SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
PUBLIC EXAMINATION 2002

2002 SAMPLE CHEMISTRY PAPER

The external assessment requirements of the curriculum statement are listed on page 2.

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

Pages: 16
Questions: 4

Time: 3 hours

Question Booklet 1

Examination material: Question Booklet 1 (16 pages)
Question Booklet 2 (14 pages)
Question Booklet 3 (12 pages)
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Candidates

1. You will have 10 minutes to read the paper. You must not write in your question booklets during this reading time but you may make notes on the scribbling paper provided.

2. You will be expected to extract information such as atomic number and relative atomic mass from the periodic table on page 3, which you may remove from this booklet before the examination begins. A table showing the relative activities of a number of metals is on the back of page 3.

3. This paper consists of twelve questions, four in Question Booklet 1, four in Question Booklet 2, and four in Question Booklet 3:

   Question Booklet 1 (Questions 1 to 4)
   Answer ***all parts*** of Questions 1 to 4 in the spaces provided in this question booklet.
   You may write on page 16 if you need more space to finish your answers.

   Question Booklet 2 (Questions 5 to 8)
   Answer ***all parts*** of Questions 5 to 8 in the spaces provided in Question Booklet 2.
   You may write on page 14 of Question Booklet 2 if you need more space to finish your answers.

   Question Booklet 3 (Questions 9 to 12)
   Answer ***all parts*** of Questions 9 to 12 in the spaces provided in Question Booklet 3.
   You may write on page 12 of Question Booklet 3 if you need more space to finish your answers.

4. There is no need to fill all the space provided; clear, well-expressed answers are required. If you delete part or all of an answer you should clearly indicate your final answer.

5. The total mark is 200. The twelve questions are of approximately equal value.

6. Attach your SACE registration number label to the box at the top of this page. Copy the information from your SACE registration number label into the boxes on the front covers of Question Booklet 2 and Question Booklet 3.

7. At the end of the examination, place Question Booklet 2 and Question Booklet 3 inside the back cover of Question Booklet 1.

2002 SAMPLE CHEMISTRY PAPER

The purpose of this sample paper is to show the structure of the Chemistry examination and the style of questions that may be used. The following extract is from the *Chemistry Stage 2 Curriculum Statement.*

Assessment Component 1: Examination

This assessment component is designed to assess primarily Learning Outcomes 2, 4, 5, 6, 7, and 8. It is weighted at 50%.

The 3-hour external examination also assesses the understanding of the key ideas and the intended student learning.

For the examination students will be given a sheet containing a periodic table and a table showing the relative activities of a number of metals.

The following percentages represent the approximate allocation of marks to each strand in the examination:

Acquiring Knowledge of Chemistry	10%
Understanding and Problem-solving	60%
Using Knowledge of Chemistry	10%
Communicating Knowledge of Chemistry	20%.

Criteria for Judging Performance

Suggested criteria for judging performance are set out below. The relevant learning outcomes are listed in parentheses.

Students' performance in the examination will be judged by the extent to which they demonstrate:

- ability to design practical chemical investigations (2);
- critical analysis and evaluation of chemical information and procedures (4);
- knowledge and understanding of chemical concepts (5);
- ability to solve a variety of chemical problems (6);
- understanding of how knowledge can be used to make informed decisions (7);
- communication skills in a range of contexts, using chemical terms and conventions correctly (8).

PERIODIC TABLE OF THE ELEMENTS

1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminium 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.90	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.70	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (97)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3	57[1] La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radius 226.0	89[2] Ac Actinium (227)	104 (261)	105 (262)	106 (263)												

Lanthanide Series[1]	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinide Series[2]	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237.0	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (255)	103 Lr Lawrencium (260)

PLEASE TURN OVER

You may remove this page from the booklet by tearing along the perforations.

You may refer to the following table, which shows the relative activities of a number of metals, when answering questions involving metals.

Metal activity

Most active					*Least active*
A1	Zn	Pb	Cu	Ag	Au

QUESTION 1

An experiment was carried out in which hydrochloric acid and marble chips were added to five flasks at different temperatures. The temperature of each flask and the volume of gas produced in 1 minute in each flask were recorded. The table below shows the results of the experiment:

Flask	Temperature (°C)	Volume of gas (mL)
1	24.1	5.0
2	37.5	11.2
3	45.7	21.4
4	61.2	46.4
5	69.8	82.8

(a) (i) State *one* hypothesis that could be tested by this experiment.

_____

_____

_____

_____

_____ (2 marks)

(ii) State whether or not the results support this hypothesis.

_____

_____ (1 mark)

(b) Identify *two* factors that should be held constant in all five flasks.

Factor 1: _____

_____

Factor 2: _____

_____ (2 marks)

(c) Errors in measurements occur in experiments such as the one described on the page opposite.

