SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2005

2005 CHEMISTRY

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET 1

15 pages, 4 questions

Wednesday 16 November: 1.30 p.m.

Time: 3 hours

Question Booklet 1

Examination material: Question Booklet 1 (15 pages)
Question Booklet 2 (12 pages)
Question Booklet 3 (13 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 or use a calculator 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 of Question Booklet 1, which you may remove from this booklet before the examination begins. Tables showing the relative activities of metals and SI prefixes are 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 15 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 12 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 13 of Question Booklet 3 if you need more space to finish your answers.

4. There is no need to fill all the space provided; clearly written, 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.

STUDENT'S DECLARATION ON THE USE OF CALCULATORS

By signing the examination attendance roll I declare that:

- my calculators have been cleared of all memory;
- no external storage media are in use on these calculators.

I understand that if I do not comply with the above conditions for the use of calculators I will:

- be in breach of the rules;
- receive zero marks for the examination;
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as SSABSA determines.

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 Radium 226.0	89[2] Ac Actinium (227)	104 (261)	105 (262)	106 (263)												

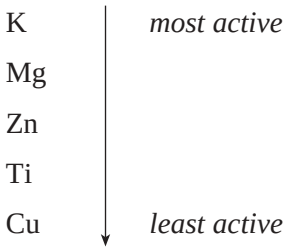
Lanthanide Series[1]	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 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)

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

PLEASE TURN OVER

You may refer to the following table, which shows the relative activities of a number of metals, when answering questions that involve metals:

Metal Activity



You may refer to the following table, which shows SI prefixes, their symbols and their values, when answering questions that involve the conversion of units:

SI prefix	Symbol	Value
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

QUESTION 1

The elements titanium and zinc make important contributions to modern society.

(a) Identify the block of the periodic table in which titanium and zinc are found.

_____ (1 mark)

(b) The element titanium occurs naturally as the mineral titanium dioxide, TiO_2.

(i) TiO_2 reacts with sodium hydroxide to form the ion TiO_3^{2-}.

(1) Write an equation for the reaction of TiO_2 with sodium hydroxide.

(2 marks)

(2) Explain how this reaction indicates that titanium has some non-metallic properties.

_____

_____

_____

_____ (2 marks)

(ii) TiO_2 is used in products that prevent sunburn. One sunburn cream contains a 3.0%w/w concentration of TiO_2.

Calculate the mass, in g, of TiO_2 needed to prepare 250 g of this sunburn cream.

(1 mark)

(iii) Finely powdered TiO_2 and $CaCO_3$ particles can be used in paint to reduce the concentration of nitrogen oxides in the air. The light energy that TiO_2 absorbs from sunlight is used to convert nitrogen oxides into nitric acid.

(1) State a name for the type of reaction in which light energy is absorbed.

_____ (1 mark)

(2) Write a half-equation for the conversion of NO into HNO_3.

(2 marks)

(3) The nitric acid reacts with the $CaCO_3$ to form calcium nitrate.

Write an equation for this reaction.

(2 marks)

(4) State one advantage of reducing the concentration of nitrogen oxides in the air in urban areas.

_____ (1 mark)

(5) State one chemical advantage of using finely powdered TiO_2 and $CaCO_3$ particles in the paint.

_____ (1 mark)

(iv) TiO_2 is used to prepare pure titanium for medical uses. The sequence of reactions is shown below:

Reaction 1 $\quad TiO_2 + C + Cl_2 \longrightarrow TiCl_4 + CO$

Reaction 2 $\quad TiCl_4 + 2Mg \longrightarrow Ti + 2MgCl_2$

(1) Balance the equation for Reaction 1. (1 mark)

(2) State the function of carbon in Reaction 1.

_____ (1 mark)

(3) Explain why copper cannot replace magnesium in Reaction 2.

_____

_____

_____

_____ (2 marks)

TOTAL: 17 marks

QUESTION 2

Food components listed on food packaging include carbohydrates, amino acids, and proteins.

(a) Carbohydrates are classified as polysaccharides, disaccharides, and monosaccharides. Polysaccharides can be converted into disaccharides and monosaccharides in living cells.

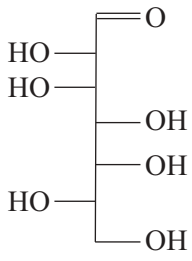
(i) State the type of reaction in which polysaccharides are converted into disaccharides and monosaccharides.

_____ (1 mark)

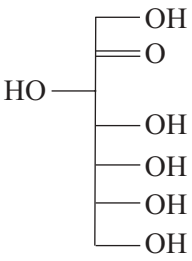
(ii) Write an equation for the conversion of polysaccharides into monosaccharides.

(2 marks)

(iii) The structural formulae of two monosaccharides, **A** and **B**, are shown below:



A



B

(1) Explain why **A** and **B** are described as isomers.

