Quality Assessment Task

Exam Preparation HSC CHEMISTRY

INTRODUCTION

Core Module and Task:

- Core Modules 1, 2 and 3 Core Revision/Trial Examination Multiple Choice and Short-Answer Questions

This **task** relates to all Chemistry syllabus **outcomes**.

The topics covered in this task are: **Core Modules 1, 2 and 3.**

This task will be marked out of **75**. Your teacher will advise you of the actual value of this task for your internal assessment.

The marks for each question are as indicated.

You have **2 hours 15 minutes** to complete this task and it is to be taken under examination conditions.

A **Periodic Table, Data Sheet** and **Multiple Choice Answer Sheet** will be provided by your teacher.

Multiple Choice questions must be answered on the **Answer Sheet** provided.

Short-Answer Questions must be answered in the spaces provided on the **question paper**.

Published by Warringal Publications and Barrile Consulting

TASK

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part
Use the multiple-choice answer sheet provided.

1. Ethanol can be refluxed with a small amount of concentrated sulfuric acid to form ethene.
   What type of reaction is this?
   (A) Esterification
   (B) Dehydration
   (C) Polymerisation
   (D) Reduction

2. Which of the following cations can be identified using a flame test?
   (A) Al^{3+}
   (B) Ba^{2+}
   (C) Mg^{2+}
   (D) Zn^{2+}

3. The molar heat of combustion of alcohols increases as the length of the carbon chain increases.
   This increase is due to:
   (A) more energy being required to break the extra bonds between the extra C and H atoms.
   (B) more energy being released as more molecules of carbon dioxide and water are formed.
   (C) more energy being required to change the alcohols to the gaseous state as the molecules become longer.
   (D) more energy being transferred from the environment to the alcohol as the molecule becomes longer.

4. A solution of 0.005 mol/L sulfuric acid solution has a pH at 25ºC of:
   (A) 2.3
   (B) 11.7
   (C) 2
   (D) 12

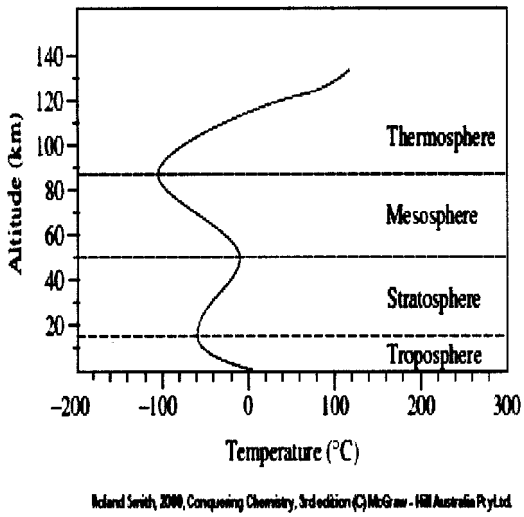
5. The list which contains only basic oxides is:
   (A) NO, CO, CO_2, SO_2
   (B) Na_2O, BaO, CaO, K_2O
   (C) SO_2, SO_3, NO_2, CO_2
   (D) BaO, SO_2, SO_3, NO

6. Graphite and diamond are examples of:
   (A) allotropes.
   (B) isomers.
   (C) isotopes.
   (D) monomers.

Published by Warringal Publications and Barrile Consulting

7. Which statement best represents Arrhenius' definition of an acid?
   (A) Acids contain oxygen.
   (B) Acids are proton donors.
   (C) Acids contain replaceable hydrogen.
   (D) Acids ionise in solution to form hydrogen ions.

8. 0.1 mol/L ethanoic acid is neutralised by a solution of 0.1 mol/L sodium hydroxide. The best indicator for this titration is:
   (A) methyl orange
   (B) phenolphthalein.
   (C) bromothymol blue.
   (D) litmus.

9. 

Acland Smith, 2000, Conquering Chemistry, 3rd edition (C) McGraw - Hill Australia Pty Ltd.

   The incorrect statement relating to the atmosphere is:
   (A) Pollution from cars and industry is found mainly in the troposphere.
   (B) CFCs are usually broken down in the troposphere.
   (C) Ozone is destroyed by CFCs in the stratosphere.
   (D) The temperature increases as altitude increases in the stratosphere.