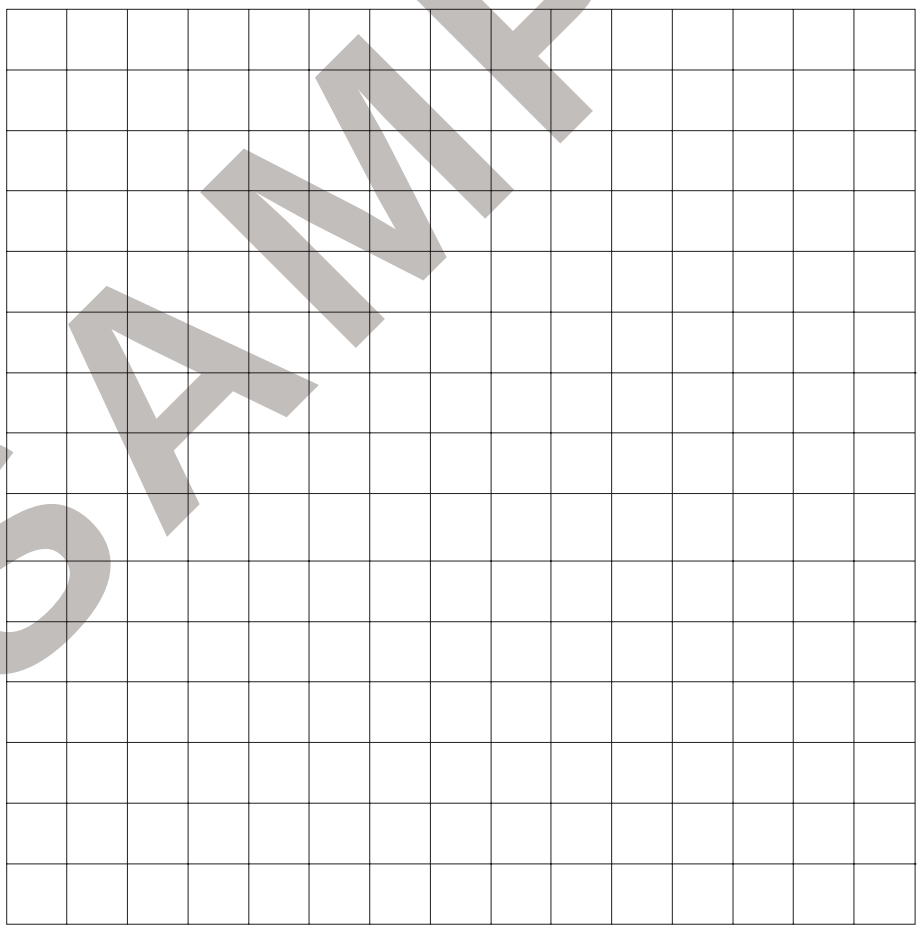
(i) Describe *one* source of systematic error that might occur in this experiment.

(2 marks)

(ii) Describe *one* source of random error that might occur in this experiment.

(2 marks)

(d) Graph the results of this experiment on the grid below.



(6 marks)

(e) A student was concerned that thermometers she used were not giving satisfactory results. She tested her thermometer and two others in a solution at a temperature of exactly 25.2°C and obtained the following readings:

Thermometer 1	24.9°C
Thermometer 2	25.42°C
Thermometer 3	25.1°C

(i) Identify the most precise thermometer. _____ (1 mark)

(ii) Identify the most accurate thermometer. _____ (1 mark)

TOTAL: 17 marks

QUESTION 2

(a) Chlorine, Cl_2, is often used in the disinfection of swimming-pools. For effective disinfection, the concentration of chlorine needs to be a minimum of 2 ppm.

Calculate the minimum effective concentration of chlorine, in mol L^{-1}.

(2 marks)

(b) The formation of hypochlorous acid by the reaction of chlorine with water is shown in the equation below:

$$Cl_2 + H_2O \rightleftharpoons HCl + HOCl$$

(i) State the property of chlorine and compounds such as hypochlorous acid that makes them effective at killing bacteria.

(1 mark)

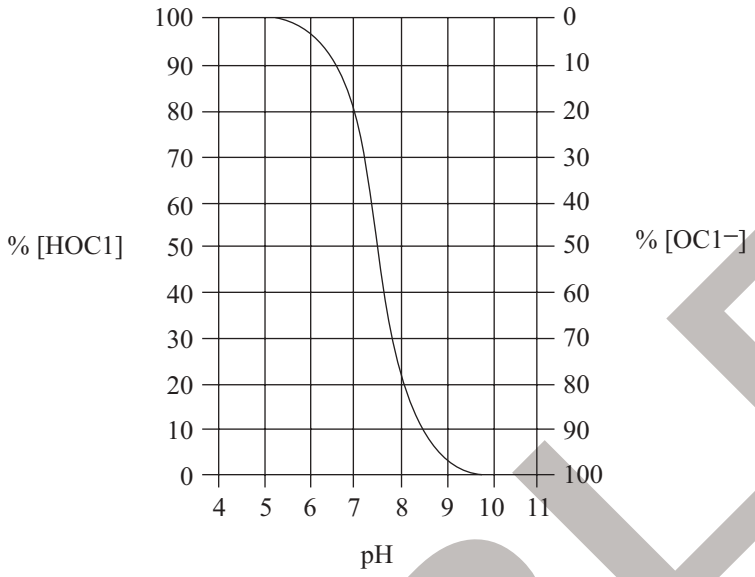
(ii) Explain the effect that the addition of sodium hydroxide solution would have on the concentration of Cl_2 in solution.

(4 marks)

(iii) The HOCl ionises as shown in the equation below:

$$HOCl \rightleftharpoons H^+ + OCl^-$$

The graph below shows the percentages of [HOCl] and [OCl^-] in water at different pH values at 25°C:



(1) State the ratio $\frac{[HOC1]}{[OC1^-]}$ when the pH is 7.

_____ (2 marks)

(2) State the effect of the addition of sodium hypochlorite solution on the pH of the water.

_____ (1 mark)

(c) Dichloroethane is produced by an addition reaction between ethene and chlorine in the presence of the catalyst $FeCl_3$.

(i) Draw the structure of the isomer of dichloroethane most likely to be produced by this reaction.

(2 marks)

(ii) This reaction is exothermic.

State whether the temperature of the reaction mixture would increase or decrease during the reaction.

_____ (1 mark)

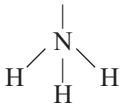
(iii) Explain the effect of the catalyst $FeC1_3$ on the rate of the reaction.

(3 marks)

TOTAL: 16 marks

QUESTION 3

(a) The structural formula of the ammonia molecule is shown below:



Explain why the shape of the ammonia molecule is trigonal pyramidal and not trigonal planar.