_____

_____

_____

_____ (2 marks)

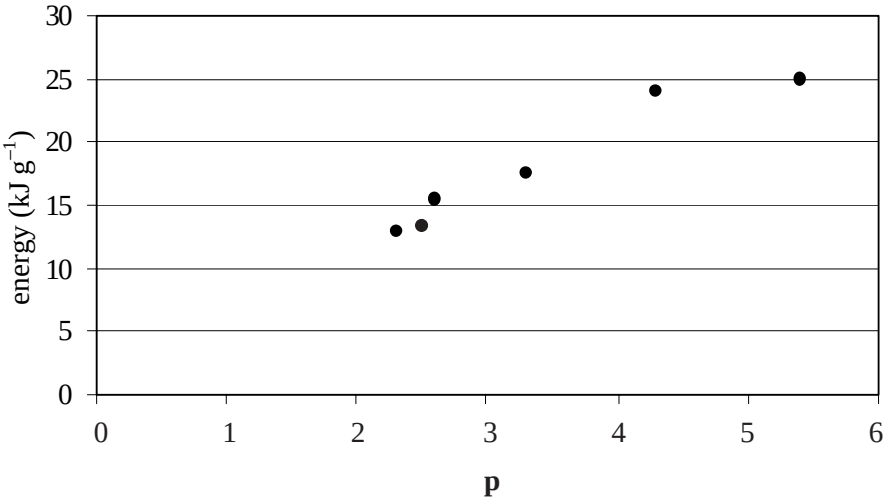
(2) Identify which one of **A** and **B** would react with Tollen's reagent, and state the observation that would indicate a reaction had occurred.

_____

_____

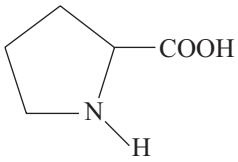
_____ (2 marks)

(b) An experiment was performed to study the effect of the chemical structure of amino acids on their energy content. The energy released by the combustion of each amino acid was plotted against a value related to the combustible portion, **p**, of the amino acid. The results of the experiment are shown in the graph below:



(i) Draw a line of best fit to complete the graph. (1 mark)

(ii) The structural formula of the amino acid proline is shown in the diagram below:



(1) Write the molecular formula of proline.

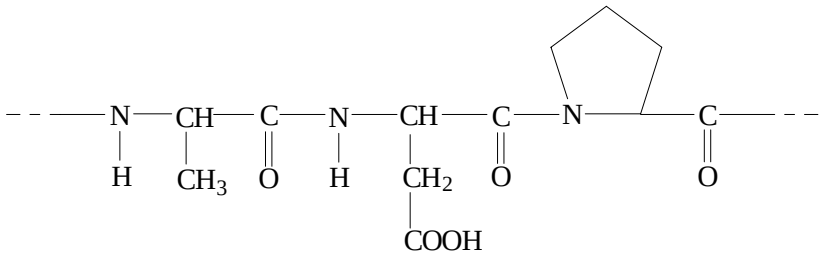
_____ (2 marks)

(2) The value of **p** for proline is 4.7.

On the graph above, show the energy released by the combustion of 1 g of proline and hence state the value to two significant figures.

_____ (2 marks)

(iii) One section of a protein chain that includes proline is shown in the diagram below:



(1) State the number of amino acids used to form this section.

_____ (1 mark)

(2) The energy content of protein in food is stated as an average value on food packaging.

Explain why the energy content of protein in food can be stated only as an average value whereas the energy content of glucose in food is stated as a specific value.

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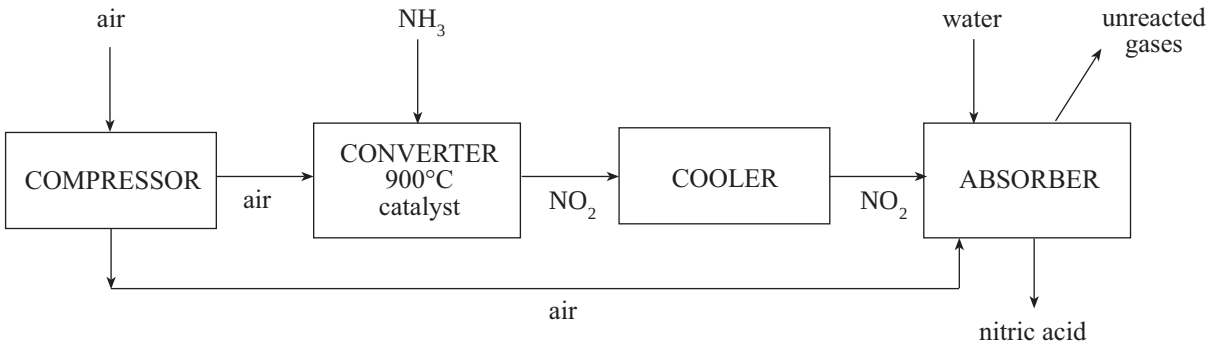
_____ (3 marks)

