1

Government of South Australia

SACE Board of SA

External Examination 2015

2015 CHEMISTRY

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ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET

1

16 pages, 4 questions

Wednesday 11 November: 9 a.m.

Time: 3 hours

Question Booklet 1

Examination material: Question Booklet 1 (16 pages)
Question Booklet 2 (11 pages)
Question Booklet 3 (10 pages)
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Students

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 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 11 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 10 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 180. 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
- have my results for the examination cancelled or amended
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as the SACE Board of South Australia 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 Caesium 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 183.8	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)	89[2] Ac Actinium (227)	104 Rf Rutherfordium (267)	105 Db Dubnium (268)	106 Sg Seaborgium (271)	107 Bh Bohrium (272)	108 Hs Hassium (270)	109 Mt Meitnerium (276)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (280)	112 Cn Copernicium (285)		114 Fl Flerovium (289)		116 Lv Livermorium (293)		

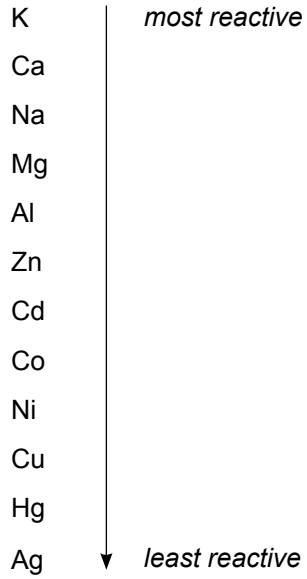
Lanthanide Series[1]	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 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)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

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 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
tera	T	10^{12}
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

Magnesium oxide, MgO, has many uses.

(a) MgO acts as a catalyst in the conversion of vegetable oil into biodiesel.

(i) Explain how the reaction rate is increased by this catalyst.

_____

_____

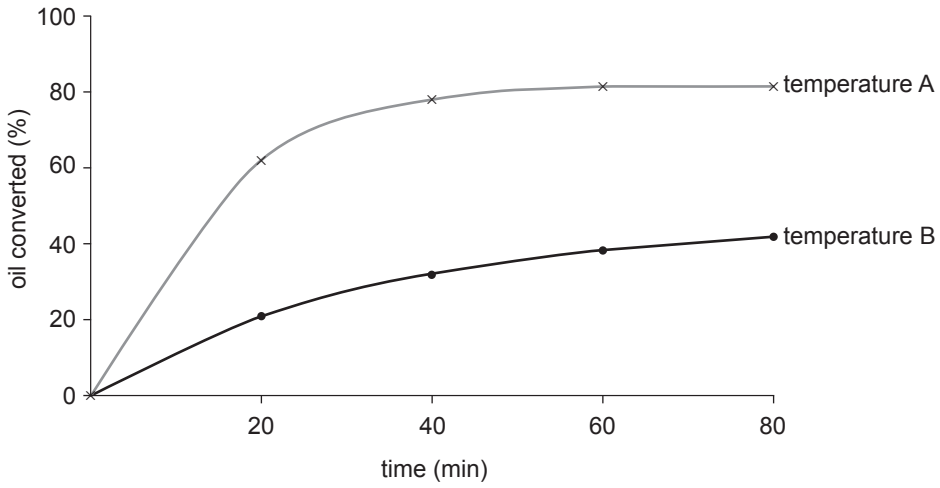
_____

_____

_____

_____ (3 marks)

(ii) The percentage of oil converted into biodiesel for the catalysed reaction at two different temperatures, A and B, is shown below:



(1) State which feature of the curves indicates that, during the first 20 minutes, the reaction occurs at a greater rate at temperature A than it does at temperature B.

_____ (1 mark)

(2) Suggest why the curve for temperature A levels out at 60 minutes.

_____

_____ (1 mark)

(iii) This conversion can also be catalysed by an enzyme.

Explain why the percentage of oil converted in an enzyme-catalysed reaction is very low at high temperatures.

_____

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_____

_____ (3 marks)

(b) MgO is used to remove phosphates from waterways.

(i) One human activity that leads to increased phosphate levels in waterways is the use of tripolyphosphates in detergent formulations.

(1) Draw the structural formula of the linear tripolyphosphate ion.

(2 marks)

(2) State another human activity that can lead to increased phosphate levels in waterways.

_____ (1 mark)

(ii) When MgO is added to water, it reacts with water to produce magnesium ions and hydroxide ions.

(1) State the nature of Mg that enables MgO to react with water to produce hydroxide ions.

_____ (1 mark)

(2) Magnesium ions remove phosphates by forming a precipitate.

Write an ionic equation for the reaction of magnesium ions with phosphate ions to form a precipitate.

(2 marks)

(iii) High levels of phosphates in still waterways result in excessive algal growth.

