SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2007

2007 CHEMISTRY

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET

1

17 pages, 4 questions

Wednesday 14 November: 1.30 p.m.

Time: 3 hours

Question Booklet 1

Examination material: Question Booklet 1 (17 pages)
Question Booklet 2 (14 pages)
Question Booklet 3 (16 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 17 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 16 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;
- have my marks for the examination cancelled or amended;
- 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 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)							

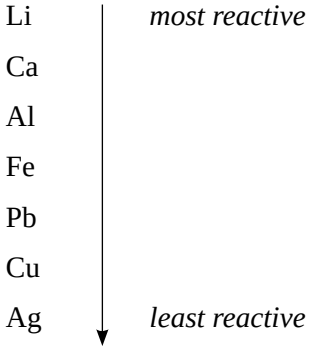
Lanthanide Series[1]	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 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 (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

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}

SSABSA

QUESTION 1

Oxides of sulfur and nitrogen are major pollutants that contribute to the formation of acid rain in industrialised countries.

(a) (i) State whether sulfur has a high, an intermediate, or a low electronegativity.

_____ (1 mark)

(ii) (1) Draw a diagram to show the bonding and shape of a molecule of SO_2.

(2 marks)

(2) On the diagram that you have drawn above, show the polarity of one bond, using the appropriate convention. (2 marks)

(3) State why the bond between S and O is polar.

_____

_____ (1 mark)

(4) State why the molecule is polar.

_____

_____ (1 mark)

(b) (i) State one natural process that releases oxides of nitrogen into the atmosphere.

_____ (1 mark)

(ii) State the pH below which rainfall is classified as acid rain.

_____ (1 mark)

(iii) NO_2 reacts with rainwater to form acid rain containing HNO_3.

(1) Write an equation for this reaction.

(2 marks)

(2) This acid rain affects plant growth in several ways.

(A) Identify the component of this acid rain that improves soil for plant growth, and explain your answer.

Component: _____

Explanation: _____

_____

_____ (3 marks)

(B) Many plants do not thrive under acid conditions.

Identify one effect of acid rain on soil that reduces plant growth.

_____

_____ (1 mark)

(iv) Acid rain causes iron structures to deteriorate.

Write an ionic equation for the reaction of acid rain with iron.

(2 marks)

TOTAL: 17 marks

QUESTION 2

Solid oxygen bleaches produce hydrogen peroxide, H_2O_2, in water.

(a) (i) State the chemical action of H_2O_2 that enables it to act as a bleach.

_____ (1 mark)

(ii) Explain why the rate of production of H_2O_2 from oxygen bleaches increases as the temperature of the water increases.

_____

_____

_____

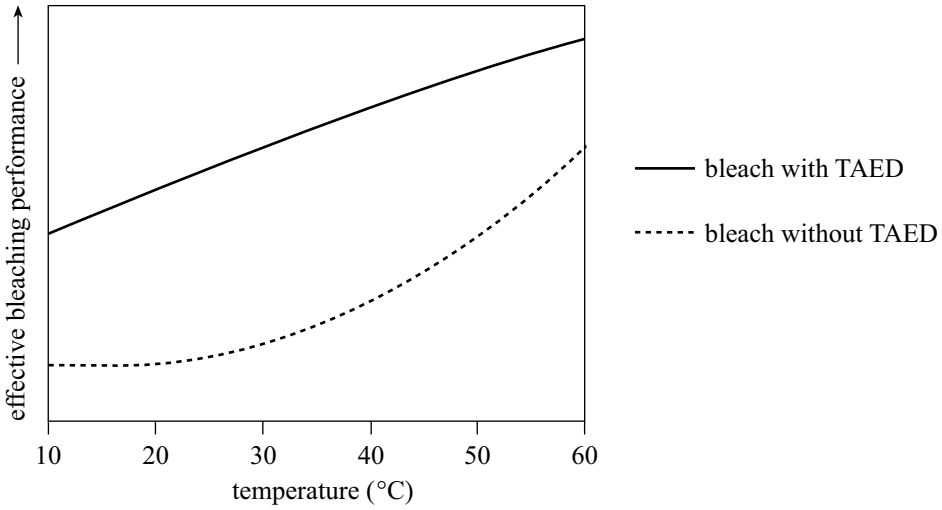
_____

_____

_____ (3 marks)

(b) A compound called TAED is added to some oxygen bleaches to improve their bleaching performance.

The performance of one oxygen bleach at different temperatures, with and without TAED, is shown in the graph below:



The addition of TAED to the oxygen bleach has economic advantages for the consumer.

Using the graph above, explain one economic advantage that adding TAED to the oxygen bleach has for the consumer.

_____

_____

_____

_____ (2 marks)

(c) An experiment to investigate the stability of one solid oxygen bleach involves measuring the concentration of H_2O_2 released into solution by samples stored for different periods of time. The concentration of H_2O_2 released into solution by each sample is determined by titration with a standard solution of MnO_4^-.

(i) Identify one factor that must be held constant in this experiment.

_____ (1 mark)

(ii) In this titration MnO_4^- is converted into Mn^{2+}.

(1) Complete the following half-equation for this conversion.

MnO_4^- $\longrightarrow$ Mn^{2+}

(2 marks)

(2) State the oxidation number of Mn in:

MnO_4^- _____

Mn^{2+} _____ (2 marks)

(3) Hence state whether this conversion is an oxidation or a reduction.