(2 marks)

Credit will be given for the correct use of significant figures in calculations in answers to part (b).

(b) Effluent discharged from a certain industrial plant may contain ammonia. Samples of the effluent are therefore collected and analysed to determine the ammonia content. The analysis is carried out as follows:

Step 1 A 100.0 mL sample of effluent is boiled to drive off the dissolved ammonia.

Step 2 The ammonia driven off is bubbled into 10.0 mL of 0.0100 mol L^{-1} hydrochloric acid.

$$NH_{3\,(g)} + HCl_{(aq)} \longrightarrow NH_4Cl_{(aq)}$$

Step 3 The unreacted hydrochloric acid is titrated with 0.0100 mol L^{-1} sodium hydroxide. A titre value obtained in such a titration is 5.23 mL.

$$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(1)}$$

(i) Calculate the number of moles of hydrochloric acid originally in the 10.0 mL aliquot of hydrochloric acid.

(2 marks)

(ii) Calculate the number of moles of hydrochloric acid that reacted with the sodium hydroxide. This is the amount of unreacted hydrochloric acid remaining after the ammonia was bubbled into it.

(3 marks)

(iii) Calculate the number of moles of hydrochloric acid that reacted with the ammonia bubbled into it from the sample of effluent.

(2 marks)

(iv) Calculate the concentration of ammonia, in mol L^{-1}, in the sample of effluent.

(3 marks)

(v) A laboratory technician who carries out this analysis uses the following formula to calculate the concentration of ammonia in the sample of effluent, in ppm:

$$(\text{mL of } 0.0100 \text{ mol } L^{-1} \text{ HCI}_{(aq)} - \text{mL of } 0.0100 \text{ mol } L^{-1} \text{ NaOH}_{(aq)}) \times 1.703$$

Use this formula to calculate the concentration of ammonia in ppm.

(2 marks)

(vi) Predict how the sodium hydroxide titre at Step 3 will change if the amount of ammonia in the effluent increases. Explain your prediction.

Prediction: _____

Explanation: _____

_____

_____

_____ (3 marks)

TOTAL: 17 marks

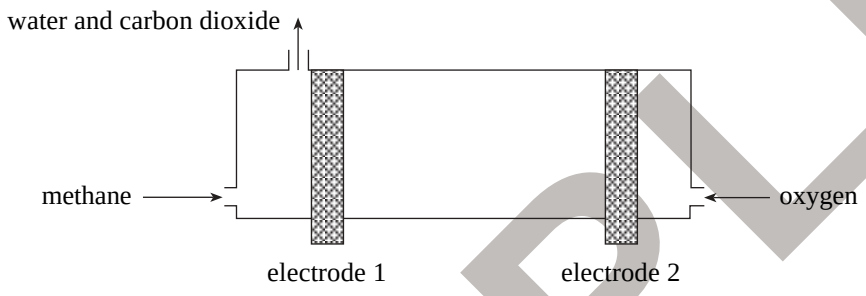
QUESTION 4

(a) Methane is considered to be a greenhouse gas.

(i) Explain what is meant by the term ‘greenhouse gas’.

(2 marks)

(ii) Methane is used in a galvanic cell. Methane reacts at one electrode and oxygen reacts at the other. Water and carbon dioxide are the products.



(1) Complete the following half-equation:

$$CH_4 \longrightarrow CO_2$$

(2 marks)

(2) State whether the electrode at which methane reacts is the anode or the cathode, and explain your answer.

(3 marks)

Credit will be given for answers to part (b) which show clear, well-expressed ideas, and which present accurate and relevant information in a well-organised, logical manner. Your answer, which should include equations, should be confined to the space provided and should take approximately 12 minutes.

(b) The oxides of nitrogen are undesirable in the atmosphere because they may contribute to photochemical smog.

Explain how nitric oxides that are released into the atmosphere by motor vehicles may, under certain atmospheric conditions, cause the formation of photochemical smog. Include in your answer *at least one* reason why photochemical smog is considered undesirable.

(10 marks)

TOTAL: 17 marks

You may write on this page if you need more space to finish your answers to Question Booklet 1. Make sure to label each answer carefully (e.g. 4(a)(ii)(2) continued).

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
PUBLIC EXAMINATION 2002

2002 SAMPLE CHEMISTRY PAPER

SACE REGISTRATION NUMBER

SEQ | FIGURES | CHECK LETTER | BIN

CHEMISTRY

Pages: 14
Questions: 4

Question Booklet 2

Write your answers to Questions 5 to 8 in this question booklet.

QUESTION 5

(a) A peptide was hydrolysed and the following procedure was used to identify the individual amino acids:

Step 1 A sample containing the mixture of amino acids was applied to a silica gel chromatography plate at position **X**, as shown in Figures 1 and 2 below.

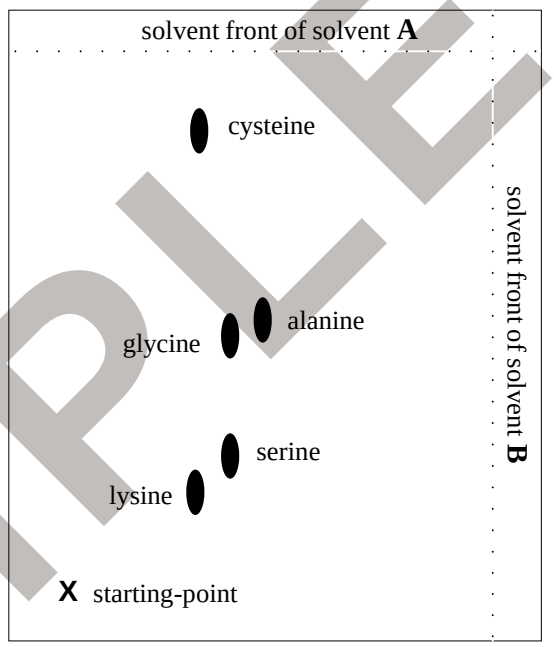
Step 2 Solvent **A** was used as the mobile phase.