Explain how excessive algal growth can lead to reduced oxygen levels in still waterways.

_____

_____

_____

_____

_____ (2 marks)

TOTAL: 16 marks

QUESTION 2

One process for the production of ethanol is shown in the equilibrium reaction below:

$$C_2H_{4(g)} + H_2O_{(g)} \rightleftharpoons C_2H_5OH_{(g)}$$

(a) State the effect of increasing the temperature on the rate of this reaction.

_____ (1 mark)

(b) In one reaction, 2.0 mol of C_2H_4 and 1.2 mol of H_2O were placed in an evacuated and sealed 1 L flask. At equilibrium, 1.9 mol of C_2H_4 remained unreacted.

Calculate the number of moles of C_2H_5OH and H_2O present at equilibrium.

(3 marks)

(c) The K_c values for this reaction at two different temperatures are shown in the table below:

Temperature (°C)	K_c
25	3.08
127	0.260

(i) State the effect of increasing the temperature on the yield of C_2H_5OH.

_____ (1 mark)

(ii) Explain how the information in the table above shows that the forward reaction is exothermic.

_____

_____

_____

_____

_____

_____ (3 marks)

Credit will be given for answers to part (d) which correctly use appropriate chemical terms and effectively communicate knowledge and understanding of chemistry.

Your answer should be confined to the space provided.

(d) Selecting an appropriate pressure for this process is an important consideration for manufacturers.

Explain two advantages to manufacturers of using a high pressure, but suggest why manufacturers may decide to use a moderate pressure instead.

(8 marks)

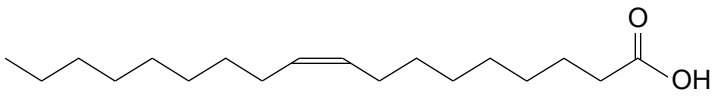
TOTAL: 16 marks

QUESTION 3

Canola oil is an edible vegetable oil that contains the triglyceride triolein.

(a) Triolein is produced in a reaction of propane-1,2,3-triol with oleic acid.

The structural formula of oleic acid is shown below:



(i) Draw the structural formula of triolein.

(2 marks)

(ii) Identify the other product of this reaction.

_____ (1 mark)

(b) Canola oil can be chemically converted into a product with a higher proportion of saturated carbon chains.

(i) State the name given to this type of reaction.

_____ (1 mark)

(ii) Explain how the more saturated product can be preferable for consumer use.

_____

_____

_____

_____ (2 marks)

(c) Canola oil is used in cooking. During the cooking process some of the triolein undergoes hydrolysis. One sample of canola oil was tested after use in cooking and found to have a pH of 5.5.

(i) Calculate the concentration, in $mol\,L^{-1}$, of H^+ in this sample.

(2 marks)

(ii) State the likely source of H^+ in this sample.

_____ (1 mark)

(d) Used canola oil from the food industry can be converted into new materials.

(i) Canola oil can be converted into carboxylate salts when treated with NaOH solution.

(1) Draw the structural formula of the carboxylate ion formed from triolein.

(2 marks)

(2) Describe how the structure of this ion enables it to remove grease from clothing during washing.

_____

_____

_____

_____ (2 marks)

(ii) Used canola oil can be converted into biodiesel.

The amount of energy released from the complete combustion of biodiesel is $37.8\,kJ\,g^{-1}$.

The mass of 1 mL of biodiesel is 0.87 g.

Calculate the amount of energy released by the complete combustion of 1 L of biodiesel.

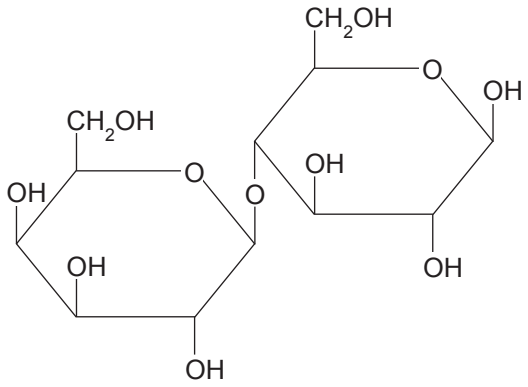
(3 marks)

TOTAL: 16 marks

QUESTION 4

Carbohydrates, proteins, and fats are found in cows' milk.

(a) Lactose is found in cows' milk. The structural formula of lactose is shown below:



(i) State if lactose is a carbohydrate, a protein, or a fat.