TOTAL: 16 marks

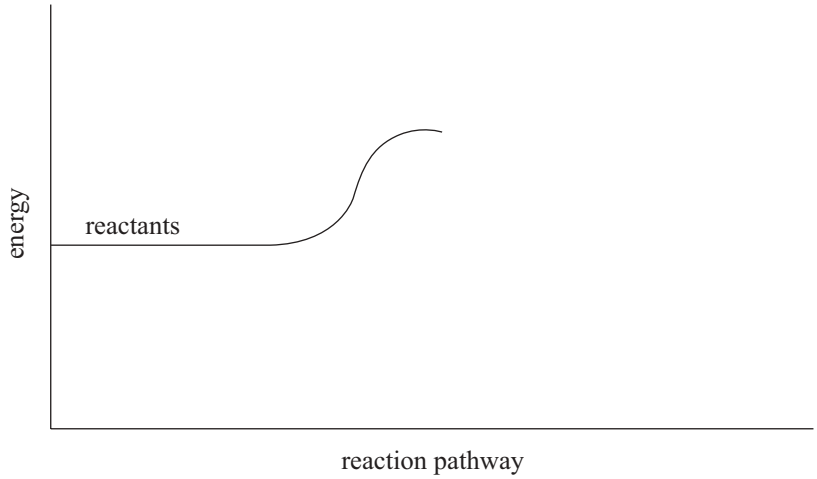
QUESTION 3

The production of nitric acid in a factory is summarised in the flow chart below:



(a) The production of NO_2 in the converter involves a series of chemical reactions. The overall reaction in the converter is exothermic.

(i) The beginning of the energy profile for the overall reaction is shown in the diagram below:



(1) Complete the energy profile diagram, clearly identifying ΔH and the activation energy. (3 marks)

(2) Using the energy profile diagram, explain why the gases in the converter need to be heated initially.

_____

_____

_____

_____ (2 marks)

(3) Explain why heating is no longer necessary once the reaction has started.

_____

_____

_____

_____ (2 marks)

(ii) The catalyst is important for the efficiency of the reaction in the converter.

(1) On the energy profile diagram in part (i), draw the reaction pathway of this reaction without the catalyst. (1 mark)

(2) State the effect of the catalyst on the enthalpy of this reaction.

_____ (1 mark)

(b) (i) Identify from the flow chart the two raw materials that are added to the absorber to convert the NO_2 into nitric acid.

_____ (2 marks)

(ii) Determine the oxidation state of nitrogen in NO_2.

_____ (1 mark)

(iii) Write an equation for the conversion of NO_2 into nitric acid in the absorber.

(2 marks)

(iv) Describe one disadvantage for the manufacturer if gases containing NO_2 are emitted from the factory.

_____

_____

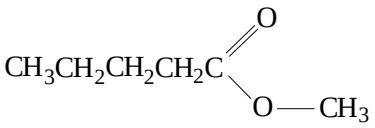
_____

_____ (2 marks)

TOTAL: 16 marks

QUESTION 4

(a) Methanol is used to make a compound with the structural formula shown in the diagram below:



Write the systematic name of this compound.

_____ (2 marks)

(b) Methanol is produced by the reaction of carbon monoxide with hydrogen, as shown in the equation below:

$$CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$$

Equilibrium is established in a closed system under high pressure in the presence of a catalyst.

(i) State two reasons for using high pressure in this system.

_____

_____

_____

_____ (2 marks)

(ii) State why a closed system is necessary to establish equilibrium.

_____

_____ (1 mark)

(iii) At a particular temperature, the value of K_c for this equilibrium is 0.02.

(1) Write the K_c expression for this reaction.

(1 mark)

(2) Using this K_c value, state whether the equilibrium mixture at this temperature contains a greater proportion of products or of reactants. Explain your answer.

_____

_____

_____ (2 marks)

(iv) At a different temperature, CO and H_2 were placed in a 1.0 L reaction container and allowed to reach equilibrium. The data collected are shown in the table below:

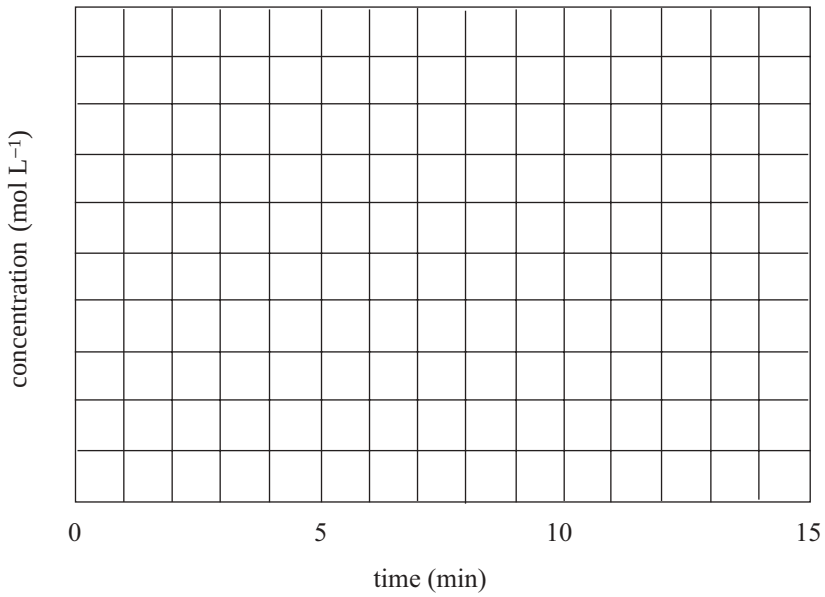
	CO	H_2	CH_3OH
initial moles	5.0	5.0	0
moles at equilibrium			2.0

(1) Calculate the number of moles of CO and H_2 at equilibrium.

