

General Chemistry

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

Symbol/ Expression	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. M_r relative molecular mass and A_r relative atomic mass, will not be used.	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 the footnote at the bottom of this page.	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 (e.g. grams per 100 mL, grams per 100 grams, 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.

[11]

The term "number of moles" is to be avoided in favour of the "amount of substance". In the same manner, the size of an object can be described in terms of its "length", rather than its "number of metres".

Enthalpy Changes, ΔH. *Units commonly used, kJ mol^{-1}*

- $\Delta_r \boldsymbol{H}^o$, standard enthalpy of reaction. For example:

  $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$ $\quad\quad$ $\Delta_r \boldsymbol{H}^o(H_2O, 298\ K) = -570\ kJ\ mol^{-1}$

  The term mol^{-1} means one mole of reaction, which is defined 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.

- $\Delta_f \boldsymbol{H}^o$, standard enthalpy of formation, per mole of product. For example the standard enthalpy of formation of liquid water:

  $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ $\quad\quad$ $\Delta_f \boldsymbol{H}^o(H_2O, l, 298\ K) = -285\ kJ\ mol^{-1}$

- $\Delta_c \boldsymbol{H}^o$, standard enthalpy of combustion, per mole of substance burnt. For example the standard enthalpy of combustion of hydrogen gas to give liquid water:

  $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow 2H_2O(l)$ $\quad\quad$ $\Delta_c \boldsymbol{H}^o(H_2, g, 298\ K) = -285\ kJ\ mol^{-1}$

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

- $\Delta_{fus}\boldsymbol{H}$, enthalpy of fusion (melting).
- $\Delta_{vap}\boldsymbol{H}$, enthalpy of vaporisation.

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
	$2MgSO_4$	two moles of magnesium sulfate
#	$\frac{1}{5}KMnO_4$	one-fifth of a mole of potassium manganate VII (permanganate)

\# *Indicates examples that are artificial and are used as a convenient way of calculating amounts of substance (moles).*

Equations for Chemical Reactions

$H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$	forward reaction
$H_2(g) + Br_2(g) \equiv 2HBr(g)$	equilibrium
$H_2(g) + Br_2(g) = 2HBr(g)$	stoichiometric relation

States of Aggregation

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

E.g. **s** solid, ***l*** liquid (preferably serif font *l*, not looped ***P***), **g** gas or vapour

aq aqueous solution (dissolved in water)

HCl(g)hydrogen chloride in the gaseous state

Temperature

Celsius temperature	°C
Thermodynamic (Kelvin) temperature	K

Pressure

Symbol *p*. Units are Pascals (Pa), or more commonly kPa.

Standard pressure, $\mathbf{p^o}$, = 10^5Pa = 1 bar = 1 atm

IUPAC Approved Spelling

Spelling of the element with atomic number 16 is the original English spelling of **sulfur**.

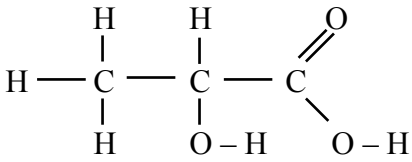
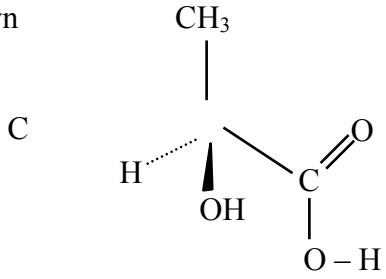
Derived ions have consistent spelling