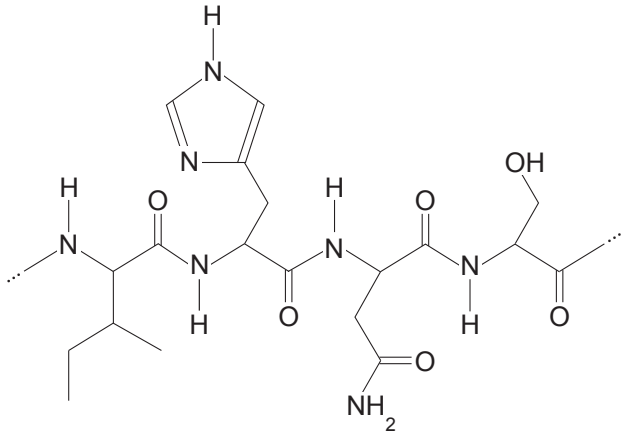
_____ (1 mark)

(ii) At room temperature, the lactose in cows' milk may be converted into lactic acid, $C_3H_6O_3$. The lactic acid molecule contains a secondary alcohol group and a carboxyl group.
Draw the structural formula of lactic acid.

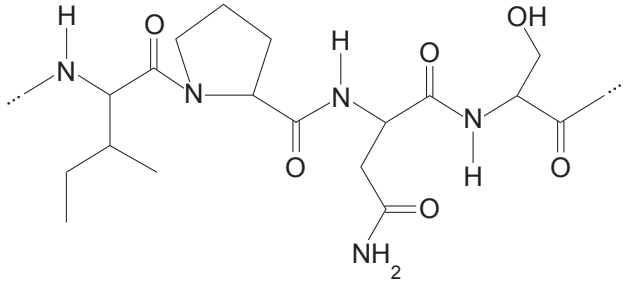
(2 marks)

(b) Two of the proteins found in cows' milk are the beta-caseins A1 and A2. Sections of these two polymer chains are shown in the diagram below:

section of A1



section of A2



(i) Circle *one* peptide link on the diagram above. (1 mark)

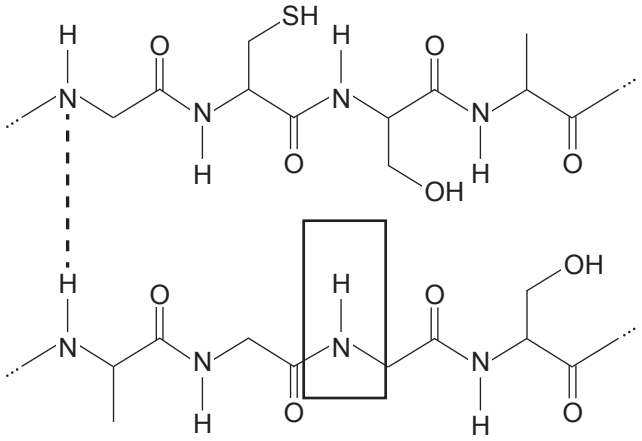
(ii) In the diagram above, the section of A2 includes one amino acid unit that is not in the section of A1.

(1) Draw an arrow on the section of A2 to identify this amino acid unit. (1 mark)

(2) Draw the structural formula of the amino acid from which this unit is derived.

(2 marks)

(iii) The diagram below shows two sections of the A1 polymer chain:

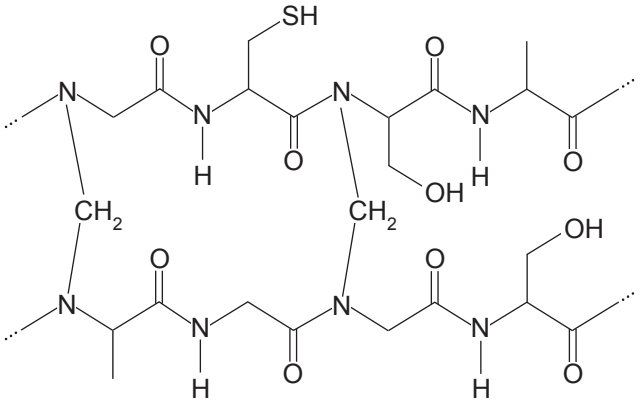


(1) Using the appropriate symbols, on the diagram above, indicate the polarity of the N – H bond in the rectangle. (2 marks)

(2) Name the secondary interaction represented by the dashed line in the diagram above.

_____ (1 mark)

(iv) A1 can be modified to produce a polymer that is used to make plastic buttons. A section of the new polymer produced is shown below:



Explain why this new polymer is more rigid than the unmodified A1 polymer.

_____

_____

_____

_____ (2 marks)

TOTAL: 12 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. 3(d)(i)(2) continued).

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2015 CHEMISTRY

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SEQ | FIGURES | CHECK LETTER | BIN

CHEMISTRY

QUESTION BOOKLET

2

11 pages, 4 questions

Wednesday 11 November: 9 a.m.