Step 3 The plate was dried and turned through 90° anticlockwise.

Step 4 Solvent **B** was used as the mobile phase and produced the chromatogram shown in Figure 2.

chromatogram after Step 2

Figure 1



chromatogram after Step 4

Figure 2

(i) Draw the chromatogram in Figure 1, to show how it would appear after Step 2. (3 marks)

(ii) State why the chromatogram must be run in the second solvent, solvent **B**, for the individual amino acids to be identified.

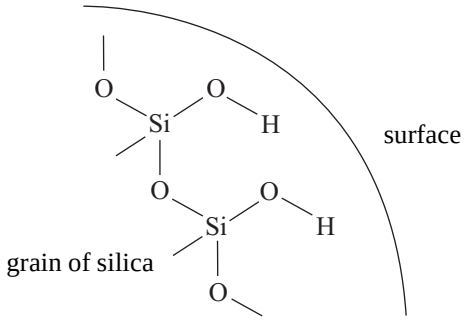
_____

_____ (1 mark)

(iii) State which amino acid(s) would have been difficult to identify if *only solvent **B*** had been used.

_____ (2 marks)

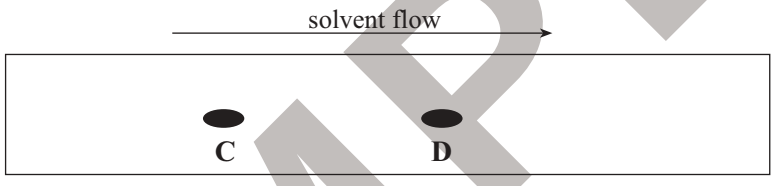
(b) One stationary phase frequently used in chromatography contains hydrated silica. The surface of a grain of hydrated silica contains oxygen atoms bonded to silicon atoms and to hydrogen atoms, as shown in the diagram below:



(i) State whether the surface of a grain of hydrated silica is a polar or a non-polar stationary phase.

_____ (1 mark)

(ii) The diagram below shows where compound **C** (which is more polar) and compound **D** (which is less polar) would be observed on a chromatogram that uses hydrated silica as the stationary phase:



Explain the relative positions of **C** and **D**.

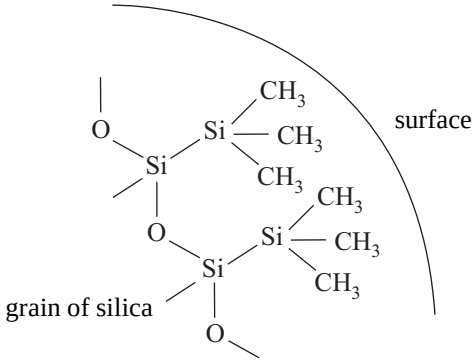
_____

_____

_____

_____ (2 marks)

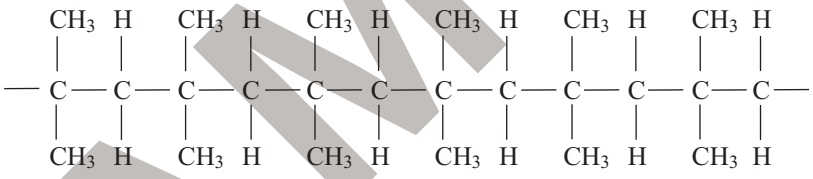
(c) Silica can be modified by chemical treatment to form a material with the structure shown in the diagram below:



Explain why this material could be used to adsorb spilt oil.

(2 marks)

(d) A product that contains poly(isobutylene) may also be used to adsorb spilt oil. The structural formula of poly(isobutylene) is shown below:



poly(isobutylene)

(i) On the diagram above, indicate the repeating unit. (1 mark)

(ii) (1) Draw the structural formula of the monomer from which poly(isobutylene) is derived.

(1 mark)

(2) Describe what would be observed if a solution of bromine was added to the monomer.

_____

_____

_____

_____ (2 marks)

(iii) Name the type of polymerisation by which poly(isobutylene) is produced.

_____ (1 mark)

(iv) State whether poly(isobutylene) is likely to be a thermoplastic or a thermoset polymer.

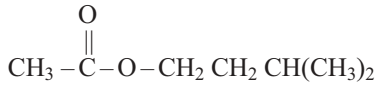
_____ (1 mark)

TOTAL: 17 marks

QUESTION 6

Many foods contain edible oils and other esters.

(a) The structural formula of an ester, **E**, that is a constituent of pineapple oil and banana oil is shown below:



E

(i) **E** can be prepared in the laboratory from a carboxylic acid and an alcohol.