(2 marks)

(2) Equilibrium was established at 10 minutes.

Using the data, draw graphs on the grid below to show the change in concentrations of CO and CH_3OH from 0 to 15 minutes.



(3 marks)

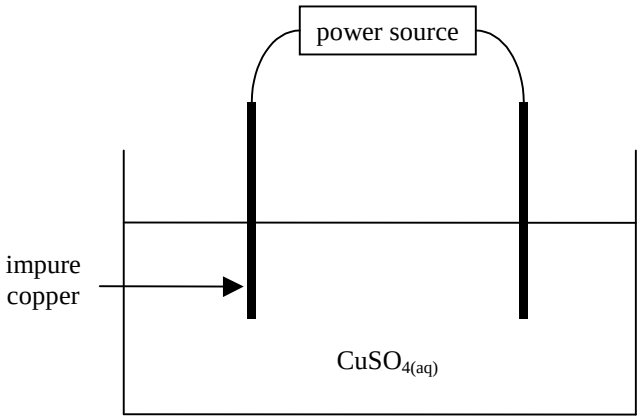
(c) Copper can be used to make the catalyst necessary for the production of methanol.

(i) Predict the likely method of reduction used to convert a copper mineral into copper.

_____

(1 mark)

(ii) The copper used in the catalyst must be of high purity. Impure copper can be refined using electrolytic apparatus, as shown in the diagram below:



(1) State whether the impure copper is connected to the positive terminal or to the negative terminal of the power source.

_____ (1 mark)

(2) Write a half-equation for the production of pure copper.

(2 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(b)(i) continued).

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2005

2005 CHEMISTRY

SACE REGISTRATION NUMBER

SEQ | FIGURES | CHECK LETTER | BIN

CHEMISTRY

QUESTION BOOKLET

2

12 pages, 4 questions

Wednesday 16 November: 1.30 p.m.

Question Booklet 2

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

QUESTION 5

(a) Hair is made of protein.

(i) The structure of one section of a protein chain in hair is shown in Diagram 1 below:

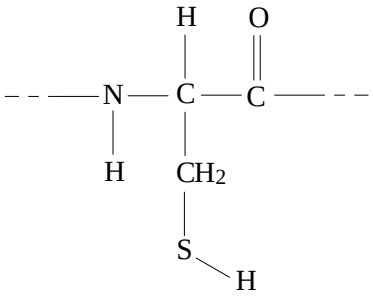


Diagram 1

Draw the structural formula of the amino acid used to form this section of the protein chain.

(2 marks)

(ii) Two protein chains in hair can be joined by a sulfur–sulfur bridge, as shown in Diagram 2 below:

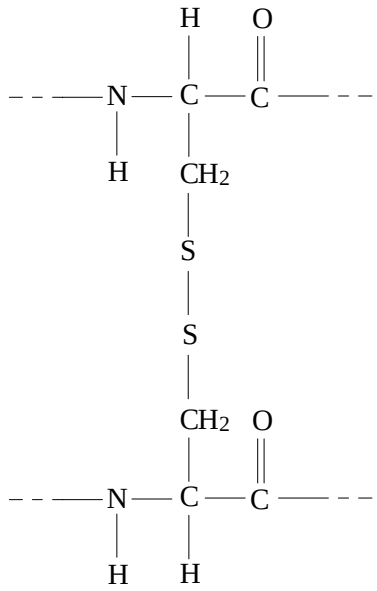


Diagram 2

Name the type of bond that holds the two sulfur atoms together.

_____ (1 mark)

(iii) The structures of sections of two protein chains in hair are shown in Diagram 3 below:

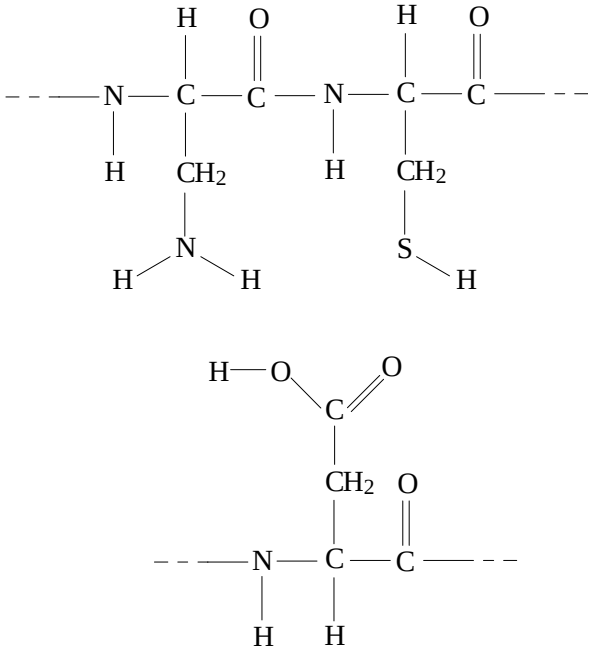


Diagram 3

(1) Draw one hydrogen bond that forms between the two protein chains in Diagram 3, indicating the partial charges on the atoms involved. (2 marks)

(2) State which bond is stronger, the hydrogen bond in Diagram 3 or the bond between the two sulfur atoms in Diagram 2.