Question Booklet 2

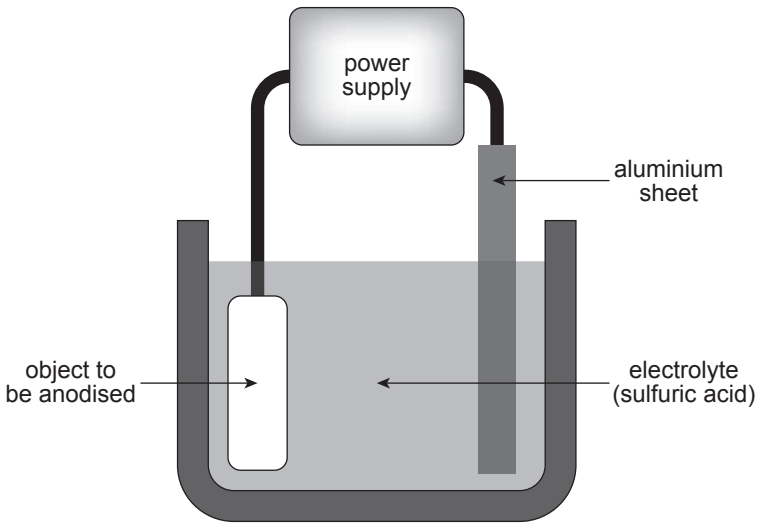
Write your answers to Questions 5 to 8 in this question booklet.

2

QUESTION 5

Anodising is an electrochemical process in which a thick coating of aluminium oxide, Al_2O_3, forms on the surfaces of aluminium objects.

(a) A simplified diagram of an electrochemical cell used in anodising is shown below:



(i) Identify this cell as either galvanic or electrolytic.

_____ (1 mark)

(ii) H_2 forms at one electrode, as shown in the following half-equation:

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

State whether this reaction occurs at the positive electrode or at the negative electrode.

_____ (1 mark)

(iii) Al_2O_3 forms at the other electrode.

(1) Complete the following half-equation for the formation of Al_2O_3.

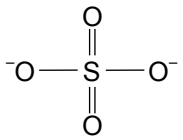
$$Al \longrightarrow Al_2O_3$$

(2 marks)

(2) State whether Al_2O_3 forms at the anode or at the cathode.

_____ (1 mark)

(iv) The electrolyte in the cell contains sulfate ions. A diagram of the sulfate ion is shown below:



Name and explain the shape of this ion.

_____

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_____

_____ (4 marks)

(b) The surfaces of anodised objects can be coloured by treatment with dyes. A dye solution of cobalt sulfate, $CoSO_4$, is used to produce a bronze colour.

(i) State the oxidation number of cobalt in $CoSO_4$.

_____ (1 mark)

(ii) Using subshell notation, write the electron configuration for the cobalt ion in $CoSO_4$.

_____ (2 marks)

(c) In the highly alkaline conditions in a dishwasher, Al_2O_3 on the surfaces of anodised objects may react with OH^- to form soluble aluminate ions.

(i) Write an equation for the reaction of hydroxide ions, OH^-, with aluminium oxide, Al_2O_3.

(2 marks)

(ii) State one disadvantage of using a dishwasher to wash anodised objects.

_____ (1 mark)

TOTAL: 15 marks

QUESTION 6

Acid rain has a pH that is low enough to cause environmental damage.

(a) NO_2 is an atmospheric pollutant that reacts with rainwater to form acid rain.

(i) (1) Write an equation for the reaction of NO_2 with rainwater.

(2 marks)

(2) Hence, explain why the pH of acid rain is lower than that of rainwater.

_____

_____

_____

_____ (2 marks)

(ii) Identify another atmospheric pollutant that can contribute to the formation of acid rain.

_____ (1 mark)

(b) $CaCO_3$ rocks and aluminosilicate clays are often found in rivers. Acid rain reacts with these materials to produce Ca^{2+} in river water.

(i) Write an equation for the reaction of $CaCO_3$ with acid rain.

(2 marks)

(ii) Aluminosilicates are formed from silicates. Anorthite ($CaAl_2Si_2O_8$) is an aluminosilicate clay found in some rivers.

(1) Write the formula for the aluminosilicate ion in anorthite.

_____ (2 marks)

(2) Determine the percentage of silicon atoms that have been replaced by aluminium atoms in $CaAl_2Si_2O_8$.

(1 mark)

(iii) An equilibrium exists between Ca^{2+} and H^+ in rivers, as represented by the following equation:

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

Using Le Châtelier's principle, explain how the presence of clay reduces the effect of acid rain on river water.

_____

_____

_____

_____

_____

_____ (3 marks)

(iv) River water can be used as a domestic water supply.