10. Micro-organisms in water required for human consumption are removed by:
   (A) filtration only.
   (B) precipitation using flocculation then filtration.
   (C) treatment with fluoride ion followed by filtration.
   (D) treatment with chlorine followed by filtration.

11. Ozone reacts with nitric oxide according to the equation
   $NO(g) + O_3(g) \rightarrow iNO_2(g) + O_2(g)$
   0.66 g $NO(g)$ was mixed with 0.72 g $O_3(g)$.
   What is the maximum volume of $O_2(g)$ produced at 0°C and 100 kPa?
   (A) 0.34 L
   (B) 0.37 L
   (C) 0.55 L
   (D) 0.50 L

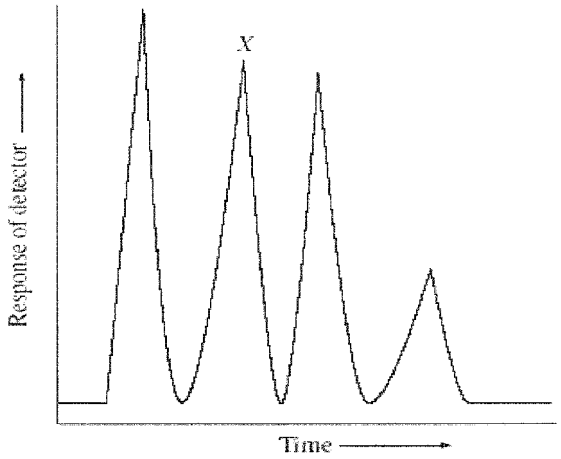
Published by Warringal Publications and Barrile Consulting

12. Phosphorus pentachloride can be prepared by the following reaction:
$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$ $\Delta H = -88$ kJ/mol
Which of the following sets of conditions would produce the highest yield of phosphorus pentachloride?
(A) High temperature, high pressure
(B) Low temperature, low pressure
(C) Low temperature, high pressure
(D) High temperature, low pressure

13. A co-ordinate covalent bond is formed when:
(A) ozone breaks up into oxygen and a free radical.
(B) a proton is transferred to a base.
(C) oppositely charged ions are arranged in an ionic lattice.
(D) monomers link together to form an addition polymer.

14. Heavy rainfall in a water catchment area usually results in:
(A) increased turbidity of the water.
(B) an increase in alkalinity of the water supply.
(C) more nitrogen dissolved in the water.
(D) the water becoming more saline.

15. In gas chromatography, compounds may be separated based on their molecular weight. The smaller the molecular weight, the more quickly the compound is detected. A gas chromatographic analysis was performed on a mixture of ethanol, 1-butanol, 1-propanol and 1-pentanol. The results are shown in the diagram.



Which substance does peak X correspond to?
(A) Ethanol
(B) 1-butanol
(C) 1-propanol
(D) 1-pentanol

Published by Warringal Publications and Barrile Consulting

Part B – 60 marks
Attempt Questions 16–28
Allow about 1 hour 45 minutes for this part.

Answer in the spaces provided.
The marks for each question are indicated at the beginning of each question.
Marks for each part of a question are indicated at the end of that part.

Show all relevant working in questions involving calculations. Diagrams should be drawn in pencil and labelled in pen.

Question 16. (7 marks)
During your Chemistry course you carried out a first-hand investigation to show how the heats of combustion of alcohols varied with the length of the carbon chain.

(a) Name the alcohols you used and draw the structural formula to represent one of these compounds. Indicate the name corresponding to the formulae you have drawn. 2

(b) Describe the method you used to determine the heat of combustion of one of these alcohols. Include a labelled diagram in your answer. 3

Published by Warringal Publications and Barrile Consulting

(c) Discuss the validity of your experiment in determining the heat of combustion of a fuel. 2

Question 17 (2 marks)

(a) Draw a structural formula to represent the compound which is commercially known as styrene. 1

(b) Give the systematic name for the polymer formed from this compound. 1

Question 18 (6 marks)

Cellulose is a biomass fuel.