_____ (1 mark)

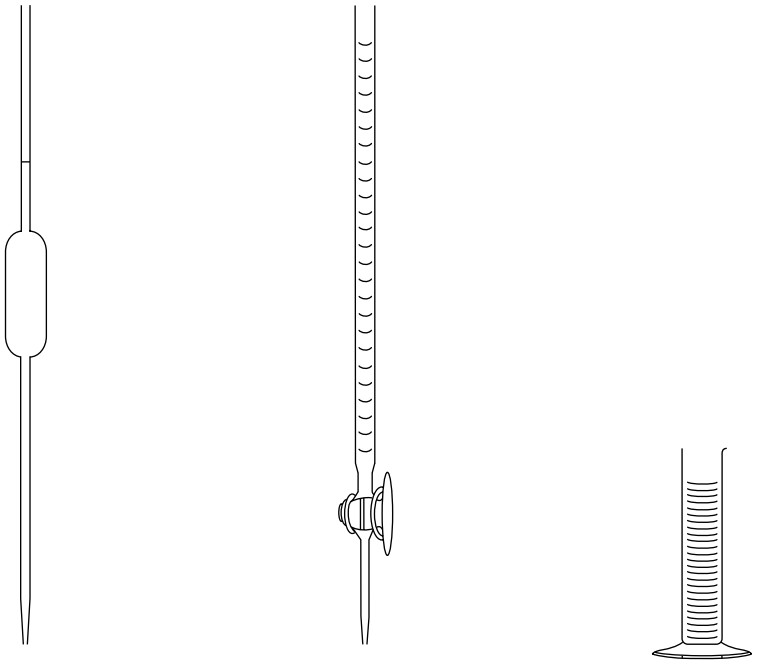
(iii) In this titration 25.00 mL samples of bleach solution are titrated with a standard solution of MnO_4^-.

(1) The bleach solution is transferred to a conical flask.

State whether the conical flask should be rinsed with distilled water or with the bleach solution immediately before titration.

_____ (1 mark)

(2) Three pieces of glassware that can be used to measure a volume of 25 mL are shown in the diagram below:



X **Y** **Z**

(A) State which one of **X**, **Y**, and **Z** is the most appropriate piece of glassware in which to transfer the bleach solution.

_____ (1 mark)

(B) Name this piece of glassware.

_____ (1 mark)

(d) Oxygen bleaches may also be used to sterilise water, but the use of chlorine compounds is often preferred.

Identify one chlorine compound that is used to sterilise water.

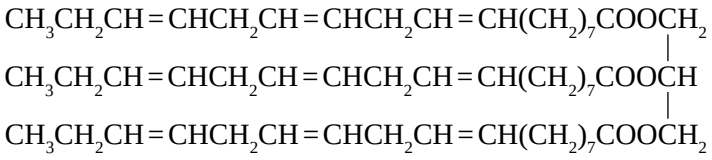
_____ (1 mark)

TOTAL: 16 marks

QUESTION 3

Plants under stress produce chemicals that protect them from attack by other organisms.

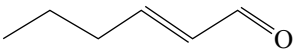
(a) When grass is cut, a series of chemical reactions follow, beginning with the breakdown of triglycerides to produce linolenic acid. The structural formula of one such triglyceride is shown below:



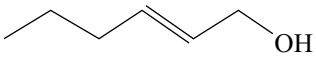
(i) Draw the structural formula of linolenic acid.

(2 marks)

(ii) Linolenic acid is then converted into two compounds with the structural formulae shown below:



compound A



compound B

(1) Identify a suitable reagent that could be used in the laboratory to distinguish between these two compounds.

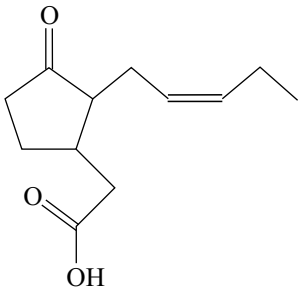
_____ (1 mark)

(2) State the observations that would be made after testing each compound with the reagent you identified in part (1).

Compound **A**: _____

Compound **B**: _____ (2 marks)

(b) Jasmonic acid is another molecule produced by plants under stress. The structural formula of jasmonic acid is shown below:



(i) On the structural formula above, circle the ketone functional group. (1 mark)

(ii) Jasmonic acid undergoes addition reactions.

(1) State the observation that would be made when jasmonic acid undergoes an addition reaction with bromine.

_____ (1 mark)

(2) Draw the structural formula of the product formed when jasmonic acid undergoes an addition reaction with hydrogen.

(2 marks)

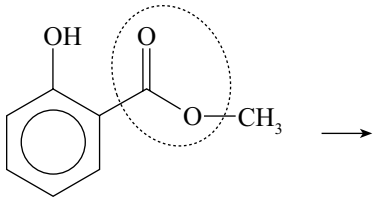
(iii) Jasmonic acid also reacts with sodium hydrogencarbonate solution.

State the observation that would be made as a result of this reaction.

_____ (1 mark)

(c) Plants that are under attack by insects release methyl salicylate, which is then hydrolysed.

The hydrolysis of methyl salicylate in one plant is outlined in the diagram below:



+ compound **X**

methyl salicylate **salicylic acid**

(i) Name the functional group circled in the diagram above.

_____ (1 mark)

(ii) On the labelled space in the diagram above, draw the structural formula of salicylic acid. (2 marks)

(iii) State the systematic name of compound **X**.

_____ (2 marks)

(iv) State the evidence that suggests that this reaction is occurring under acidic rather than alkaline conditions in this plant.

_____ (1 mark)

TOTAL: 16 marks

QUESTION 4

Ancient coins often contain copper and silver.

(a) Many ancient coins were composed mainly of copper.

(i) Write the electron configuration of copper, using subshell notation.

_____ (2 marks)

(ii) Green spots on ancient coins contain the corrosion product copper(II) ethanoate.