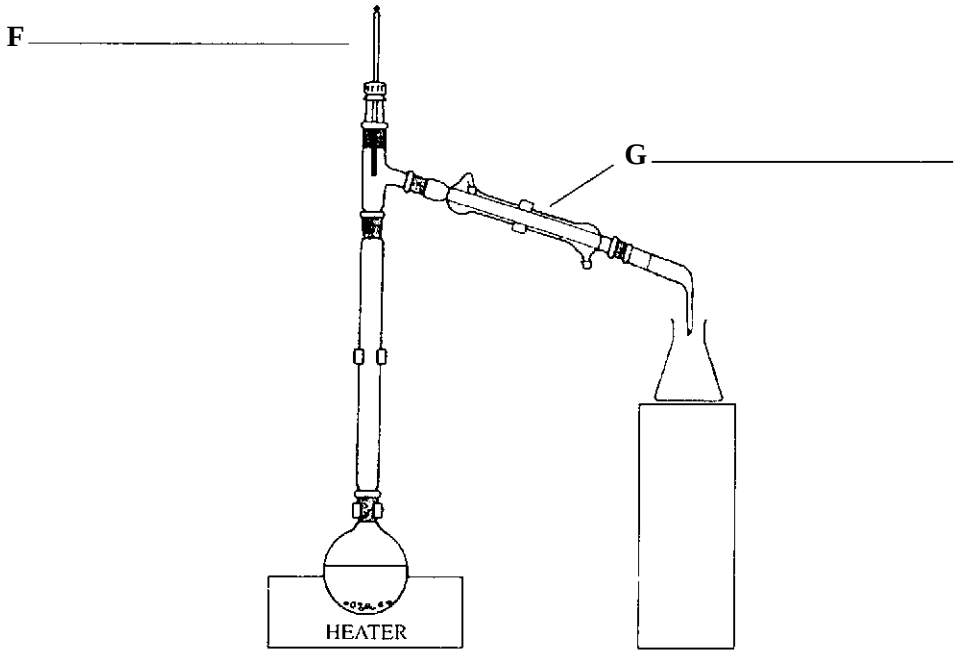
(1) Write the structural formula of the alcohol.

(1 mark)

(2) State the systematic name of the alcohol.

_____ (2 marks)

(ii) Apparatus used to collect **E** by distillation is shown in the diagram below:



(1) State the names of the components labelled **F** and **G** in the spaces provided on the diagram above. (2 marks)

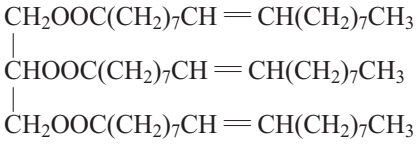
(2) On the diagram above, indicate the direction of the water flow in and out of **G**. (1 mark)

(3) On the diagram above, circle and name the part of the apparatus that collects the distillate. (1 mark)

(4) State the function of the boiling chips in the flask shown in the diagram on the page opposite.

_____ (1 mark)

(b) Fats and oils are tri-esters. The structural formula of one oil, **H**, is shown below:



H

(i) Liquid vegetable oils may be converted into margarine by catalytic hydrogenation. Draw the structural formula of a product obtained by the hydrogenation of **H**.

(1 mark)

(ii) Diacetyl and methyl acetyl carbinol are two liquids added to margarine to imitate the flavour of butter. The structural formula of each liquid is shown in the diagram below:

diacetyl **methyl acetyl carbinol**

(1) On the diagram above, circle and name the functional group that is in methyl acetyl carbinol but not in diacetyl. (2 marks)

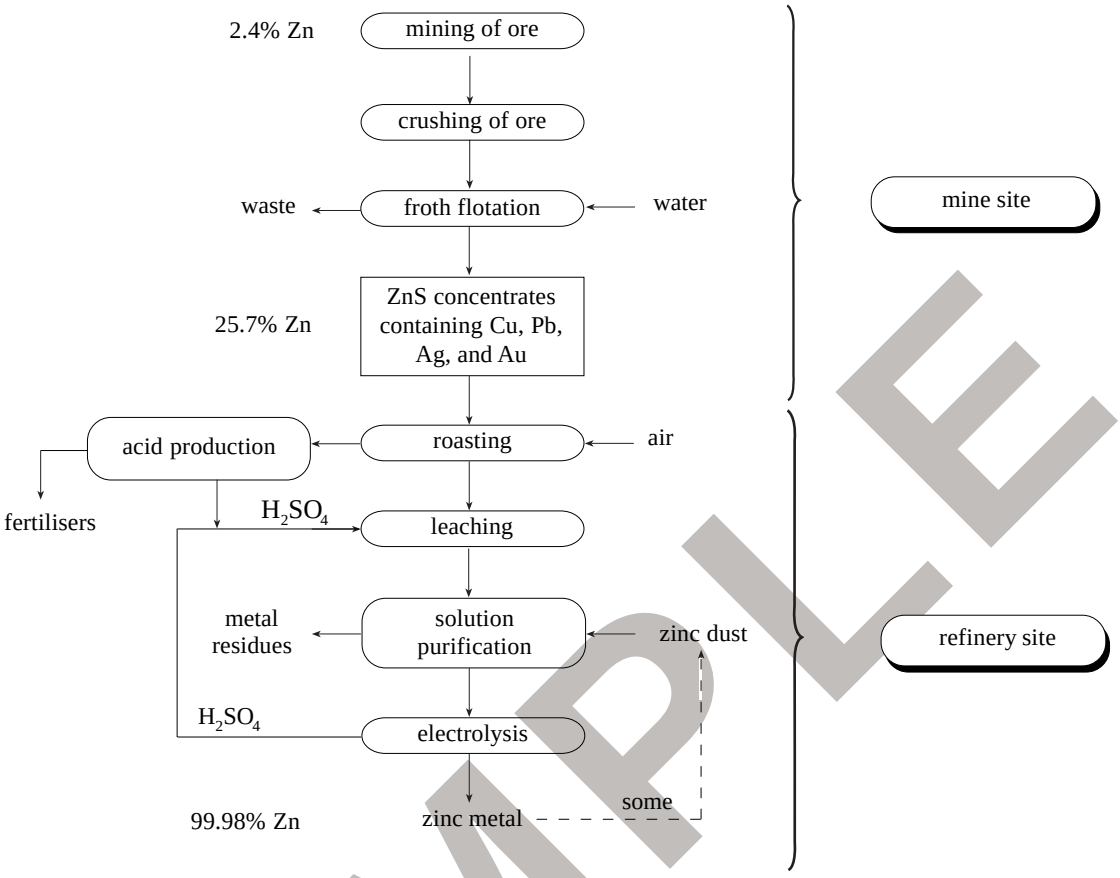
(2) Describe how you would carry out a chemical test in the laboratory to distinguish between unlabelled samples of diacetyl and methyl acetyl carbinol.