(a) Describe the structure of cellulose. 3

Published by Warringal Publications and Barrile Consulting

(b) Evaluate the potential of cellulose as a source of other materials. 3

Question 19 (3 marks)

The transuranic element, americium-241, is used in smoke detectors. It emits alpha particles, which cause ionisation of the air in the detector. Smoke prevents the current flow and triggers the alarm.

(a) What are transuranic elements? Give another example of a transuranic element. 2

(b) Write a nuclear equation for the alpha decay of americium-241. 1

Published by Warringal Publications and Barrile Consulting

Question 20 (5 marks)

Sulfur reacts with oxygen to form 2 different oxides. Both of these oxides react with water.

(a) Write equations to show:
  (i) the formation of one of these oxides
  (ii) the reaction of this oxide with water. 2

(b) Name the products formed in each reaction. 1

(c) "Oxides of sulfur can be released into the atmosphere by both industrial and natural processes". Give examples to explain this statement. 2

Question 21 (6 marks)

(a) A student wished to set up a galvanic cell using lead and silver electrodes. Draw a labelled diagram of this cell which shows:
  (i) the anode
  (ii) the cathode
  (iii) the electrolyte solutions used
  (iv) the direction of electron flow in the external circuit
  (v) the direction of ion flow in the salt bridge. 2

Published by Warringal Publications and Barrile Consulting

(b) Write half equations for the reactions which occur and calculate the overall cell potential under standard conditions. 2

(c) What is meant by "standard conditions" in the context of a galvanic cell? 2

Question 22 (3 marks)

The following equation shows the equilibrium that exists between gaseous and dissolved carbon dioxide.

CO_2 (g) $\rightleftharpoons$ CO_2 (aq) + heat

(a) Explain, in terms of Le Chatelier's Principle, what happens to the solubility of carbon dioxide as the top is removed from a bottle of soft drink. 2

(b) Does carbon dioxide become more or less soluble as the temperature of water decreases? Explain your answer. 1

Published by Warringal Publications and Barrile Consulting

Question 23 (4 marks)

Citric acid is a weak acid and is triprotic.

(a) Draw the structural formula for citric acid. 1

(b) Using citric acid as an example, explain what is meant by a weak acid. 1

(c) How would you confirm using suitable named indicators that it is
(i) an acid
(ii) a weak (rather than a strong) acid. 2

Question 24 (3 marks)

A student, wishing to determine the concentration of a sodium hydroxide solution by titration, found that 26.5 ml of 0.0800 mol L^{-1} sulfuric acid solution was needed to react with 25.0 mL of the sodium hydroxide solution.

(a) Calculate the concentration of the sodium hydroxide solution, in mol L^{-1}. 2

(b) Name an indicator the student could use in carrying out this titration. What colour changes would the student observe during the titration? 1

Published by Warringal Publications and Barrile Consulting

Question 25 (4 marks)

A student wishes to prepare the ester ethyl propanoate in the laboratory.

(a) List the chemicals she needs to prepare this ester. 2

(b) Explain why reflux must be used in this laboratory preparation. 2

Question 26 (4 marks)

Monitoring of combustion within engines is important to the performance of those engines and to the quality of the atmosphere. Discuss this statement.

Published by Warringal Publications and Barrile Consulting

Question 27 (6 marks)

(a) Give the systematic name and structural formula of a CFC. 2

(b) What chemicals are now used in Australia instead of CFCs? Assess the impact on the environment of the replacement of CFCs by these other chemicals. 4

Published by Warringal Publications and Barrile Consulting

Question 28 (7 marks)

(a) The quality of natural water systems can be gauged by measuring the dissolved oxygen (DO) and the BOD.
Discuss this statement. 3

(b) Describe chemical tests you have carried out to confirm the presence of sulfate ions in water samples. Write equations for any reactions you describe. 2

(c) Why has AAS replaced chemical testing to detect the presence of heavy metal ions in water? 2