e.g. sulfide sulfate sulfite thiosulfate

Graph Axes and Table Headings

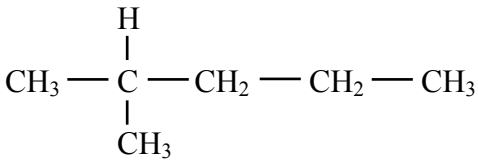
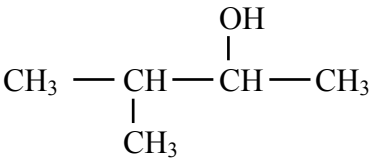
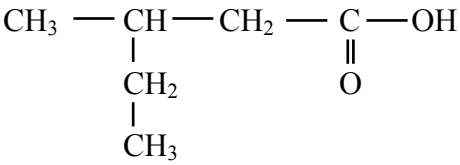
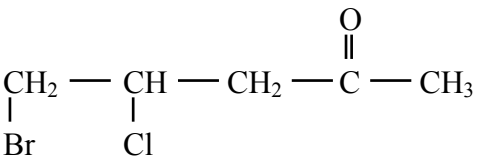
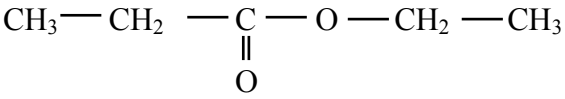
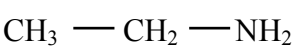
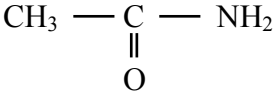
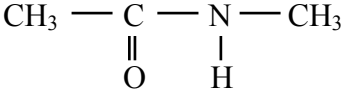
Labelled as quantity/unit e.g. c / mol L^{-1} and not c (mol L^{-1}). Only values will then be written on the axes or in a table.

Organic Chemical Formulae

Formula	**Information conveyed**	**Example for lactic acid**
empirical	Stoichiometric proportions of atoms only. Simplest ratio formula	CH_2O
molecular	Formula of the actual molecule	$C_3H_6O_3$
constitutional (condensed structural)	Structure relationships of atoms shown	$CH_3CHOHCOOH$
structural	Atoms and bonds shown	
structural formula showing stereochemistry	Arrangement of atoms in space shown	

Organic chemical nomenclature

IUPAC conventions will be followed. Some examples are:

Structure	**IUPAC name**
	2-methylpentane
	3-methyl-2-butanol
	3-methylpentanoic acid
	5-bromo-4-chloro-2-pentanone
	ethyl propanoate
	ethylamine
	ethanamide
	N-methylethanamide

References:

Mills I., Cvitas T., Homann K., Kallay N. and Kutchitsu K. *Quantities, Units and Symbols in Physical Chemistry*. Blackwell Scientific Publications, Melbourne, 1988.

Packer, J.E. *The Basic Vocabulary and Language of Chemistry*. Copies from the author at the Chemistry Department, University of Auckland, Private Bag 92019, Auckland 1996.

Note A: Physical Quantities, Units and Symbols

Quantitative aspects of chemistry are to be based on the following physical quantities in terms of their SI definition.

Physical quantity (symbol)	**Name of Unit**	**Symbol of Unit**
mass (m)	kilogram (gram)	kg (g)
length (l)	metre	m
temperature (T)	kelvin	K
time (t)	second	s
amount of substance (n)	mole	mol
volume (V)	litre	L

Note B: Significant Figures

1. During calculations rounding off should occur in the final answer.
2. Answers should be to the lowest number of significant figures present in the data.

e.g. Use the information given below to find the mass of water removed by heating.

Show your working clearly and neatly.

Data:

Mass of $Na_2CO_3.XH_2O$ before heating	=	3.48g
Mass of anhydrous Na_2CO_3 remaining after heating	=	1.59g
$M(Na_2CO_3)$	=	106 g/mol
$M(H_2O)$	=	18 g/mol

In this problem, the lowest significant figure given 2 in the mass of water.
Hence the answer should be given to 2 significant figures.

Mass of water = 3.48g - 1.59g = 1.89 $\dot{.}$ 1.9g

APPENDIX 2

PSSC Internal Assessment Approval Summary Form

200___

CHEMISTRY

Country _____ School _____

Topic	*Task*		Start Date	End Date	Task Weight %	
	Practicals ***Tick the 4 included practicals – 10 marks (or 7.5%) each***	**Tick (✓)**				
	1.					**30**
	2.					
	3.					
	4.					
	5.					
	6.					
	7.					
	8.					
• ***CAT***				**Aug / Sept**		**20**
• **Extended Investigative Project**				**14 August**		**40**
• **Other Task 1**						**10**
• **Other Task 2**						
• **Other Task 3**						
T O T A L					**100**	

Are you using the approved _____ IA programme? ***YES*** ***NO***

- *If YES, you are required only to complete the form above and note any minor adjustments you have made.*
- *If NO, you are required to complete a full IA Approval including providing assessment tasks/schedules, topics, etc.*

Note: 1. Task outlines and marking schemes for all tasks must be submitted together with this completed Summary form.
2. One of the 4 included practicals must be an Acid-base titration **and** one must be a Qualitative analysis
3. Be specific about start and end dates (not just week 2, term 2 etc.)