Write the formula of copper(II) ethanoate.

_____ (2 marks)

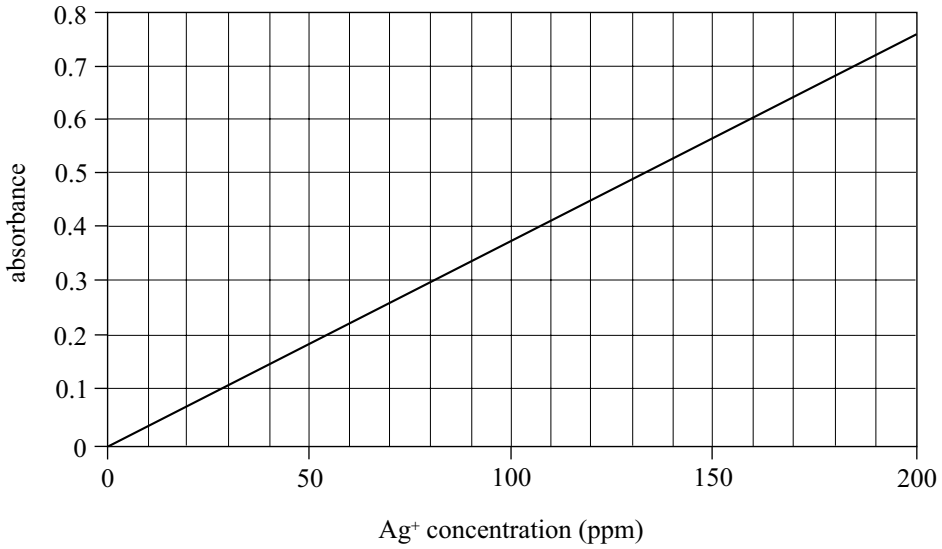
(b) The ancient Romans discovered that copper coins dipped in molten silver chloride became coated with silver.

Write an equation for this reaction.

(2 marks)

(c) Atomic absorption spectroscopy (AAS) can be used to analyse the composition of ancient coins.

(i) A calibration graph used to determine the silver content of ancient coins is shown below:



The absorbance reading for one ancient coin is 0.23.

Using the calibration graph, determine the silver content of the ancient coin.

_____ (2 marks)

(ii) AAS can also be used to determine the copper content of ancient coins.

State two changes that must be made to the procedure in order to determine the copper content.

_____

_____

_____

_____ (2 marks)

Credit will be given for answers to part (d) 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.

(d) The only cleaning agents recommended for use on ancient coins are soapy water or CF_3CCl_3, which is a non-polar solvent.

Describe and explain how both soapy water and CF_3CCl_3 remove grease from coins.

(8 marks)

TOTAL: 18 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. 1(b)(iii)(2)(A) continued).

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2007

2007 CHEMISTRY

SACE REGISTRATION NUMBER

SEQ | FIGURES | CHECK LETTER | BIN

CHEMISTRY

QUESTION BOOKLET

2

14 pages, 4 questions

Wednesday 14 November: 1.30 p.m.

Question Booklet 2

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

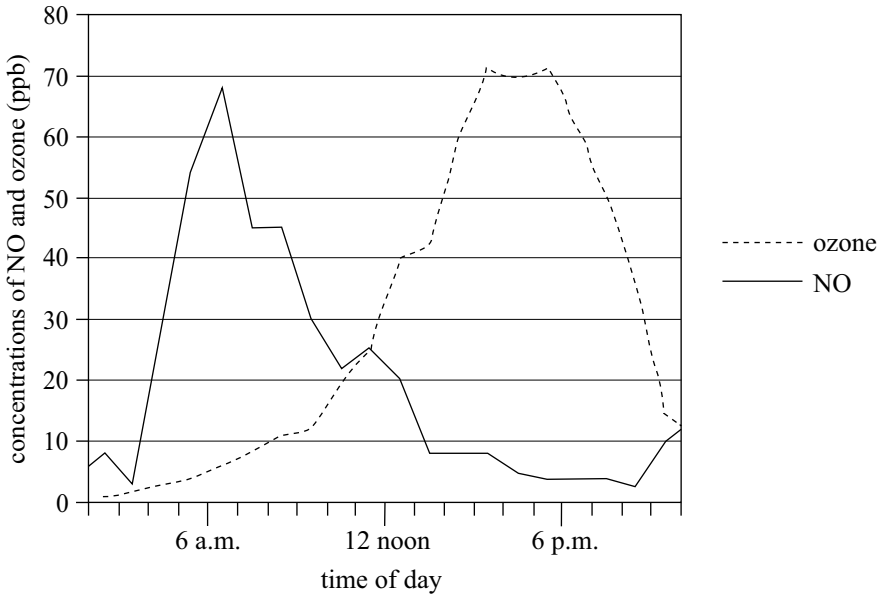
QUESTION 5

Combustion of fuels in vehicles leads to the formation of nitrogen oxides. The concentration of nitrogen oxides affects the concentration of ozone in the troposphere.

(a) Write an equation for the formation of NO.

(2 marks)

(b) NO, NO_2, and ozone are formed above a city street on a sunny day. The concentrations of NO and ozone are shown in the graph below:



(i) When the concentration of ozone reaches 50 ppb its effect on living organisms can be observed.

(1) Using the graph above, identify the earliest time of day at which the effect of ozone on living organisms is likely to be observed.

_____ (1 mark)

(2) State one harmful effect of ozone in the troposphere.

_____ (1 mark)

(ii) (1) Explain why, on a sunny day, the concentration of ozone reaches a maximum after the concentration of NO reaches a maximum. Include two equations in your answer.