(5 marks)

TOTAL: 16 marks

QUESTION 7

Zinc ore contains zinc blende (ZnS), usually mixed with small amounts of other minerals. Zinc metal is extracted in the series of processes shown in the flow chart below:



(a) Name *two* raw materials used in the extraction of zinc metal.

_____

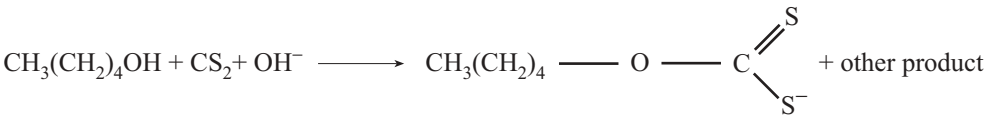
_____ (2 marks)

(b) Name *two* by-products produced in the extraction of zinc metal.

_____

_____ (2 marks)

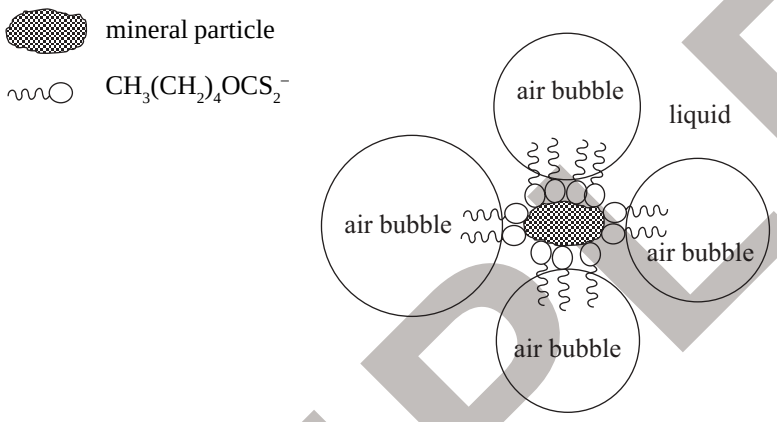
(c) The process of froth flotation involves the use of xanthates, which have structures similar to those of soaps and detergents. The equation for the formation of a xanthate ion is shown below:



(i) Write the formula of the 'other product' shown in the equation above.

_____ (1 mark)

(ii) The action of xanthates in froth flotation is shown in the diagram below:



Explain why the xanthate ions arrange themselves as shown in the diagram above.

_____

_____

_____

_____

_____

_____ (3 marks)

(iii) Suggest *two* reasons for carrying out the froth flotation at the mine site rather than at the refinery site 500 km away.

_____

_____

_____

_____ (2 marks)

(d) Write a balanced equation for the roasting of the ZnS.

(2 marks)

(e) The process of solution purification involves the removal of metal ions (such as silver ions) that would interfere with the production of zinc metal during electrolysis.

State why silver ions in the electrolysis solution would interfere with the production of zinc metal.

_____

_____ (1 mark)

(f) (i) Write the half-equation for the reaction at the positive electrode in the electrolysis of the zinc solution.

(2 marks)

(ii) State why the electrolyte used for the production of aluminium has to be molten and not an aqueous solution of aluminium ions.

_____

_____

_____

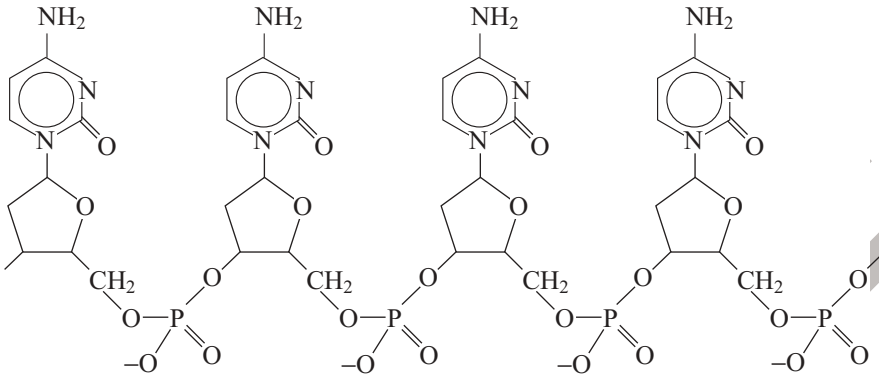
_____ (2 marks)

TOTAL: 17 marks

QUESTION 8

Sugars are essential to the functioning of cells.

(a) The structural formula below shows a section of a nucleic acid chain:



(i) State *one* function of nucleic acids.

_____ (1 mark)

(ii) On the diagram above, mark *one* repeating unit on the nucleic acid chain. (1 mark)

(iii) (1) Determine the molecular formula of the sugar that has been used in producing this nucleic acid chain.

_____ (1 mark)

(2) This sugar also exists in a chain form that reacts with Tollen's reagent (ammonical silver nitrate solution).

Name the *two* functional groups present in the chain form of this sugar.

_____ (2 marks)

(iv) Write the formulae of *two* products obtained when this nucleic acid decays under anaerobic conditions.

(2 marks)

(b) Cells produce energy by the aerobic respiration of glucose.

(i) (1) Write a thermochemical equation for the aerobic respiration of glucose, given that 2803 kJ of energy are released per mole of glucose and the water produced is in the liquid state.

(4 marks)

(2) Calculate the quantity of heat released during the complete combustion of 0.0100 g of glucose.

(2 marks)

(ii) Name the *two* products formed from the fermentation of glucose.