_____ (1 mark)

(3) Some alkaline hairstyling products strengthen the interactions between protein chains.

Explain the effect these products would have on the type of interaction between the two protein chains shown in Diagram 3.

_____

_____

_____

_____

_____

_____ (3 marks)

(b) (i) Lead(II) ethanoate is used in a men's hair product to dye white hair black.

Write the formula of lead(II) ethanoate.

_____ (2 marks)

(ii) Atomic absorption spectrometry can detect lead in hair.

(1) Explain how standard solutions of lead nitrate may be used to calibrate a spectrometer.

_____

_____

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_____

_____ (4 marks)

(2) Calculate the mass, in mg, of lead nitrate needed to prepare 250 mL of 150 ppm standard solution.

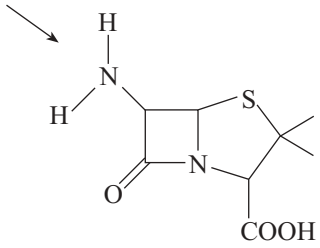
(2 marks)

TOTAL: 17 marks

QUESTION 6

Penicillins are used to treat bacterial infections in animals.

(a) A common form of penicillin has the structural formula shown in the diagram below:



(i) (1) State whether the amino group, indicated by the arrow, is primary, secondary, or tertiary.

_____ (1 mark)

(2) Explain why the arrangement of atoms around the nitrogen atom in this amino group is trigonal pyramidal.

_____

_____

_____

_____

_____

_____ (3 marks)

(ii) Penicillin is usually given to animals in the form of its sodium salt.

(1) On the diagram above, circle the functional group that must be altered for the sodium salt to be produced. (1 mark)

(2) Explain why penicillin is given to animals in the form of its sodium salt rather than in its molecular form.

_____

_____

_____

_____

_____

_____ (3 marks)

(b) The synthetic penicillin amoxycillin hydrolyses in a solution of sodium hydroxide.

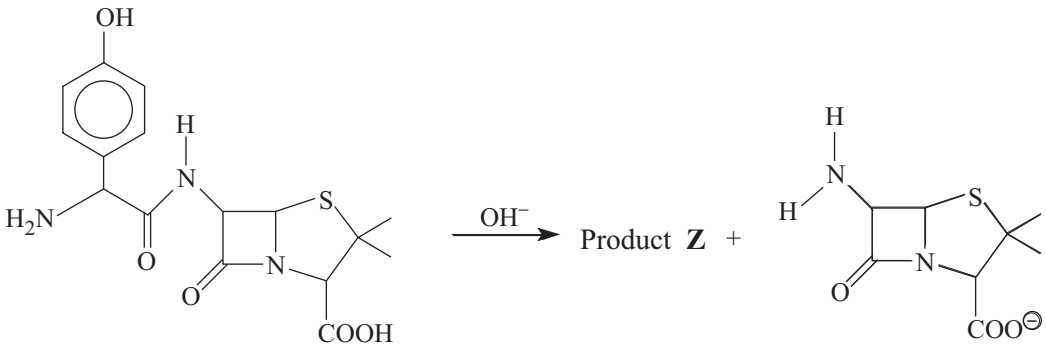
(i) Calculate the mass of sodium hydroxide needed to prepare 1 L of solution of concentration 0.005 mol L^{-1}.

(2 marks)

(ii) Determine the pH of this solution of sodium hydroxide.

(3 marks)

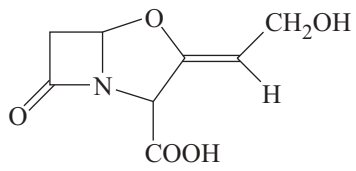
(iii) The alkaline hydrolysis of amoxycillin results in the formation of two products, as shown in the diagram below:



Draw the structural formula of Product **Z**.

(2 marks)

(iv) Amoxycillin is sometimes mixed with clavulanic acid. The structural formula of clavulanic acid is shown in the diagram below:



State the colour change that is observed when a solution of clavulanic acid is shaken with a solution of bromine.

_____

_____ (2 marks)

TOTAL: 17 marks

QUESTION 7

Hydrogen and methanol are fuels used to power some motor vehicles.

(a) Hydrogen can be used in a fuel cell.