Published by Warringal Publications and Barrile Consulting

FOR THE TEACHER

QAT Code	Tasks	Outcome/s	Core Modules or Options
QATCHEM1A	First-hand investigation. Model making. Report writing. Graphing skills. Analysis of secondary data.	H7, H8, H9, H10, H11, H12, H13, H14, H15.	Core Module 1: Production of Materials
QATCHEM1B	Topic Test: Short-answer questions.	H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16.	Core Module 1: Production of Materials
QATCHEM1C	Analysis and interpretation of data	H1, H3, H4, H5, H6, H7, H8, H12, H13, H14, H15, H16.	Core Module 1: Production of Materials
QATCHEM2A	First-hand investigation. Documentation of results. Model making. Analysis of results and interpretation of chemical data. Chemical calculations.	H6, H9, H10, H11, H13, H14.	Core Module 2: Acidic Environment
QATCHEM2B	Topic Test: Multiple choice and short-answer questions.	H1, H2, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16.	Core Module 2: Acidic Environment
QATCHEM2C	Analysis and interpretation of data.	H1, H2, H4, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16.	Core Module 2: Acidic Environment
QATCHEM3A	Research. Report writing. Model making. Open-book test.	H2, H3, H6, H7, H8, H9, H16.	Core Module 3: Chemical Monitoring and Management
QATCHEM3B	Topic Test: Short-answer questions.	H2, H3, H6, H7, H8, H9, H11, H12, H13, H14, H15, H16.	Core Module 3: Chemical Monitoring and Management
QATCHEM3C	Analysis and interpretation of data.	H4, H13, H14, H16.	Core Module 3: Chemical Monitoring and Management

Published by Warringal Publications and Barrile Consulting

QAT Code	Tasks	Outcome/s	Core Modules or Options
QATCHEM4A	Open -ended investigation. Model making. Secondary research. Report writing. Open-book test.	H1, H3, H5, H7, H8, H9, H10, H11, H12, H13, H14.	Option: Industrial Chemistry.
QATCHEM4B	Topic Test: Short-answer questions	H1, H3, H5, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16	Option: Industrial Chemistry.
QATCHEM5A	First-hand investigation. Secondary research. Report writing. Open-book test.	H8, H11, H12, H13, H14.	Option: Shipwrecks, Corrosion and Conservation.
QATCHEM5B	Topic Test: Short-answer questions.	H3, H5, H6, H7, H8, H10, H13, H14.	Option: Shipwrecks, Corrosion and Conservation.
QATCHEM6A	Revision questions /Trial Examination of Core Modules. Multiple choice and short-answer questions.	All	Core Modules 1, 2 and 3
QATCHEM6B	Revision questions /Trial Examination of Core Modules. Multiple choice and short-answer questions.	All	Core Modules 1, 2 and 3
QATCHEM6C	Revision questions /Trial Examination of Core Modules. Multiple choice and short-answer questions.	All	Core Modules 1, 2 and 3

Published by Warringal Publications and Barrile Consulting

GENERAL COMMENTS FOR TEACHERS.

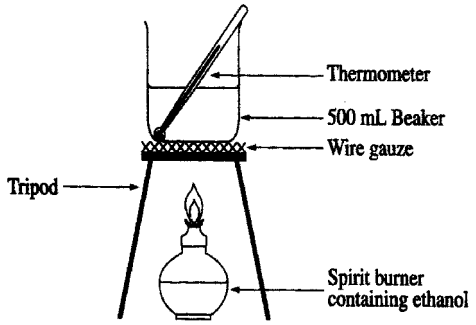
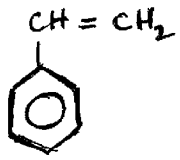
- The **INTRODUCTION** page for this QAT should be given to students well in advance of the date set for the task.
- A Periodic Table, Data Sheet and a Multiple Choice Answer Sheet should be provided to students at the beginning of the test.
- This QAT may be coupled with QATCHEM4B or QATCHEM5B to form a full Trial Examination.