_____ (2 marks)

(c) Glucose can be formed from disaccharides.
Write a balanced equation for the hydrolysis of a disaccharide to form glucose.

(2 marks)

TOTAL: 17 marks

You may write on this page if you need more space to finish your answers to Question Booklet 2. Make sure to label each answer carefully (e.g. 5(d)(ii)(2) continued).

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
PUBLIC EXAMINATION 2002

2002 SAMPLE CHEMISTRY PAPER

SACE REGISTRATION NUMBER

SEQ | FIGURES | CHECK LETTER | BIN

CHEMISTRY

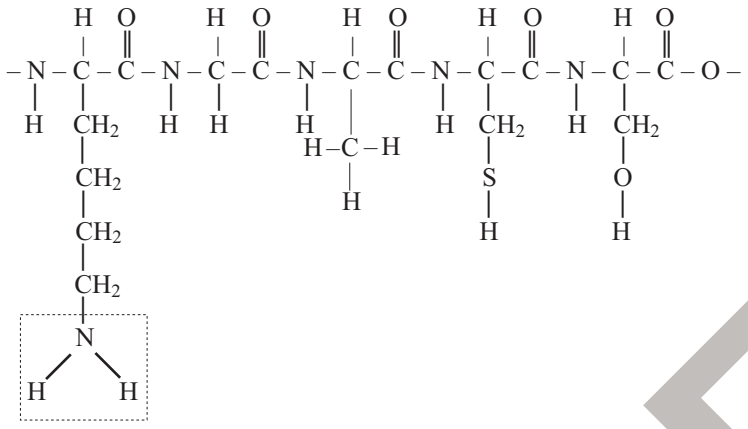
Pages: 12
Questions: 4

Question Booklet 3

Write your answers to Questions 9 to 12 in this question booklet.

QUESTION 9

A section of a protein chain in an enzyme is shown in the diagram below:



I

(a) (i) State the name of functional group **I**. _____ (1 mark)

(ii) On the diagram above, circle *one* peptide (amide) group. (1 mark)

(iii) On the diagram above, indicate the polarity of the S–H bond. (1 mark)

(b) Hydrogen bonding contributes to the three-dimensional arrangement of a protein chain.

(i) Describe a hydrogen bond.

_____

_____

_____

_____ (2 marks)

(ii) On the diagram above, clearly indicate *one* hydrogen atom, shown in the protein chain, that could form a hydrogen bond to the nitrogen atom in functional group **I**. (1 mark)

(iii) Environmental conditions may disrupt the hydrogen bonding in a protein.

(1) Describe *one* environmental condition that may disrupt the hydrogen bonding in a protein.

_____

_____ (2 marks)

(2) Explain how the disruption of the protein chain in an enzyme affects its function.

(3 marks)

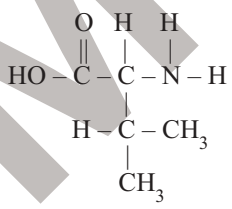
(c) (i) State the number of amino acid molecules that were used in making the section of the protein chain shown on the page opposite.

(1 mark)

(ii) Draw the structural formula of the smallest amino acid monomer that has been incorporated in this section of the protein chain.

(2 marks)

(iii) The structural formula of an amino acid is shown below:



This amino acid is able to self-ionise.

Draw the structural formula of the salt formed when this amino acid self-ionises.

(2 marks)

TOTAL: 16 marks

QUESTION 10

Atomic absorption spectroscopy (AAS) can be used to detect impurities such as cadmium in refined copper.

(a) A sample of copper was prepared for atomic absorption spectroscopy according to the following flow chart:

1.00 g sample of copper → dissolved in acids → made up to 100.0 mL (Solution A) → 10.0 mL sample taken → made up to 100.0 mL (Solution B) → analysed using AAS

(i) Name the piece of volumetric apparatus used to:

(1) take the 10.0 mL sample.

_____ (1 mark)

(2) prepare exactly 100.0 mL of Solution B.

_____ (1 mark)

(ii) Name the solution used to rinse the piece of volumetric apparatus used to take the 10.0 mL sample.

_____ (1 mark)

(b) A calibration curve for measuring cadmium impurity must be constructed before samples of copper can be analysed.

(i) Describe how to construct a calibration curve for measuring cadmium impurity.

_____

_____

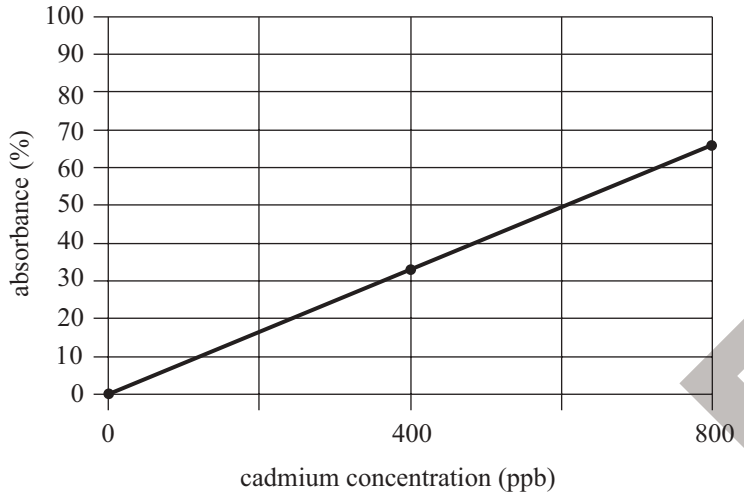
_____

_____

_____

_____ (3 marks)

(ii) A laboratory technician produced a calibration curve for cadmium absorbance, using three data points, as shown on the graph below:



(1) The absorbance for the sample of Solution B was 22%.

Use the graph above to determine the concentration of the cadmium ions, in ppm.