(i) At one electrode of the fuel cell, hydrogen gas reacts to form hydrogen ions, as shown in the equation below:

$$H_2 \longrightarrow 2H^+ + 2e^-$$

Identify this electrode as the anode or the cathode, and give a reason for your choice.

_____

_____ (2 marks)

(ii) Hydrogen for use in a fuel cell can be produced by the electrolysis of water.

State the energy change that takes place during electrolysis.

_____ (2 marks)

(b) Hydrogen can also be produced by the breakdown of methanol in a steam reformer.
The breakdown of methanol to hydrogen occurs in two stages, as shown in the reactions below:

Reaction 1 $CH_3OH \rightleftharpoons CO + 2H_2$

Reaction 2 $CO + H_2O \rightleftharpoons CO_2 + H_2$

Write an equation for the overall reaction for the production of hydrogen.

(1 mark)

(c) Some energy data for hydrogen and methanol are shown in the table below:

Fuel	**Enthalpy of combustion (kJ mol^{-1})**	**Energy per gram (kJ g^{-1})**
hydrogen	242	**X** =
methanol	725	22.6

(i) Calculate the value of **X**, in kJ g^{-1}, for hydrogen and write the value in the table above.

(2 marks)

(ii) Using the data in the table, state which of the two fuels would be more efficient to use in a motor vehicle. Explain your answer.

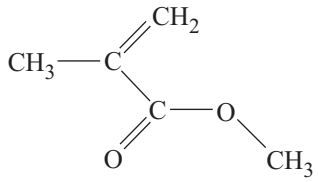
(3 marks)

(iii) One problem with the use of methanol as a fuel is its high solubility in water.

Explain why methanol is highly soluble in water.

(3 marks)

(d) Methanol is used to make the monomer that is converted into the polymer Perspex. The structural formula of this monomer is shown in the diagram below:



(i) State the type of polymerisation reaction in which this monomer is converted into Perspex.

(1 mark)

(ii) Draw one section of the polymer chain of Perspex, showing two repeating units. Clearly mark one repeating unit on your structure.

(3 marks)

TOTAL: 17 marks

QUESTION 8

Ethanol is a fuel that can be produced from renewable resources.

(a) (i) The value for the enthalpy of combustion of ethanol is 1364 kJ mol^{-1}. When asked for the thermochemical equation for the complete combustion of ethanol, a student wrote the following equation:

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O \quad ; \quad \Delta H = 1364 \text{ kJ}$$

Rewrite this equation as a correct thermochemical equation.

(2 marks)

(ii) In a laboratory experiment to determine the enthalpy of combustion of ethanol, a spirit burner containing ethanol was used to heat 100.0 mL of water in a metal calorimeter.

The data collected during the experiment are shown below:

Initial temperature of water	= 21.5ºC
Final temperature of water	= 66.8ºC
Initial mass of spirit burner	= 152.714 g
Final mass of spirit burner	= 151.806 g
Specific heat capacity of water	= 4.18 J g^{-1} K^{-1}

Use the appropriate data to calculate the heat released, in kJ, during the combustion of this amount of ethanol.

(3 marks)

(iii) The experiment was repeated several times and an average value for the enthalpy of combustion of 941 kJ mol^{-1} of ethanol was obtained.

(1) State the purpose of calculating an average value for the enthalpy of combustion.

_____

_____ (1 mark)

(2) Identify one possible source of error, and state how this would affect the experimental value obtained.

_____

_____

_____ (2 marks)

Credit will be given for answers to part (b) which show clearly written, 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.

(b) Corn syrup is an aqueous solution that contains monosaccharides. When corn syrup is fermented, ethanol is produced.

State the reaction conditions used for the production of ethanol by fermentation. Explain why these conditions are used.

(8 marks)

TOTAL: 16 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. 7(c)(iii) continued).

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2005

2005 CHEMISTRY

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QUESTION BOOKLET

3

13 pages, 4 questions

Wednesday 16 November: 1.30 p.m.

Question Booklet 3

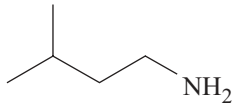
Write your answers to Questions 9 to 12 in this question booklet.

SSABSA

QUESTION 9

Plants can obtain nitrogen through the decomposition of organic matter or the addition of synthetic fertiliser.

(a) The structural formula of one molecule produced in the decomposition of organic matter is shown in the diagram below:



(i) State whether this molecule is the product of aerobic or anaerobic decomposition.

_____ (1 mark)

(ii) State the systematic name of this molecule.

_____ (2 marks)

(b) Ammonium sulfate is a synthetic fertiliser commonly used to provide nitrogen needed by plants.

(i) Explain why ammonium sulfate provides nitrogen in a form suitable for use by plants.

_____

_____

_____

_____ (2 marks)

(ii) Aqueous solutions of ammonium ions, NH_4^+, are acidic.

(1) Write an equation for the reaction of the ammonium ion with water to form an acidic solution.

(2 marks)

An acidic solution should not be stored in an iron container.

(2) Write the electronic configuration of iron, using subshell notation.

_____ (2 marks)

(3) Write an ionic equation for the reaction of iron with an acidic solution.