Teacher's Name: ……..
Teacher's Signature: …… **Date**: ……
Principal's Name: …….
Principal's Signature: …… **Date**: ……

APPENDIX 3

CAT for PSSC Chemistry 20%

Guidelines for CAT

The CAT should

1. be designed by the board or their appointee annually.
2. assess manipulative skills listed below.
3. have a station type format.
4. have a limited number of stations which require a teacher check.
5. each station to have a time limit.
6. have checklist type marking scheme.
7. use common chemicals and equipment for stations.
8. have a list of equipment required and instructions for setting up.
9. be scheduled for late in the year.

Manipulative skills to be assessed

1. Measuring skills using the following equipment:
   - balances
   - measuring cylinder
   - burette
   * - volumetric flask
   - pipette
   - stop watches
   - thermometer

2. Following instructions
   - simple instructions
   - multi step instructions
   - limited instructions (students to be able to develop working procedures or sequencing)

3. Experimental skills
   - safe handling of chemicals
   - safe disposal of chemicals
   - cleaning procedures
   - equipment setup
   - using correct procedures for the following equipment
     - burette
     - pipette
     - filter funnel
     - volumetric flask
     - conical flask
     - distilled water bottle
     - watch glass/ weighing bottle

   as in titrations, standard solutions and dilutions.

4. General efficiency
   - how quickly and confidently the tasks are carried out.
   - successful completion of the task or part task within a time limit.
   - good use of available working space (bench space + placing of equipment + chemicals).

Manipulative skills to be assessed to be included in Advisory Section.

APPENDIX 4

PSSC CHEMISTRY

Extended Investigative Assessment Schedule

Data obtained from Student Log, Report, Display and Talk

Name: ..... Class: .....

Four Aspects -		
	Achieved high standard	3
! Focusing and Planning	Achieved good standard	2
! Information Gathering	Attempted	1
! Processing and Interpreting	Not attempted	0
! Reporting		

will be assessed. Each aspect has 5 achievement criteria which are judged on the 4 point scale shown above.

FOCUSING AND PLANNING

Achievement Criteria

! Episodes of work recorded on a log	
! Details on finding/ choosing topic, and refining of the research question given	
! Details on experimental design development given including problems, solutions and follow-up on any advice given.	
! Method developed with clear specifications, replications and control of variables if required	
! Details of resources, references etc. given	
Total:	------ 15

INFORMATION GATHERING

Achievement Criteria

! Appropriate equipment used for collecting data of required accuracy	
! Correct use of equipment	
! Appropriate overall method/ procedures used	
! Appropriate method of recording results used; i.e. tables, graphs, charts etc.	
! Variety of relevant background information used to support investigation.	
Total:	----- 15

PROCESSING AND INTERPRETING

Achievement Criteria

! Trends, relationships or patterns in results (if present) identified	
! Limitations of results recognised; i.e. sources of errors, problems etc.	
! Evidence of continuing review of procedures	
! Possible future lines of investigation identified	
! Findings compared with established theory	
Total:	----- 15

REPORTING

Achievement Criteria

! Valid conclusions drawn based on discussion of the results	
! Student produces visual display	
! Report produces which is based on project outline and makes scientific sense	
! Neat and tidy presentation; word processed; consistent formatting	
! Using appropriate forms of communication in report and presentation; i.e. scientific terms, units, charts, tables, etc.	
Total:	----- 15
Overall Total:	------ 60

COMMENT:

ADVISORY SECTION

A. Common Assessment Task (CAT)

1. The Common Assessment Task (CAT) will form part of the overall assessment for PSSC Chemistry. The CAT will be designed to specifically assess skills in:
   - measurement
   - following instructions
   - handling materials and equipment.

2. Activities involving measurement will draw from the following list of equipment:

balance, measuring cylinder, burette, pipette, volumetric flask, stopwatch and thermometer

3. Activities involving handling materials and equipment will draw from the following list:

chemicals, burette, pipette, filter funnel, volumetric flask, conical flask, watch glass, weighing bottle and distilled water bottle

4. The task will be in the format of **'station activity'**, with a maximum of four stations each having a specified time limit for students.