_____

_____

_____

_____

_____

_____

_____

_____ (4 marks)

(2) Using the graph opposite, estimate the time of day at which the concentration of NO_2 reaches a maximum.

_____ (1 mark)

(3) Ozone reacts with hydrocarbons in the atmosphere to produce a pollutant with the structural formula CH_3CH_2CHO.

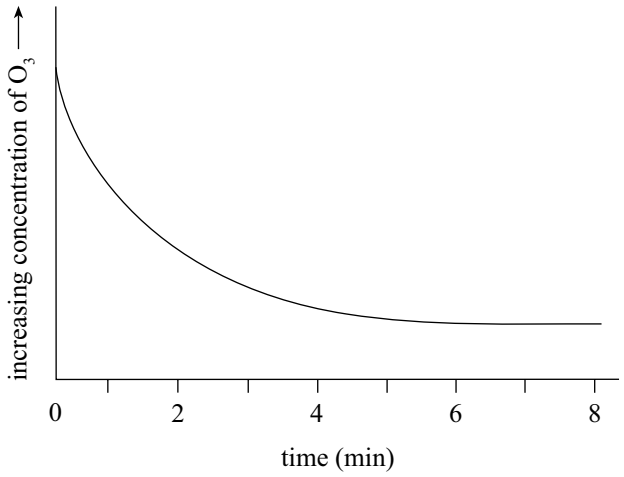
State the systematic name of CH_3CH_2CHO.

_____ (2 marks)

(c) In the absence of sunlight and at a low concentration of NO_2, ozone is removed from the atmosphere, as shown in the reaction below:

$$NO + O_3 \longrightarrow NO_2 + O_2$$

In a laboratory investigation of this reaction the concentration of ozone was measured over a period of time with the results shown in the graph below:



(i) Using collision theory, explain why the concentration of O_3 fell more rapidly in the first 3-minute interval than in the interval between 3 and 6 minutes.

_____

_____

_____

_____

_____

_____ (3 marks)

(ii) On the graph above, sketch the curve that would be expected if this reaction were carried out under the same conditions but with the addition of a catalyst. (2 marks)

TOTAL: 16 marks

QUESTION 6

Chemical reactions can be used to provide portable sources of heat.

(a) Propane gas, C_3H_8, is used in portable burners. The energy released by the complete combustion of C_3H_8 in oxygen is 49 900 J g^{-1}.

(i) Calculate the energy released, in kJ, by the complete combustion of 1.0 mole of C_3H_8 in oxygen.

(2 marks)

(ii) Hence write the thermochemical equation for the complete combustion of C_3H_8 in oxygen.

(4 marks)

(b) A self-heating drink container has been designed so that the energy released by the reaction of solid CaO and water in one chamber of the container heats a drink in another chamber of the container.

(i) State the name used to describe any reaction that causes an increase in temperature.

_____ (1 mark)

(ii) Write an equation for the reaction of CaO and water.

(2 marks)

(iii) In one container the reaction of CaO and water released 75 kJ of energy to heat 350 g of an aqueous drink. The initial temperature of the drink was 21°C.

(1) Calculate the maximum temperature change of the drink after the reaction of the CaO and water.

[4.2 J of energy is needed to raise the temperature of 1.0 g of water by 1.0°C.]

(3 marks)

(2) Hence calculate the maximum temperature reached by the drink.

(1 mark)

(3) State one assumption made in the calculation of the maximum temperature change of the drink.

_____

_____ (1 mark)

(4) Calculate the minimum mass of CaO needed to release 75 kJ of energy, given that the complete reaction of 1.0 mole of CaO and water releases 65 kJ of energy.

[The molar mass of CaO = 56 g mol^{-1}.]

(2 marks)

(5) Suggest one disadvantage of using this self-heating drink container in a cold climate.

_____

_____ (1 mark)

TOTAL: 17 marks

QUESTION 7

Lead–acid batteries provide cars with a chemical source of electricity.

(a) The reactions that take place at the electrodes when a lead–acid battery is discharging are represented by the half-equations below:

Electrode 1 $Pb_{(s)} + SO_{4(aq)}^{2-} \longrightarrow PbSO_{4(s)} + 2e^-$

Electrode 2 $PbO_{2(s)} + SO_{4(aq)}^{2-} + 4H_{(aq)}^{+} + 2e^- \longrightarrow PbSO_{4(s)} + 2H_2O$

(i) State which electrode is acting as the anode.

_____ (1 mark)

(ii) Using the half-equations above, explain your answer to part (i).

_____

_____

_____ (2 marks)

(b) Lead ions, Pb^{2+}, are released into the waste water produced during the manufacture of lead–acid batteries. Various methods can be used to reduce the concentration of Pb^{2+} in the waste water to an acceptable level.

(i) Dilution is one method that can be used to reduce the concentration of Pb^{2+} in waste water.

The concentration of Pb^{2+} in one sample of waste water is 4000 ppb.

(1) State the concentration of Pb^{2+}, in ppm, in the waste water.

(1 mark)

(2) The concentration of Pb^{2+} in drinking water must be no greater than 0.010 ppm.

Calculate the minimum volume, in litres, to which 1 L of the waste water must be diluted to be suitable for drinking.

(2 marks)

(ii) The concentration of Pb^{2+} in waste water can also be reduced by cation exchange using a zeolite column.

(1) State two characteristics of the zeolite structure that make it effective in removing Pb^{2+} from large volumes of water.

_____

_____

_____ (2 marks)

(2) Explain why the presence of Al^{3+} in the waste water would reduce the effectiveness of the zeolite in removing Pb^{2+}.