Explain one disadvantage of increased levels of $Ca^{2+}_{(aq)}$ in river water that is used as a domestic water supply.

_____

_____

_____

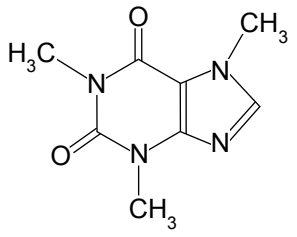
_____ (2 marks)

TOTAL: 15 marks

QUESTION 7

Energy drinks contain a variety of ingredients, including caffeine, taurine, and sugars.

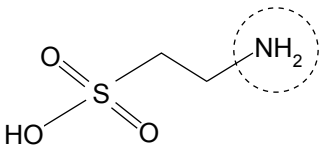
(a) Caffeine acts as a stimulant. The structural formula of caffeine is shown below:



Write the molecular formula of caffeine.

_____ (2 marks)

(b) Taurine may improve athletic performance. The structural formula of taurine is shown below:



(i) Classify the circled group as a primary, a secondary, or a tertiary amino group.

_____ (1 mark)

(ii) State one feature of the structural formula of taurine that indicates that taurine is not classified as an amino acid.

_____

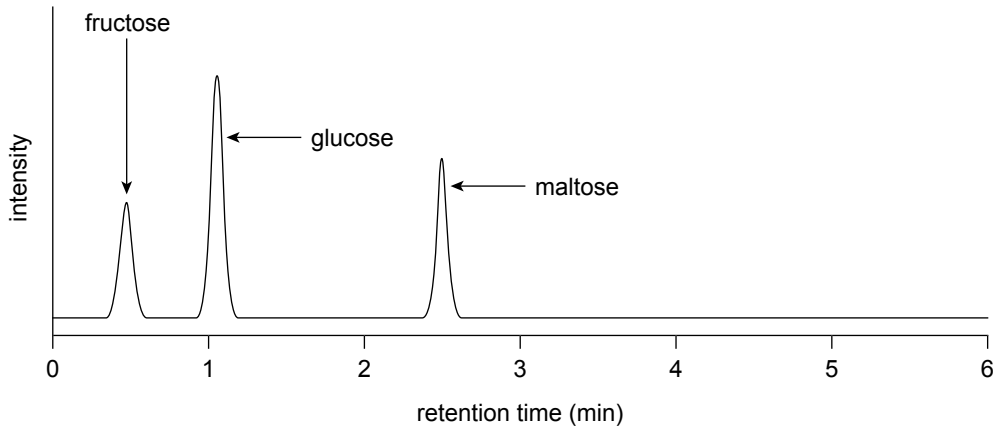
_____ (1 mark)

(iii) Taurine is able to undergo self-ionisation.

Draw the structural formula of the self-ionised form of taurine.

(2 marks)

(c) Three sugars in one brand of energy drink were analysed by column chromatography, using a polar solvent and a non-polar stationary phase. A diagram of the chromatogram is shown below:



(i) (1) Identify the sugar that moved most slowly through the column.

_____ (1 mark)

(2) State and explain which of the three sugars is the most polar.

_____

_____

_____

_____

_____

_____ (3 marks)

(ii) In the acidic conditions of the energy drink, maltose hydrolyses and forms glucose.

(1) Write an equation for the hydrolysis of maltose, $C_{12}H_{22}O_{11}$.

(2 marks)

(2) State one way in which the diagram of the chromatogram would look different if all the maltose had been hydrolysed.

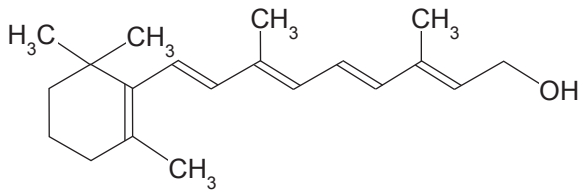
_____

_____ (1 mark)

TOTAL: 13 marks

QUESTION 8

Retinol is a form of vitamin A that is used to synthesise pharmaceutical products. The structural formula of retinol is shown below:



(a) Retinol can be completely saturated by reaction with hydrogen gas.

The molar mass of retinol is 286.45 g mol^{-1}.

Calculate the molar mass, in g mol^{-1}, of the completely saturated form of retinol.

(2 marks)

(b) A sample of yellow retinol was spilt on a white laboratory coat and formed a stain. An attempt was made to remove the stain by treating it with an appropriate solvent.

(i) State why retinol is largely non-polar.

_____

_____ (1 mark)

(ii) Explain whether retinol is more likely to dissolve in propan-2-ol or in water.