(2 marks)

(2) Three data points are usually considered inadequate in the construction of a calibration curve.

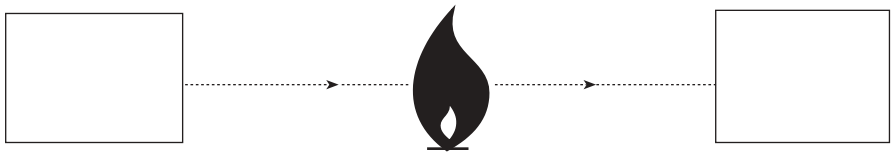
State why more data points are preferred.

_____

_____ (1 mark)

Credit will be given for answers to part (c) which show clear, well-expressed ideas, and which present accurate and relevant information in a well-organised, logical manner. Your answer should be confined to the space provided and should take approximately 10 minutes.

(c) The main components of the instrument used in atomic absorption spectroscopy are shown in the diagram below:



lamp flame detector

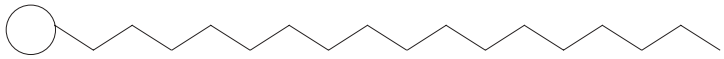
Explain how an atomic absorption spectrometer can be used to detect cadmium impurity in refined copper. In your answer refer to each of the components shown in the diagram above.

(8 marks)

TOTAL: 17 marks

QUESTION 11

(a) The diagram below represents a soap anion:



(i) On the diagram above, circle the part of the soap anion that is hydrophilic. (1 mark)

(ii) Soap anions form micelles in water.
State whether the hydrophilic part would be on the inside or the outside of a soap micelle.

_____ (1 mark)

(iii) Explain why soap anions clean significantly less effectively when added to water containing magnesium ions.

_____

_____

_____

_____ (2 marks)

(b) Sodium salts of polyphosphate ions are added to some detergent mixtures to remove the magnesium ions from water.

(i) Write the formula of a sodium tripolyphosphate salt.

_____ (1 mark)

(ii) Hydroxide ions are produced when tripolyphosphate ions are dissolved in water.
State the effect that increasing the concentration of hydroxide ions has on the pH of the water.

_____ (1 mark)

(c) Sodium carbonate is added to some detergent mixtures to remove the magnesium ions from water.

(i) Write an ionic equation for the reaction of sodium carbonate solution with magnesium ions.

(2 marks)

(ii) State *one* reason why sodium carbonate may be used in preference to sodium tripolyphosphate in detergent mixtures.

_____

_____ (1 mark)

(d) Magnesium ions can be removed by passing the solution through a column containing a zeolite. The formula of one zeolite is $Na_2CaAl_2Si_6O_{17}.6H_2O$.

(i) State the charge on the aluminosilicate ion in the zeolite.

_____ (1 mark)

(ii) An aluminosilicate is formed from a silicate by the replacement of some of the silicon atoms with aluminium atoms.

Calculate the percentage of silicon atoms that have been replaced with aluminium atoms in the aluminosilicate ion.

(2 marks)

(iii) One reaction of magnesium ions with zeolite may be represented by the following equation:

$$Na_2CaAl_2Si_6O_{17}.6H_2O + Mg^{2+}_{(aq)} \rightleftharpoons MgCaAl_2Si_6O_{17}.6H_2O + 2Na^{+}_{(aq)}$$

(1) Explain why sodium ions are exchanged more readily than calcium ions on the zeolite surface.

_____

_____

_____

_____ (2 marks)

(2) The zeolite column may be used many times if the zeolite is regenerated after use.

Explain why a sodium chloride solution used to regenerate the zeolite column is more effective if the solution is concentrated.

_____

_____

_____

_____ (2 marks)

TOTAL: 16 marks

QUESTION 12

(a) Nitrogen is important in the chemistry of plants.

(i) Name *one* nitrogen-containing organic chemical that is found in plants.

_____ (1 mark)

(ii) (1) State how fertilisers containing nitrate ions or ammonium ions make nitrogen available to plants.

_____

_____ (1 mark)

(2) Ammonium ions lead to an increase in the acidity of soil water.

Write an equation for the reaction of ammonium ions with water.

(2 marks)

(iii) Describe how lightning makes nitrogen from the air available to plants.

_____

_____

_____

_____

_____

_____ (3 marks)

(b) Calcium ions adsorbed onto the surfaces of clay minerals, $Ca^{2+}_{(clay)}$, are in equilibrium with dissolved calcium ions in soil water, $Ca^{2+}_{(water)}$, as shown by the equation below:

$$Ca^{2+}_{(clay)} \rightleftharpoons Ca^{2+}_{(water)}$$

(i) Plants absorb calcium ions from the soil water.

State the effect that the absorption of calcium ions by plants has on the position of the equilibrium between the adsorbed calcium ions and the dissolved calcium ions.

_____

_____ (1 mark)

(ii) (1) Explain how acid rain may lead to a calcium deficiency in soils in regions of high rainfall.

_____

_____

_____

_____

_____

_____ (3 marks)

(2) Calculate the concentration of hydronium ions in acid rain that has a pH of 3.2.

(2 marks)

(c) Acid rain results from the release of sulfur and nitrogen oxides into the atmosphere.

(i) Identify *one* human activity that leads to the release of sulfur dioxide into the atmosphere.

_____ (1 mark)

(ii) (1) One way of removing sulfur dioxide from waste gases is to bubble the gases, in the presence of air, through columns of slaked lime ($Ca(OH)_2$) to form calcium sulfate.

Write a balanced equation for this process.

(2 marks)

(2) State *one* environmental disadvantage of using this process.

_____

_____ (1 mark)

TOTAL: 17 marks

You may write on this page if you need more space to finish your answers to Question Booklet 3. Make sure to label each answer carefully (e.g. 10(b)(ii)(1) continued).