_____

_____

_____

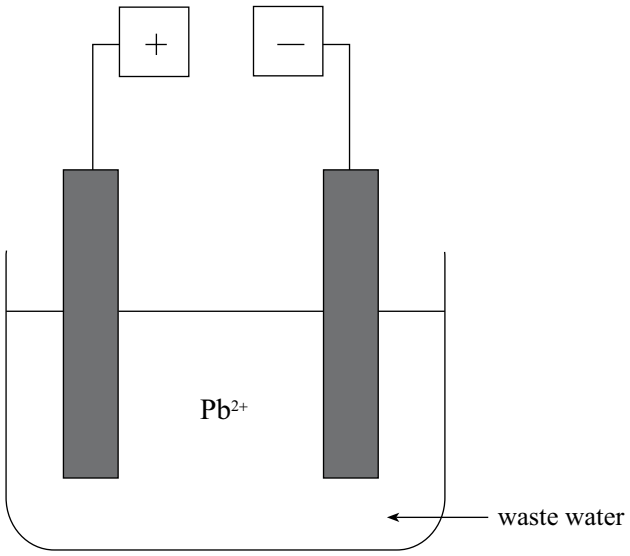
_____ (2 marks)

(3) The pH of the waste water must be maintained at between 5.5 and 7.0 for the effective removal of Pb^{2+}.

Calculate the maximum concentration of H^+, in mol L^{-1}, necessary for the effective removal of Pb^{2+}.

(3 marks)

(iii) Electrolysis can also be used to reduce the concentration of Pb^{2+} in waste water, as shown in the diagram of an electrolytic cell below:



(1) On the diagram above, draw an arrow to indicate the direction of flow of Pb^{2+} in the waste water. (1 mark)

(2) Explain why the presence of Al^{3+} in the waste water would not affect the removal of Pb^{2+} by electrolysis.

_____

_____

_____

_____ (2 marks)

(3) The use of electrolysis rather than cation exchange has advantages for a manufacturer of lead–acid batteries.

Suggest one of these advantages.

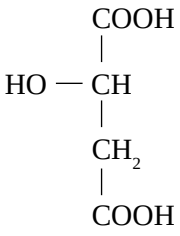
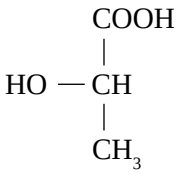
_____

_____ (1 mark)

TOTAL: 17 marks

QUESTION 8

Carboxylic acids contribute to the characteristic taste of wines. The structural formulae of two carboxylic acids found in wines are shown in the table below:

Malic acid	Lactic acid
	

A process known as malo-lactic fermentation occurs in some wines. During this process malic acid is converted into lactic acid.

(a) The extent of malo-lactic fermentation in one wine over a period of time was analysed by thin layer chromatography using a polar stationary phase.

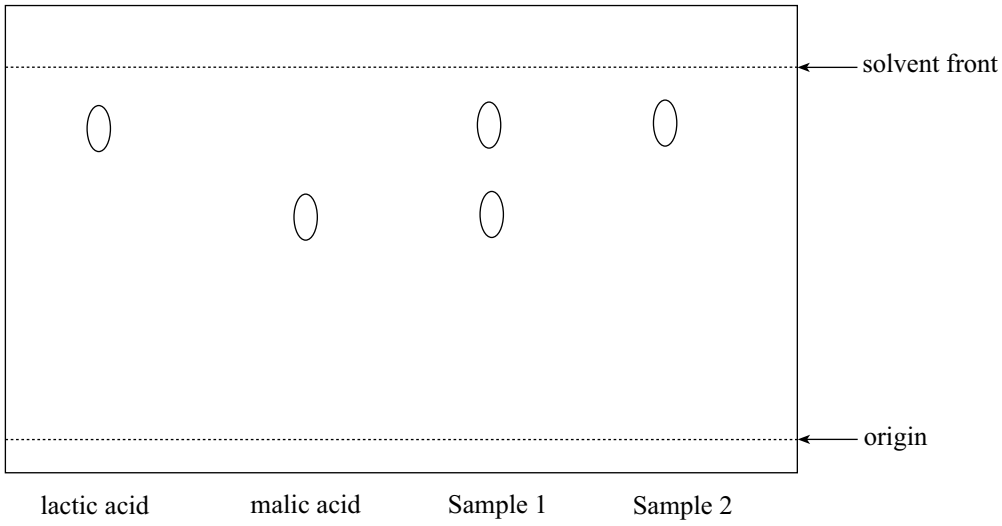
The following two samples of the wine were spotted onto the chromatography plate:

Sample 1 — no malo-lactic fermentation had occurred in the wine.

Sample 2 — malo-lactic fermentation had occurred.

Reference samples of lactic acid and malic acid were also spotted onto the plate.

The chromatogram obtained is shown below:



(i) Explain why malic acid moved a shorter distance than lactic acid.

_____

_____

_____

_____ (2 marks)

(ii) Explain how the chromatogram indicates that malo-lactic fermentation had occurred in Sample 2.