_____

_____

_____

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_____

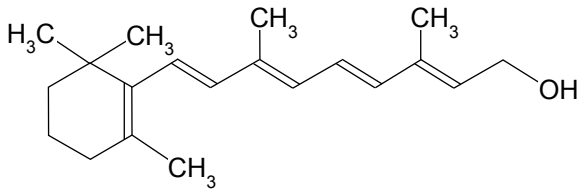
_____ (3 marks)

(iii) Hydrogen peroxide solution could have been used to bleach the stain on the laboratory coat.

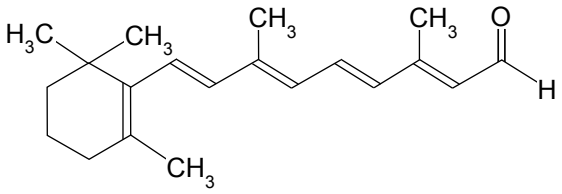
State the action of hydrogen peroxide when used as a bleach.

_____ (1 mark)

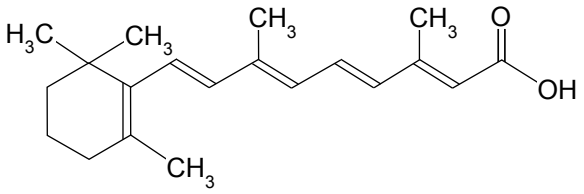
(c) Retinol reacts to form retinal, which is used to manufacture retinoic acid for use in acne creams. The structural formulae of these compounds are shown below:



retinol



retinal



retinoic acid

(i) Name the new functional group that is formed when retinol is converted into retinal.

_____ (1 mark)

Credit will be given for answers to part (ii) which correctly use appropriate chemical terms and effectively communicate knowledge and understanding of chemistry.

Your answer should be confined to the space provided.

(ii) Three unlabelled beakers were thought to contain solutions of either retinol, retinal, or retinoic acid.

Suggest reagents for *three* chemical tests that could identify the three solutions. Describe how the observations from these tests would positively identify the solutions in each beaker.

(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)(i)(2) continued).

Government of South Australia

SACE Board of SA

External Examination 2015

2015 CHEMISTRY

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CHEMISTRY

QUESTION BOOKLET 3

10 pages, 4 questions

Wednesday 11 November: 9 a.m.

Question Booklet 3

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

3

QUESTION 9

Volumetric analysis is used for the quantitative determination of $PbCO_3$ in mineral ores.

A 3.15 g sample of an ore was analysed to determine the percentage of $PbCO_3$ present, using the following procedure:

Step 1 An excess of 0.6293 mol L^{-1} $HNO_{3(aq)}$ was added to the sample. The equation for this reaction is shown below:

$$2HNO_{3(aq)} + PbCO_{3(s)} \longrightarrow Pb(NO_3)_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Step 2 When the reaction was complete, the unreacted HNO_3 was titrated with 0.1423 mol L^{-1} $NaOH_{(aq)}$. The equation for the titration reaction is shown below:

$$HNO_{3(aq)} + NaOH_{(aq)} \longrightarrow NaNO_{3(aq)} + H_2O_{(l)}$$

(a) State *one* observation that would indicate that the reaction in Step 1 was complete.

_____ (1 mark)

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

(b) (i) The volume of HNO_3 added in Step 1 was 25.00 mL.

Calculate the number of moles of HNO_3 added to the sample.

(2 marks)

(ii) The volume of NaOH required was 23.67 mL.

Calculate the number of moles of NaOH that reacted with the HNO_3 in Step 2.

(2 marks)

(iii) (1) Calculate the number of moles of unreacted HNO_3 that remained after Step 1.

(1 mark)

(2) Hence, calculate the number of moles of HNO_3 that reacted during Step 1.

(1 mark)

(iv) Calculate the number of moles of $PbCO_3$ in the ore sample.

(2 marks)

(v) Calculate the percentage, by mass, of $PbCO_3$ in the ore sample.

(3 marks)

(c) The ore analysed also contained $CaCO_3$.
State and explain the effect of $CaCO_3$ on the calculated percentage of $PbCO_3$ in the ore sample.

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_____ (3 marks)

TOTAL: 16 marks

QUESTION 10

Methane, CH_4, and methanol, CH_3OH, are commonly used fuels.

(a) The complete combustion of 1 mol of CH_4 releases 890 kJ of energy.

(i) Write a thermochemical equation for the complete combustion of CH_4.

(4 marks)

(ii) Calculate the energy released, in kJ, by the complete combustion of 1 g of CH_4.

(2 marks)

(b) CH_4 can be obtained from mining processes and from the decomposition of organic waste in landfill.

(i) State whether the production of CH_4 from organic waste occurs under aerobic conditions or anaerobic conditions.

_____ (1 mark)

(ii) State an advantage of using CH_4 obtained from organic waste rather than from mining processes.