Published by Warringal Publications and Barrile Consulting

SOLUTION PATHWAY

Suggested answers	Suggested marking guide
Questions 1 to 15 – Multiple Choice 1. B 2. B 3. B 4. C 5. B 6. A 7. D 8. B 9. B 10. D 11. A 12. C 13. B 14. A 15. C	**One mark each question.** **15**
Question 16 (7 marks in total) **(a)** Alkanols such as methanol, ethanol, 1-propanol CH_3OH, CH_3CH_2OH, $CH_3CH_2CH_2OH$ **(b)** Alcohol was placed in burner with wick and weighed. Beaker (or tin/calorimeter) containing known mass of water and thermometer placed over burner. Initial temperature of water measured. The burner was lit and water stirred as temperature rises. Flame put out and water temperature measured again. Final mass of burner measured. Diagram should be in pencil, with labels in ink. Indication of how heat of combustion determined using "heat taken in by water = heat given out by alcohol".	**(a)** **2 mark** for suitable choice of a series of compounds and correct formula. **1 mark** for suitable series but incorrect formula or correct name and formula but alcohols do not form series. **(b)** **Three marks** for correct method, diagram including labels and correct measurements taken. **2 marks** if any aspect of method or diagram incorrect. **1 mark** if method can be followed or diagram correctly drawn and labelled and corresponds to method.

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Apparatus used:  **(c)** Experiment is not valid as the method used; – does not allow for heat losses to the surroundings and to the beaker or can; – assumes complete combustion, which does not occur as evidenced by the amount of soot on the bottom of the beaker; – does not give a result which is comparable with that given in chemical data books.	**(c) 2 marks** for recognition that method of experiment does not allow an accurate determination of heat of combustion, with correct reasons given for at least 2 sources of errors. **1 mark** only if sources of error given but answer does not discuss that validity is due to problems in experimental design. **7**
Question 17 **(a)**  **(b)** Poly(ethenylbenzene)	**(a)** **One mark.** **(b)** **One mark.** **2**

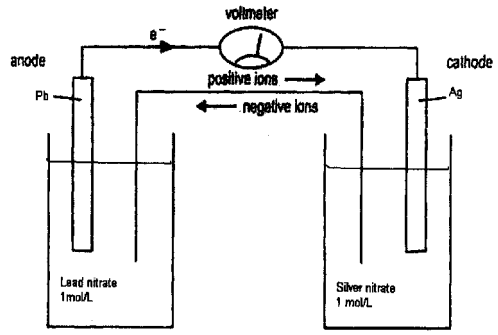
Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 18 (6 marks in total) **(a)** (i) Cellulose is a condensation polymer made when glucose monomer units join together in plant cells by the splitting out of a water molecule. (ii) Neighbouring units are linked by beta linkages. This means that the orientation of neighbouring molecules is identical. As a result, the cellulose polymer chain is linear, not coiled (long straight chains). (iii) Neighbouring chains are linked by H-bonding between the –OH groups on neighbouring chains. **(b)** (i) Answer must discuss the structure of cellulose as being a 6 carbon structure, potentially capable of being converted into 2-carbon units and hence into ethanol, ethylene and polymers based on ethylene. (ii) Answer must recognise that the technology does not currently exist to stop the breakdown of cellulose at 6-carbon or 2- carbon stage at an economic (rather than experimental) level. (iii) Answer must recognise that cellulose is already being converted into other materials such as rayon, CMC, cellulose acetate.	**3 marks** if 3 aspects of structure. **2 mark** if only 2 of 3. **1 mark** if only 1 of 3. **(b)** **3 marks** if 3 aspects listed discussed and evaluation statement included in answer. **2 marks** if only 2 aspects. **1 mark** if only 1 aspect considered. **6**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 19 (Total of 3 marks) **(a)** Transuranic elements are those elements with atomic numbers greater than 92. They are artificially produced and are found in the periodic table after uranium. They are produced by bombardment of other nuclei with neutrons or high speed positive particles such as helium or carbon nuclei. Example: any element after uranium in PT. **(b)** $^{241}_{94}$ Am → $^{4}_{2}$He + $^{237}_{92}$U	**(a)** **Two marks** if correct definition and correct example. **1 mark** if only 1 of above. **(b)** **One mark** **3**
Question 20 (Total of 5 marks) **(a)** Sulfur reacts to form either sulphur dioxide or sulphur trioxide. (i) S(s) + O_2(g) _ SO_2 (g) (ii) SO_2 (g) + H_2O (l) → H_2SO_3 (aq) **(b)** Products are sulphur dioxide and sulphurous acid. **(c)** Sulfur dioxide can be formed in volcanic regions (sulphur from the magma burning in air). This is a natural process. Equation as per (a) (i) above. Sulfur dioxide can also be produced when metal sulfides are roasted to form the metal oxide and sulphur dioxide, an industrial process. ZnS (s) + 3 O_2(g) → ZnO(s) + SO_2 (g)	**(a)** **Two marks** for 2 correct equations. (1 mark each equation) **(b) One mark** if both names correct or correspond to products produced in the reactions or if sulphur trioxide and sulfuric acid. **(c) Two marks** for correct explanation of both an industrial and natural process or for equations to illustrate each. **One mark** if only one of natural or industrial processes explained, with example. 5