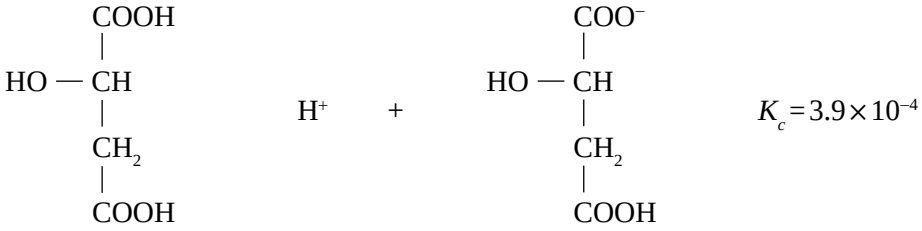
_____

_____

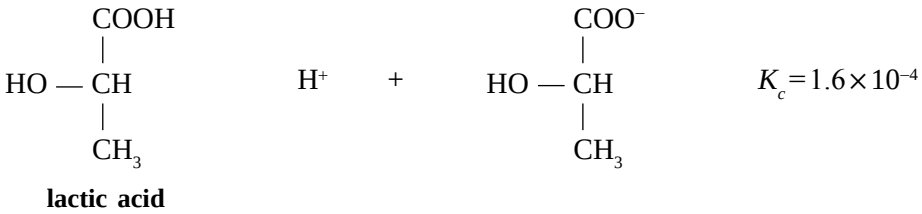
_____

_____ (2 marks)

(iii) Malic acid and lactic acid ionise in water, as shown in the equations below:



malic acid



lactic acid

(1) State which is the stronger acid.

_____ (1 mark)

(2) Using the information above, explain why malo-lactic fermentation causes wine to become less acidic.

_____

_____

_____

_____ (2 marks)

(b) Enzymes are needed for malo-lactic fermentation to occur.

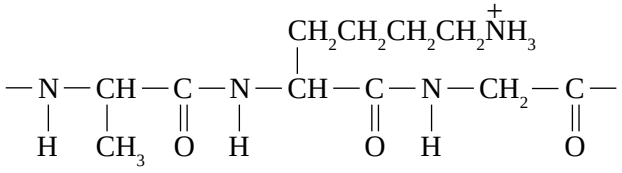
(i) State the name given to the monomers that bond together to form enzymes.

_____ (1 mark)

Credit will be given for answers to part (ii) 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.

(ii) A section of the structure of one enzyme is shown below:



Explain how high temperatures and high pH would affect the ability of the enzyme to function.

(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(b)(ii)(2) continued).

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2007

2007 CHEMISTRY

SACE REGISTRATION NUMBER

SEQ | FIGURES | CHECK LETTER | BIN

CHEMISTRY

QUESTION BOOKLET

3

16 pages, 4 questions

Wednesday 14 November: 1.30 p.m.

Question Booklet 3

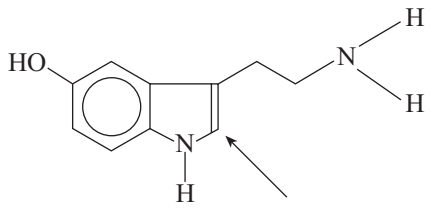
Write your answers to Questions 9 to 12 in this question booklet.

SSABSA

QUESTION 9

Certain compounds play an important role in the function of the human nervous system.

(a) The concentration of serotonin in the brain is thought to control depression in human beings. The structural formula of serotonin is shown below:



(i) (1) On the structural formula above, circle the primary amino group. (1 mark)

(2) State why this amino group is classified as primary.

_____ (1 mark)

(ii) Explain why the arrangement of atoms around the central atom indicated by the arrow is a trigonal planar shape.

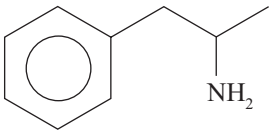
_____

_____

_____

_____ (2 marks)

(b) Amphetamine is a chemical that stimulates the human nervous system. The structural formula of amphetamine is shown below:



Amphetamine has a low solubility in water and is usually taken in the form of a salt.

(i) Using the structural formula above, explain why amphetamine has a low solubility in water.

_____

_____

_____

_____ (2 marks)

(ii) Amphetamine is converted into a salt by reaction with an acid solution.

(1) With reference to the structural formula above, explain how amphetamine reacts with an acid solution.

_____

_____

_____

_____ (2 marks)

(2) Draw the structural formula of the product of the reaction of amphetamine with an acid solution.

(2 marks)

(iii) The concentration of amphetamine in the human body can be monitored by urine analysis. The following procedure is used:

Step 1 NaOH solution is added to react with amphetamine salt in the urine.

Step 2 The mixture is shaken with a small amount of a non-polar organic solvent.

Step 3 The organic layer is collected and analysed for amphetamine by chromatography.

(1) Explain why the amphetamine salt is soluble in the aqueous urine layer.

_____

_____

_____

_____ (2 marks)

(2) Name the glassware used to separate the aqueous urine layer from the non-polar organic layer.

_____ (1 mark)

(c) Lithium carbonate, Li_2CO_3, is commonly used in tablet form as a mood stabiliser. The tablets release Li^+ into the aqueous body fluid.

One commonly prescribed tablet contains 0.25 g of Li_2CO_3.

(i) Calculate the number of moles of Li^+ in one tablet.

(2 marks)

(ii) The volume of aqueous body fluid in an average adult is approximately 42 L.

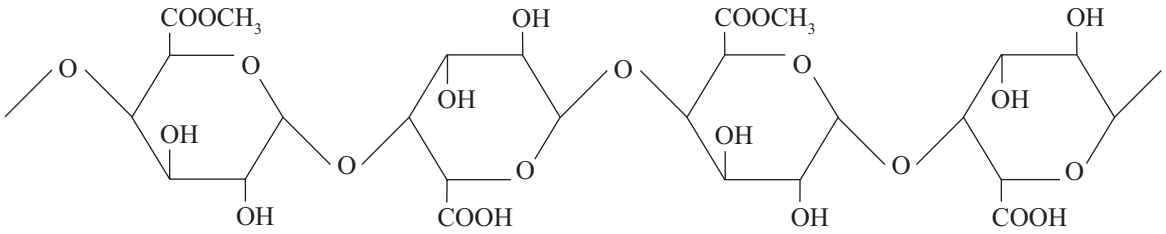
Calculate the average concentration of Li^+, in mmol L^{-1}, in the aqueous body fluid of an adult who has taken four tablets.