_____

_____ (1 mark)

(c) In an investigation of the combustion of methanol, 17 g of CH_3OH released sufficient energy to heat 900 g of water from 20°C to 100°C.

(i) Calculate the heat released from the combustion of 1 mol of CH_3OH, given that the specific heat capacity of water is $4.18\,J\,g^{-1}\,K^{-1}$.

(4 marks)

(ii) Suggest a reason why the calculated value is lower than the true value of 726 kJ.

_____

_____ (1 mark)

(d) Engines that burn methanol operate at a lower temperature than engines that burn petrol.

Explain why engines that burn methanol generate less nitrogen monoxide than engines that burn petrol.

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_____ (3 marks)

TOTAL: 16 marks

QUESTION 11

A new manufacturing process incorporates CO_2 into a polymer, as shown below:

(a) Butadiene and CO_2 are the raw materials used in this process.

(i) State the name of the functional group in butadiene.

_____ (1 mark)

(ii) Explain whether CO_2 is a polar molecule or a non-polar molecule.

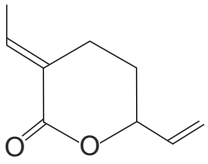
_____

_____

_____

_____ (2 marks)

(b) The structural formula of the lactone monomer is shown below:



(i) Circle the ester group in the lactone monomer. (1 mark)

(ii) In alkaline conditions, the lactone monomer undergoes hydrolysis.
Draw the structural formula of the organic product of this hydrolysis.

(2 marks)

(c) Polymerisation occurs at the carbon–carbon double bonds in the lactone monomer.

(i) State the type of polymerisation reaction that the lactone monomer undergoes when forming the lactone polymer.

_____ (1 mark)

(ii) Polymerisation of the lactone monomer is an exothermic reaction.

(1) Explain how the exothermic nature of the reaction can benefit the manufacturer.

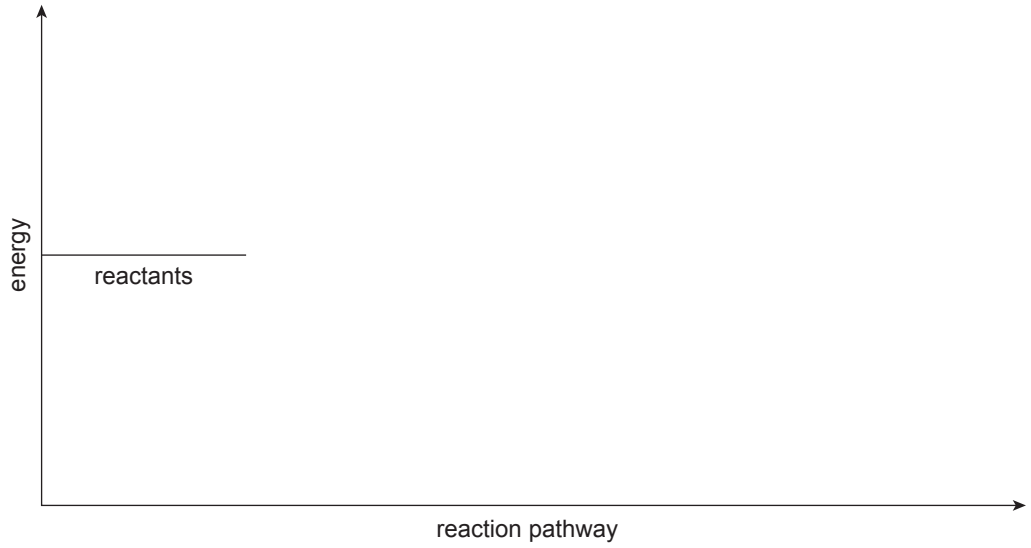
_____

_____

_____

_____ (2 marks)

(2) Using the axes below, draw a labelled energy profile diagram of the polymerisation reaction of the lactone monomer, showing the enthalpy change and the activation energy.



(3 marks)

(d) Explain how this new manufacturing process could benefit the environment.

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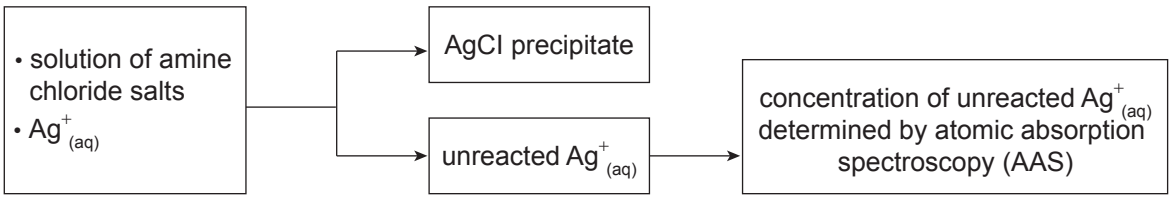
_____ (4 marks)