5. The teacher will be required to assess each student. This will be done by matching performance with a supplied checklist.

6. The CAT will be scheduled for late in the year (August-September), and will be comprehensive in its guidelines for preparation, control and marking.

7. The format of the CAT will specify:
   - a title
   - a statement of course objectives assessed by the task
   - a listing of material requirements for completion of the task
   - guidelines for the teacher on advance preparation requirements
   - guidelines for the teacher on task completion and task control
   - notes on preparation by the student (if applicable)
   - task outline for the student
   - task detail for the student
   - marking scheme for the task
   - mark capture for the task.

8. Schools will be informed on the list of materials, chemicals and equipment required by the CAT at least three months before the CAT is due for completion, but teachers should ensure that the school has the items mentioned in 2 and 3 above.

B. Extended Investigation Project

I. Introduction

As part of the requirements of the PSSC Chemistry course each student will carry out a research project on a topic of his/her own choice. This project is an extended investigation and is worth 16% of your overall grade.
Within the first two weeks of the commencement of the project students will decide on a ***topic*** in Chemistry that they would like to know more about, e.g. vitamins, forensic science, soft drinks, gardening, acid rain or the ozone layer. They will then need to ***explore*** the area by reading and collecting resource material, writing to or interviewing experts, searching the internet and having discussions with teachers, parents, peers and other resource persons. At some stage students will need to decide what they want to find out then formulate an ***investigatable question or research question***. This is a clear, specific question which allows the student to design an investigation that will give the answers. Here are some examples of investigatable questions:

- Do vitamin C levels in fruit change as they ripen?
- Which citrus fruit contains the most acid?
- What % of carbonate is in an antacid tablet?
- How effective is the iodine method of obtaining fingerprints from different surfaces compared with the silver nitrate method?
- Does glucose content vary in different brands of lemonade?
- What are pH, phosphorus and nitrogen levels in garden soil and what effect does adding fertiliser(s) to the soil have on these levels?
- What effect does perming have on the texture of different types of hair?

Alternatively, students may have a problem you want to solve. They may want to design or prepare a new product with specific properties; e.g. a cleaner for removing stains from concrete or a waterproof hand cream; or design fair tests for comparing commercial products. These are all valid investigations providing that a ***practical investigation*** is carried out and some "new" chemistry is learned. Practical investigations need not be complex and can have everyday applications.

II. Project guidelines for teachers

Carrying out an investigation in science involves an interaction of many complex skills. These include focussing, planning, information gathering, processing, interpreting, and reporting.

In this activity students are required to:

- Research information related to a topic of their choice in Chemistry
- Carry out a practical investigation related to this topic
- Present a report integrating ideas from their research and investigation.

Teachers should allow 4-6 weeks for students to complete the investigation; students are expected to spend about 10-12 hours on the investigation - some of this time will be class time.

Teachers will provide a list of suggested topics or ideas for the students to select from, but students are free to come up with their own topics.

Teachers will provide **guidance** to students throughout the investigation so that students are not left on their own. This means providing milestone checkpoints to monitor student progress, providing feedback to students that confirms whether they are on the right track or not, but does NOT give specific direction. Monitoring also helps to ensure authenticity.

Suggested milestone checkpoints:

- Focussing question – check that students have identified a question that is specific and can be researched and from which a practical investigation can be developed
- Research sources – check that students have identified reference sources that will enable them to gather relevant information
- Information gathering – check that students have gathered relevant research information
- Practical investigation hypothesis – check that the hypothesis can be investigated within the time and resources available, and that it is at a suitable level of Chemistry.
- Practical data – check that data collected is sufficient to enable a conclusion to be made.
- Draft report – check that students are following the required guidelines to meet the assessment requirements.
- Final report.

Teachers are to provide the dates for each milestone in advance for students.

Students are required to maintain a log book. This will contain the summary information from their research, questions and ideas for their practical investigation, draft planning, raw data. The log book is to be submitted with each milestone report and with the final report.

The practical investigation will measure the effect of one factor or variable only, and must generate quantitative data. It could be based on field work or a laboratory experiment, and use skills and equipment that students are familiar with.

The final report will include the log book and a written report. The format of the written report will be a scientific report:

- Background information – why the topic is an issue, what makes it an issue and the reason for the investigation (not more than one page)
- Experiment – Hypothesis/Aim, Method/Equipment, Processed data (eg average data, graphs), Discussion, Conclusion
- Bibliography/References (and acknowledgements).