(2 marks)

TOTAL: 17 marks

QUESTION 10

Pectins are polysaccharides found in plants. Pectins absorb water to form gels that contribute to the rigid structure of plants. The structural formula of a section of one pectin chain is shown below:



(a) On the structural formula above, use brackets to indicate one repeating unit. (1 mark)

(b) Using the structural formula above, explain why this pectin absorbs water.

_____

_____

_____

_____

_____

_____ (3 marks)

(c) Pectins ionise in water, causing the chains to become charged.

(i) On the structural formula above, circle one functional group that ionises in water. (1 mark)

(ii) Vegetables become soft during cooking. One factor that affects the rate at which vegetables become soft is the concentration of Ca^{2+} in the cooking water.

(1) Explain how Ca^{2+} in the cooking water leads to the formation of cross links between the pectin chains.

_____

_____

_____

_____ (2 marks)

(2) Explain why restaurants in areas supplied with hard water may choose to cook vegetables in rainwater.

_____

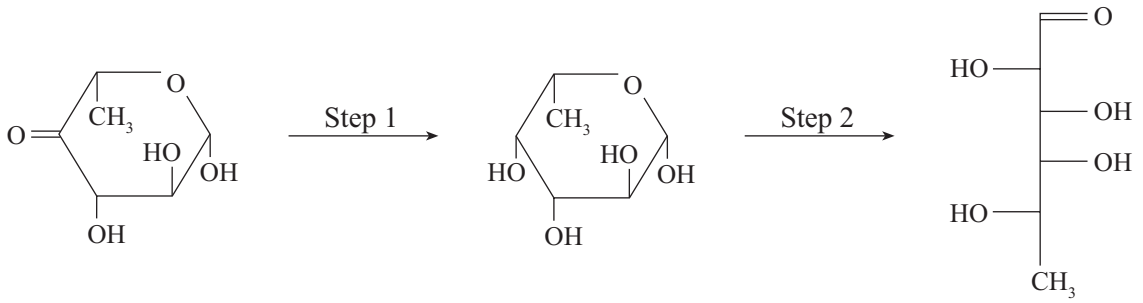
_____

_____

_____ (2 marks)

(d) Some pectins may form side chains with the monosaccharide L-fucose.

In cells L-fucose is synthesised from compound **A** in a sequence of two steps, as shown in the diagram below:



compound A **compound B** **L-fucose**

(i) Identify the type of reaction that occurs in Step 1.

_____ (1 mark)

(ii) Determine the molecular formula of L-fucose.

_____ (2 marks)

(iii) Explain why compound **B** and L-fucose are described as isomers.

_____

_____

_____ (2 marks)

(iv) Explain why L-fucose is classified as a carbohydrate.

_____

_____

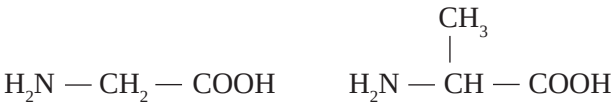
_____ (2 marks)

TOTAL: 16 marks

QUESTION 11

Spider silk is a natural polymer of great strength and toughness.

(a) Spider silk is composed of many amino acids, but is particularly rich in glycine and alanine. The structural formulae of glycine and alanine are shown below:



glycine **alanine**

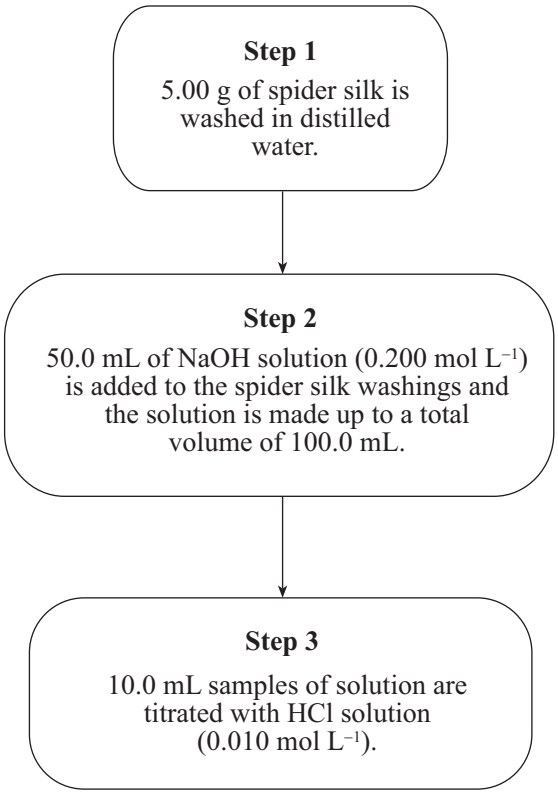
Draw the structural formula of a section of a protein chain that includes one unit of glycine and one unit of alanine.

(2 marks)

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

(b) In nature, spider silk is protected by a coating of a solution that contains a weak monoprotic acid. This makes the silk weakly acidic.

The following procedure was used to determine the percentage, by mass, of monoprotic acid in 5.00 g of spider silk.



(i) Calculate the number of moles of NaOH added to the spider silk washings in Step 2.

(2 marks)

(ii) Excess NaOH remained after the reaction in Step 2 was complete. In Step 3, 10.0 mL samples of solution were titrated with HCl to determine the number of moles of NaOH present.

The equation for the titration reaction in Step 3 is shown below:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

In one titration 42.0 mL of HCl was needed to neutralise the NaOH in one 10.0 mL sample.