TOTAL: 16 marks

QUESTION 12

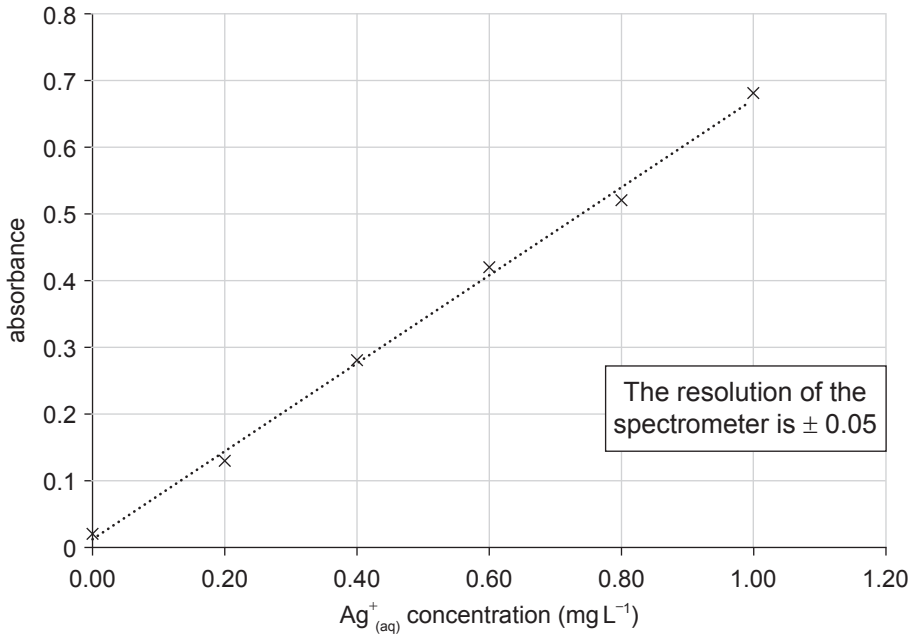
Amine chloride salts in aqueous solutions corrode metal pipes.

(a) The concentration of amine chloride salts can be measured indirectly by the process described in the flow chart below:



The concentration of unreacted $Ag^+_{(aq)}$ can then be used to determine the concentration of amine chloride salts.

The following is a calibration graph for the AAS analysis of $Ag^+_{(aq)}$:



(i) A sample of water from a metal pipe has an unreacted $Ag^+_{(aq)}$ concentration of 0.40 mg L^{-1}.

Use the information in the graph to determine the acceptable *range* of absorbance values that would correspond to this concentration.

_____ (2 marks)

(ii) To obtain this calibration graph, it is necessary to dilute a standard solution of $Ag^+_{(aq)}$.

(1) Name *two* pieces of glassware used when accurately diluting the standard solution.

_____

_____ (2 marks)

(2) Explain why a silver cathode lamp is used in the spectrometer for this analysis.

_____

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_____

_____ (2 marks)

(iii) State the feature of the graph that indicates the occurrence of random errors.

_____

_____ (1 mark)

(iv) State why it cannot be reasonably concluded from the graph that a systematic error has occurred.

_____

_____

_____ (1 mark)

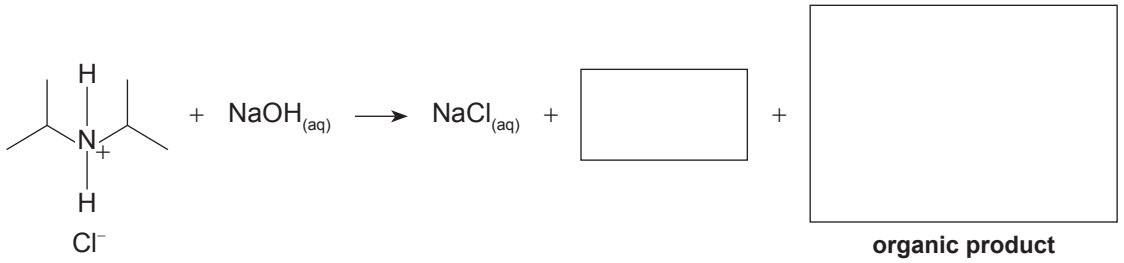
(v) The concentration of amine chloride salts in a 50 L sample of water from another metal pipe is 5 ppm.

Calculate the mass, in grams, of amine chloride salts in this sample.

(2 marks)

(b) Amine chloride salts can be removed from solution by the addition of NaOH solution.

Complete the following equation.



(3 marks)

TOTAL: 13 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. 11(c)(ii)(1) continued).