III. Project Guidelines for Students

1. PROJECT LOG

As part of your project you will be expected to complete a log (or diary) showing your work. At the end of the project you will write a report which will use the information in the log. The log will show how your project developed and must be presented for assessment with your report and display. Use a similar form to the one below. Fill in the log whenever you do any work on your project. This log will be taken in by your teacher at regular intervals so it is essential to keep it up to date.

Date:
Intentions: - *what you want to do*
Actions: - *what you did*
Problems: - *what problems were found*?
Possible solutions: - *ideas, people etc.*
Results: - *what actually happened?*
Time Taken: - *how long did you work*?

Deadlines for development and completion of your project is shown on page 27. It is important to keep on schedule. If you get behind make sure you talk it over with your teacher – don't leave it! Your log is a record of your progress and will be taken in by your teacher at each of the milestones.

2. PROJECT REPORT

A project report is used to summarise your findings and should be approximately 4 - 5 pages long. It should be easily read by anyone even if he/she was not involved in your project. You should organise your ideas in various sections - this will help you write the report. A suggested outline is included here. You can see how the log information can be used.

(i) Writing your draft report

a) Abstract
- Finally write a brief overview of the essence of your report in 200 words or less. Try to cover the aspects in the box opposite.

ABSTRACT
- purpose
- chemicals
- procedure
- results

b) Introduction
- Write an introduction for your report which should be a page or less.
- Use the two headings opposite to structure your notes.

INTRODUCTION
- Background research
- Aim(s)

c) Methods and Materials
- Write a detailed description of what you did, which would allow another chemist to duplicate your experiment if required.
- Use the headings opposite and include diagrams and sketches if appropriate.

METHODS AND MATERIALS
- Chemicals
- Experimental Design
- Equipment
- Materials

d) Results
- Write a detailed description of what you discovered in your investigation.
- Use the aspects in the box opposite to outline your results, if appropriate.

RESULTS
- Written Notes
- Tables
- Graphs
- Charts
- Diagrams and Drawings

e) Discussion

- Your discussion should be less than a page and in it you should try to interpret your results in relation to your aim(s).
- Make sure that you cover the aspects in the box opposite.

DISCUSSION
- trends (with supporting evidence)
- problems arising
- suggestions for further modification

f) Conclusion

- Write a short paragraph to summarise your results in relation to the aim.

CONCLUSION
AThe results show that ....

g) Acknowledgement

- Write a note thanking those who gave evidence and assistance.

ACKNOWLEDGEMENT
AI wish to thank the Beauty Hair Salon ...

h) References

- List the books and articles used in your research alphabetically.
- Use the format shown opposite.

REFERENCES
Alphabetical listing using the format
- Author, date, title, publisher

(ii) Editing Your Draft Copy

- Use the checklist opposite to edit your rough copy.

EDITING CHECKLIST
1. Spelling and grammar correct. ☐
2. Impersonal passive style used. ☐
3. Written in the past tense throughout. ☐
4. Style is clear and simple to understand. ☐
5. Illustrations, graphs, etc. clearly titled. ☐

(iii) Writing Your Final Copy

- As you write out your final copy for handing in, keep the points on the checklist in mind.
- Remember the Abstract goes at the **front** of the report.

FINAL EDITING CHECKLIST
1. Title page with your name and school on it. ☐
2. Correct headings used for each section. ☐
3. Sections in conventional order. ☐
4. Neat, legible writing used throughout. ☐
5. Attractively presented illustrations and graphs. ☐
6. Pages in order, numbered and stapled together. ☐
7. Final check on spelling and grammar. ☐

Hand in your completed **original** log with your log. It does not matter if it is spattered with chemicals.

3. DISPLAY OF FINDINGS

The findings from your investigation will be presented as a display suitable for public viewing. this could be a pictorial, diagrammatical or 3-dimentional representation of your findings. You can use picture, photographs, specimens, internet downloads, models or any materials form any source that could effectively convey your findings to the public.

Keep it simple. Do not show much information - leave this for your report.

NOTE: If you have problems with producing a display you *must* discuss them with your Chemistry Teacher.

Completion Date

You must hand in your display, project and report by **August 14**.