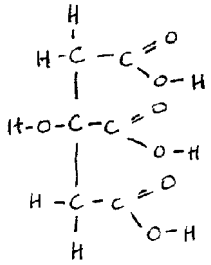
Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 21 **(Total of 6 marks)** **(a)**  **(b)** Pb (s) ⇌ Pb^{2+}(aq) + $2e^-$ +0.13 V Ag^+(aq) + e^- ⇌ Ag (s) +0.80 V Overall cell potential under standard condition is +0.93V Pb (s) + 2 Ag^+(aq) ⇌ 2Ag (s) + Pb^{2+}(aq) + 0.93 V **(c)** "Standard conditions" means that the cell is operating at 25°C, the pressure is 1 atm and that all electrolytes are at concentration of 1 molar.	**(a)** **Two marks** if all aspects of diagram correct, with diagram in pencil, labelling in pen. **One mark** only if any aspect incorrect. **(b)** **Two marks** if 2 correct equations and correct cell voltage. **One mark** if either correct equations or correct voltage or voltage corresponding to equations. **(c)** **Two marks** if 3 correct aspects. **One mark** only if 2 correct aspects. **6**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
(Question 22 (Total 3 marks) **(a)** Le Chatelier's Principle states that if a system is at equilibrium and the conditions (T and P or concentration of reactants) are altered, then the equilibrium shifts in a direction to attempt to compensate for the change. If the pressure of an equilibrium system is decreased (taking off the top of the bottle), the equilibrium shifts to favour the reaction which produces more gas molecules. The equilibrium in the bottle would move to the left, to make more gas and hence the concentration of carbon dioxide dissolved would decrease; i.e. the solubility of carbon dioxide would decrease. **(b)** If the temperature of an equilibrium system is decreased, the equilibrium shifts to favour the reaction which is exothermic. The equilibrium would move to the right, with more gas dissolving and hence the concentration of carbon dioxide dissolved would increase; i.e. the solubility of carbon dioxide would increase.	**(a)** **One mark** for correct prediction of decrease in solubility. **One mark** for correct explanation in terms of Le Chatelier's Principle. **(b)** **One mark** for correct prediction of increase in solubility. **3**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 23 (4 marks in total) **(a)** 	**(a)** **One mark** for correct structural formula.
(b) A weak acid partially ionises in water to produce hydronium ions and the conjugate base of the acid. Citric acid ionises to about 8%, meaning 8 hydronium ions are produced when one mole of citric acid undergoes its first ionisation. (The next 2 ionisation steps occur to a smaller extent).	**(b)** **One mark** for correct explanation.
(c) **(i)** Use an indicator that changes colour at pH 7. Litmus or bromothymol blue would be suitable. Litmus goes red indicating acid but does not show whether weak or strong. **(ii)** Ensure that the solution has a concentration of about 0.1 mol/L. Use a second indicator that distinguishes between strong and weak acids. Methyl orange is suitable. Methyl orange is pink if pH is less than 3 but orange if pH is closer to 5. A weak acid, of concentration 0.1M would have a pH closer to 5 than 3. Hence the orange colour (rather than pink) would confirm that citric acid is weak. Alternatively you could compare citric acid with a solution of hydrochloric acid (as a known strong acid) of the same concentration. Methyl orange would distinguish between the 2, as the pH of the citric acid would be higher as shown by the colour of the indicator.	**(c)** **Two marks** if 2 correct methods used. One mark only if 1 indicator only discussed (as question said "indicators" (plural)). **4**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 24 (3 marks in total) **(a)** $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 +$ 2H2O 2 moles + 1 mole No. of moles H_2SO_4 reacted = (26.5 /1000) x 0.0800 $= 2.33 \times 10^{-3}$ Hence no. of moles NaOH present = $2 \times 2.33 \times 10^{-3}$ Concentration sodium hydroxide solution $= 2 \times 2.33 \times 10\text{-}3 / 25 \times 10^{-3}$ $= 0.187$ mol L^{-1} (Answer should be to 3 significant figures) **(b)** Indicators or pH meters are used during titration reactions to show the end point (when the 2 solutions have reacted in the correct stoichiometric proportions, as determined by the equation). Since this is a strong acid/strong base reaction, then the pH should be close to 7 at the end point, with the pH changing from very high to very low over a one drop range. An indicator such as phenolphthalein is suitable; initially the colour in the flask will be pink/purple which will change to colourless at the end point. Other indicators (litmus, bromothymol blue, methyl orange, but not universal) could also be used.	