(2 marks)

(c) Ions in aqueous solution in soil water exist in equilibrium with ions on the surfaces of clay particles in soil. One example is shown in the following equation:

$$3NH_4^+{}_{(aq)} + Al^{3+}{}_{(surface)} \rightleftharpoons 3NH_4^+{}_{(surface)} + Al^{3+}{}_{(aq)}$$

(i) Using Le Châtelier's principle, explain how the concentration of ammonium ions in the aqueous solution changes as plants continue to absorb ammonium ions from the soil water.

(3 marks)

(ii) The addition of large amounts of ammonium sulfate to soil can be harmful to the environment as it may mobilise toxic aluminium ions that are bound to the surfaces of clay particles in some soils.

Explain how the addition of large amounts of ammonium sulfate leads to the mobilisation of aluminium ions in these soils.

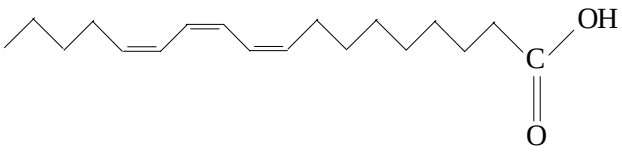
(2 marks)

TOTAL: 16 marks

QUESTION 10

Long-chain carboxylic acids have various uses.

(a) The structural formula of one long-chain carboxylic acid used in furniture oil is shown in the diagram below:



This carboxylic acid molecule readily polymerises when exposed to air.

(i) State the structural feature of this molecule that allows it to undergo addition polymerisation.

_____ (1 mark)

(ii) Cross links may form between the polymer chains.

(1) State one property of the polymer that changes as a result of the formation of cross links.

_____ (1 mark)

(2) Explain, in terms of the cross-linking, why this property changes.

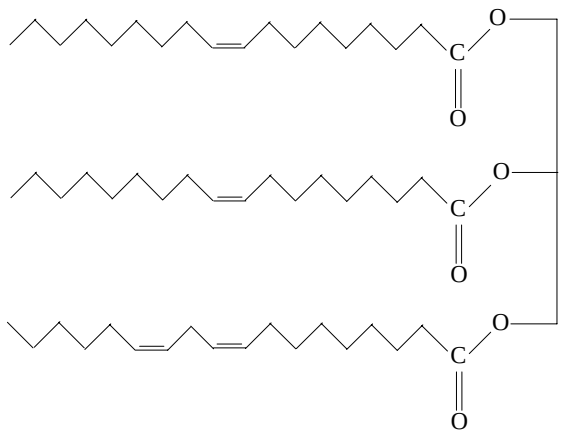
_____

_____

_____

_____ (2 marks)

(b) Long-chain carboxylic acids are components of triglycerides. The structural formula of one triglyceride molecule is shown in the diagram below:



(i) State whether this triglyceride is likely to be a solid or a liquid at 25°C.

_____ (1 mark)

(ii) This triglyceride can be converted into soap.

(1) State the systematic name of the other molecule that is formed when this triglyceride is converted into soap.

_____ (2 marks)

(2) State the part of the structure of soap that is hydrophobic.

_____ (1 mark)

(3) Describe how this part of the structure of soap enables it to dissolve grease.

_____

_____

_____

_____ (2 marks)

Credit will be given for answers to part (4) which show clearly written, 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.

(4) The effectiveness of soaps is reduced when they are used in hard water. Tripolyphosphates and zeolites both act as water-softening agents.

Describe the action of each of these water-softening agents.

(8 marks)

TOTAL: 18 marks

QUESTION 11

Compounds of chlorine are present in swimming-pool water.

Credit will be given for the correct use of significant figures in part (a). (1 mark)

(a) The following is a common method for determining the concentration of chloride ions in swimming-pool water:

Step 1 An excess quantity of standard $AgNO_3$ solution is added to a sample of swimming-pool water. This results in the removal of all the chloride ions by precipitation:

$$Ag^+ + Cl^- \longrightarrow AgCl$$

Step 2 The excess Ag^+ is titrated with standard KSCN solution in the presence of an indicator:

$$Ag^+ + SCN^- \longrightarrow AgSCN$$

The appearance of a red colour indicates the end point of the titration.

In one analysis, 25.00 mL of 0.0116 mol L^{-1} $AgNO_3$ solution was added to a 50.00 mL sample of swimming-pool water. Then 7.35 mL of 0.0143 mol L^{-1} KSCN solution was added to produce the red colour.

(i) Calculate the number of moles of Ag^+ in 25.00 mL of 0.0116 mol L^{-1} $AgNO_3$ solution.

(2 marks)

(ii) Calculate the number of moles of SCN^- that reacted in the titration at Step 2.

(2 marks)

(iii) Calculate the number of moles of silver ions, and hence the number of moles of chloride ions, in the original sample of swimming-pool water.

(2 marks)

(iv) Calculate the concentration of chloride ions, in μg mL^{-1}, in the original sample of swimming-pool water.