Ideas for research are sure to crop up as you learn more about the industry. You should be working in an area that is new ground for you and is stimulating.

It should be your own work but you should feel free to ask others for help with ideas, techniques etc.

Guidelines for development and completion of project	
What	**When**
Project Introduction	By 3rd week of March
First Log Check	By 1st week of April
Research Question Established	By 1st week of May
Second Log Check	By 1st week of May
Practical Work Intentions	By 1st week of June
Third Log Check	By 1st week of June
Practical Work Completion	By 3rd week of July
Fourth Log Check	By 3rd week of July
First draft of report	By 1st week of August
Project Submission	By August 14

4. POSSIBLE TOPICS FOR INVESTIGATION:

- Percentage of sugar in different fruits/soft drinks
- Water of crystallisation of different hydrated salts
- Effects of using fertilisers in soil
- Titration - Ethanol content in white wines
- Titration - Iron as in iron tablets, steel wool, etc.
- Factors that affect fermentation (ethanol)
- Titration - Chlorine content in swimming pools, bleaches, etc.
- Titration - Calcium carbonate in different types of carbonates e.g. egg shells, coral, etc
- Soap making
- Titration - Copper in brass and fungicides
- Acidity of aging coconut fruits
- Effects of ethene on fruits
- Titration - Citric acid in drinks and fruits
- Titration - Lactic acid in sour cream and milk
- Titration - Iron content in food
- Titration - Vitamin C content in tablets, food, drinks etc
- Titration - Chloride in cheese
- Factors affecting rate of reaction
- Heat energy of different types of fuel, alcohol, etc
- Lead content of exhaust fumes from vehicles
- Ice-cream making
- Tooth paste making
- Fatty acids in cooking oils
- Heat capacity of water and oil
- Effects of perming on different types of hair
- Titration - Ammonium sulfate in fertiliser
- Titration - Percentage of carbonate in antacid tablets
- Making of methane gas from animal manure
- Titration - Salt content in different types of chips (potato, banana, vudi, kumala etc.)
- Titration - Carbon dioxide content in human breath
- Titration - Analysis of household ammonia
- Effect of different types of detergent on oils and fats
- Generation of electricity using electrolysis
- Conductivity of different household items e.g. salt, sugar, detergents, oils etc.
- Titration - Recovery of silver from exposed photographic films
- Titration - Sulfide in cement
- pH of soils
- pH of different types of water
- bleaching property of pawpaw leaf
- chilly concentration as an insecticide
- alcohol content of *toddy* (coconut flower sap)
- rubber making
- tenderising property of young pawpaw fruits
- wax making
- desalination of sea water
- making perfume
- bread making
- biscuit making

C. SUGGESTED TEXTS and REFERENCES

Abbott, G., Hume, A., Cooper, B. (2000) *Year 12 Chemistry Practical Workbook,* Aba Books Ltd, Hamilton.

Boniface, S. Bunn, T, Sayes M. (2004) *Year 12 Chemistry Study Guide NCEA Level Two*, ESA Publications (NZ) Ltd, Auckland

Brady and Hollum, *Fundamental Concepts in Chemistry*)

Croucher, M., Croucher, P. (2000), *Chemistry Year 12*, NZ Pathfinder Series, George Hook (ed), New House Publishers, Auckland www.newhouse.co.nz

Hill & Holman, *Chemistry in Context 4th edition* , Nelson Publisher

Hill & Holman, *Chemistry in Context Laboratory Manual and Study Guide 3rd Edition* , Nelson Publisher

Irwin, D., Farrelly, R., Garnet, P. (2001) *Chemistry Contexts 1,* Pearson, Melbourne.

Mathews, P., *Advanced Chemistry* , Cambridge University Press

Mclaughlin, J.W. (1986) *Sixth Form Chemistry Notes and Examples* , Auckland

Mills I., Cvitas T., Homann K., Kallay N. and Kutchitsu K. (1988) *Quantities, Units and Symbols in Physical Chemistry*. Blackwell Scientific Publications, Melbourne.

Packer, J.E. (1996) *The Basic Vocabulary and Language of Chemistry*. Copies from the author at the Chemistry Department, University of Auckland, Private Bag 92019, Auckland

Wignall, A., Wales, T. , *Longman Write-on Notes: Year 12*, Longman