**(a)** **One mark** calculation of moles of NaOH or recognition of 2:1 ratio of moles NaOH: moles H2SO4. **One mark** calculation concentration of NaOH to 3 significant figures. **(b)** **One mark** if suitable indicator with correct colour changes given. **3**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 25 (4 marks in total) **(a)** The 3 chemicals needed are: • ethanol • propanoic acid • concentrated sulfuric acid. **(b)** The method of reflux is needed as the organic reactants and the products are volatile. Hence they would form gases as heating occurs and escape into the laboratory. No ester would be collected and the organic chemicals are irritating if inhaled. The vapours are also inflammable, so could cause a fire if they came near an open flame. Reflux keeps the reactants and products enclosed while the necessary heating occurs. Heating needs to be carried out over a long period as the reaction is slow, it is an equilibrium reaction, and there is a greater chance of successful collision at high temperatures, in the gaseous state, than at low or in liquid state.	**(a) One mark** for ethanol/propanoic acid. One mark for sulfuric acid. **(b)** **Two marks** if safety mentioned and some correct discussion of slow, low yield reaction. **One mark** only if only one of these aspects discussed. **4**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 26 (4 marks) Combustion within engines (assuming petrol or similar as fuel) produces: Carbon dioxide and water, if **complete combustion** occurs. Carbon monoxide and water, or carbon and water, or a mixture, if **incomplete combustio**n occurs. Unburnt gases (hydrocarbons) can be released into the atmosphere. Nitrogen and oxygen (from air) combine during high temperature combustion, to form nitrogen oxides, nitrogen monoxide and nitrogen dioxide. Engine performance will be optimal if complete combustion occurs, as this will produce most energy from a given amount of fuel. The release of carbon to the atmosphere causes particulate pollution. Release of carbon monoxide is dangerous as carbon monoxide is poisonous. Nitrogen oxides contribute to the formation of ozone in the troposphere and to the formation of PANs and photochemical smog. (Both cause respiratory problems). Hence, the combustion of engines must be monitored to ensure that combustion is as complete as is possible (by ensuring that the fuel to oxygen ratio is correct) to maximise the efficiency and to reduce the pollution.	**Four marks** for discussion which includes: • knowledge of gases released into the atmosphere; • understanding that different conditions produce different gases; • understanding of the relationship between performance of the engine and completeness of combustion; • understanding of the pollution caused by the exhaust gases. **A maximum of 3 marks** if answer does not discuss the importance of monitoring. **4**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 27 (6 marks in total) **(a)** CCl_3F - trichlorofluoromethane **(b)** Chemicals now used instead of CFCs are either: HCFCs (but are being phased out now). CFCs These compounds are able to substitute for CFCs (as aerosols, in fire-extinguishers, as refrigerants) but either: • Break down more readily than CFCs in the troposphere because they contain a C - H bond, hence do not reach the stratosphere where ozone depletion occurs; or • Don't contain Chlorine atoms and so can't release chlorine free radicals in the stratosphere (which cause the chain reactions breaking down the ozone). Hydrocarbons (butane) have also been used as aerosols instead of CFCs. • These don't contain chlorine and don't cause ozone breakdown but are inflammable and increase pollution in the troposphere. Ozone in upper atmosphere (stratosphere) is a benefit to life on earth. In the upper atmosphere the ozone acts to protect the earth from radiation by absorbing the high energy UV radiation, while allowing the low energy UV radiation to reach the earth. This high energy UV radiation would cause cancerous tissues (skin cancer) if it reached the earth.	**(a)** **Two marks** for correct name, formula of a CFC. **One mark** only if a CFC identified but either name or formula incorrect. **No marks** if structure and name are not of a CFC.