(3 marks)

(b) Calcium hypochlorite, $Ca(ClO)_2$, is commonly used for purifying swimming-pool water.

(i) State the action of hypochlorite ions that kills bacteria.

_____ (1 mark)

(ii) One equilibrium that is established when $Ca(ClO)_2$ is added to swimming-pool water is shown in the equation below:

$$H_2O + ClO^- \rightleftharpoons HClO + OH^-$$

The addition of rainwater to swimming-pool water affects this equilibrium.

(1) Explain why unpolluted rainwater is acidic.

_____

_____

_____

_____ (2 marks)

(2) Explain the effect that the addition of acidic rainwater will have on the concentration of ClO^- in the swimming-pool water.

_____

_____

_____

_____

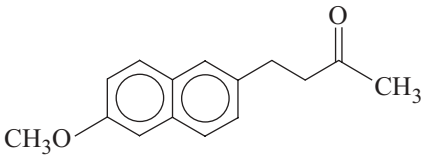
_____

_____ (3 marks)

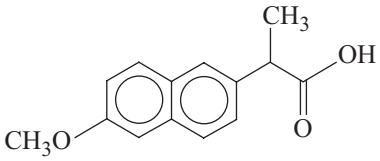
TOTAL: 16 marks

QUESTION 12

The structural formulae of two anti-inflammatory compounds are shown in the diagrams below:



Nabumetone



Naproxen

(a) Nabumetone is produced as a result of the oxidation of a secondary alcohol.

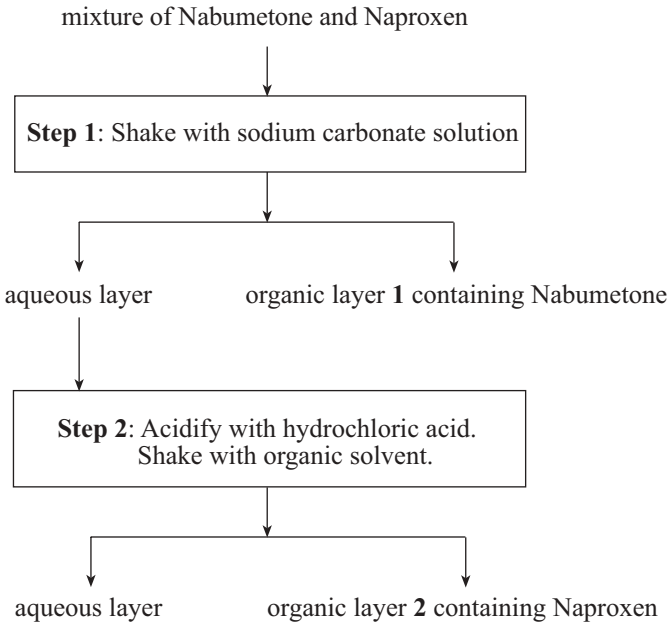
(i) Identify a reagent suitable for the oxidation of this alcohol.

_____ (2 marks)

(ii) Draw the structural formula of this alcohol.

(2 marks)

(b) A mixture of Nabumetone and Naproxen was dissolved in an organic solvent. In an attempt to obtain pure samples of both compounds a separating funnel was used to separate the mixture. The procedure for the separation is shown in the flow chart below:



(i) State two observations that would be made after the separating funnel was shaken in Step 1.

(1) _____

_____ (1 mark)

(2) _____

_____ (1 mark)

(ii) Explain why acidification is necessary in Step 2.

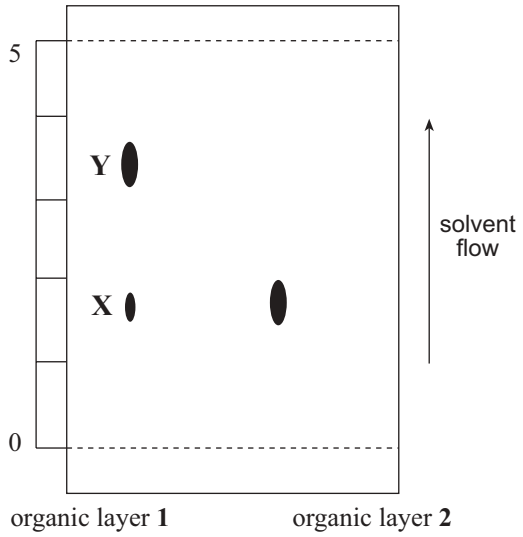
_____

_____

_____

_____ (2 marks)

(iii) Samples from organic layer **1** and organic layer **2** were analysed for purity by thin layer chromatography, using a polar stationary phase and the organic solvent as the mobile phase. The chromatogram obtained is shown in the diagram below:



(1) State the identity of component **X**.

_____ (1 mark)

(2) Calculate the R_f value of component **X**.

(2 marks)

(3) Explain why the R_f value of component **Y** is larger than the R_f value of component **X**.

(3 marks)

(4) Using the chromatogram, evaluate the effectiveness of the procedure for the separation of the two anti-inflammatory compounds.

(3 marks)

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. 9(c)(i) continued).