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Overall assessment: Hence the impact of substitution of HCFCs and HFCs for CFCs will have a long term beneficial impact on the environment by reducing significantly or stopping the ozone depletion currently occurring. However, the full impact will not be felt for many decades, because • there is already a large concentration of CFCs in the troposphere from earlier decades. • CFCs are very stable, are not combustible and are not dissolved in water (or washed out of the atmosphere by rain). • They very slowly diffuse into the stratosphere. • Legislation to ban the use of CFCs has not yet been fully implemented in some less developed countries.	**(b)** **Four marks** if: • overall assessment made; • replacement chemicals identified; • why they are beneficial correctly discussed; and • time aspect discussed. **6**

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
Question 28 (Total of 7 marks) **(a)** The amount of DO (dissolved oxygen) in the water measures whether water can support respiration of plants and marine animals in that water. High DO (9 ppm) indicates a high concentration of oxygen, hence unpolluted water. If this drops to <4ppm, then the water is considered polluted, and would not support respiration of plants and animals for other than a short period of time. The BOD measures the biological oxygen demand. When water is polluted with organic materials (such as sewage) microscopic aerobic bacteria break down this organic material. The process removes oxygen from the water and the water is said to have a high BOD. If the BOD >10 ppm then the water is said to be polluted; if <5 then the water has still enough oxygen to be regarded as clean. Hence a measure of these 2 properties can gauge the amount of pollution in the water and hence its quality. **(b)** Add dilute nitric acid to acidify the water and remove any carbonate ions. CO_3^{2-} (aq) + $2H^+ \rightarrow CO_2$ (g) + H_2O (l) Add barium chloride solution to the acidified solution. If a precipitate (white) forms, then sulfate ions are present. $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (s)	**(a)** **Three marks** for correct understanding of • DO • BOD • The relationship between pollution and each of these measures. **Two marks** only if the relationship with quality not discussed. **One mark** only if two correct facts about DO or BOD given but relationships not mentioned or incorrectly understood. **(b)** **Two marks** if correct method and correct equation. **One mark** only if method or equation incorrect. **One mark** only if solution not acidified firstly to remove carbonate ions.

Published by Warringal Publications and Barrile Consulting

Suggested answers	Suggested marking guide
(c) Heavy metal ions such as mercury, lead, cadmium, copper are only present in water in very small concentrations (yet can have detrimental impacts on living things). Chemical testing is not effective when concentrations as low as 1 - 100 ppm need to be detected as this amount of matter to be precipitated or measured would be too small for the laboratory techniques and instruments traditionally used. AAS (atomic absorption spectroscopy) can measure differences in concentrations down to 1ppm and hence can be used not only to detect the presence of ions in very low concentration but also to measure differences in these concentrations. This is important for pollution control as scientists must monitor the release of ions into the water supplies to ensure they do not exceed an agreed and legislated maximum concentration.	**(c)** Two marks if both: • Limitations and benefits of 2 methods discussed. • Answer relates the differences correctly to heavy metal ions and why low concentration measurements needed. **One mark** if only 1 of these aspects correctly considered. ***7***

Published by Warringal Publications and Barrile Consulting