(1) Calculate the number of moles of HCl needed to neutralise the NaOH in Step 3.

(2 marks)

(2) Hence state the number of moles of NaOH in the 10.0 mL sample titrated in Step 3.

(1 mark)

(3) Hence calculate the total number of moles of excess NaOH that remained after the reaction with the spider silk washings in Step 2.

(1 mark)

(4) Calculate the number of moles of NaOH that reacted with the spider silk washings in Step 2.

(1 mark)

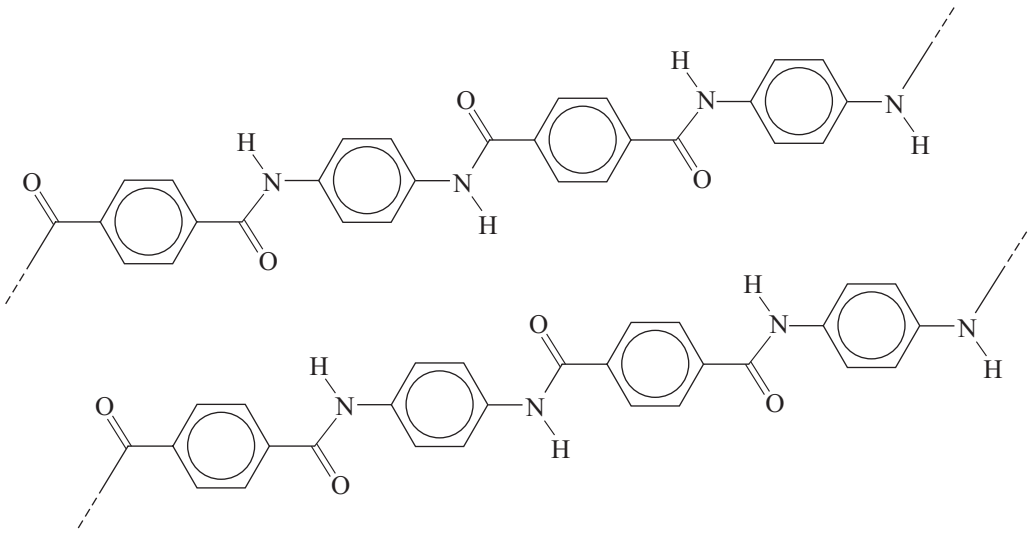
(5) The average molar mass of the weak monoprotic acid in spider silk is 118.1 g mol^{-1}.

Calculate the percentage, by mass, of the monoprotic acid in the 5.00 g of spider silk.

(3 marks)

(c) Kevlar is one of the few synthetic polymers similar to spider silk in strength and toughness.

Two polymer chains in a section of Kevlar are shown in the diagram below:



(i) On the diagram above, circle an amide group on one polymer chain. (1 mark)

(ii) Name the type of polymerisation reaction that is used to make Kevlar from its monomers.

_____ (1 mark)

(iii) One reason for the strength of Kevlar is the hydrogen bonding between the polymer chains.

On the diagram above, draw one hydrogen bond between the polymer chains. (1 mark)

(iv) One limitation of Kevlar is that it breaks down in alkaline conditions.

Draw the structural formula of one of the two products of this breakdown.

(2 marks)

TOTAL: 18 marks

QUESTION 12

The amount of carbon dioxide emitted into the atmosphere is increasing. This has the potential to enhance the greenhouse effect.

(a) Identify one major reason why the amount of carbon dioxide emitted into the atmosphere is increasing.

_____ (1 mark)

(b) Explain how this increase could lead to an increase in the average temperature of the Earth's atmosphere.

_____

_____

_____

_____

_____

_____ (3 marks)

(c) Large amounts of atmospheric carbon dioxide, $CO_{2(g)}$, dissolve in the Earth's oceans and form $CO_{2(aq)}$, as shown in Equation 1 below:

Equation 1 $\quad CO_{2(g)} + aq \rightleftharpoons CO_{2(aq)}$

(i) State the effect that an increase in the concentration of $CO_{2(g)}$ has on the concentration of $CO_{2(aq)}$. Explain your answer with reference to Le Châtelier's principle.

_____

_____

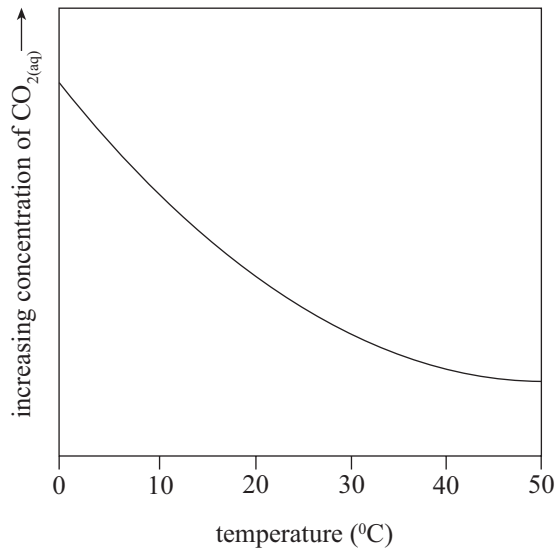
_____

_____

_____

_____ (3 marks)

(ii) The effect of temperature on the concentration of $CO_{2(aq)}$ in sea water is shown in the graph below:



(1) Using the graph above, state and explain whether the dissolving of carbon dioxide in water, as shown in Equation 1, is an exothermic reaction or an endothermic reaction.

_____

_____

_____

_____

_____

_____ (3 marks)

(2) The average concentration of $CO_{2(aq)}$ in the Earth's oceans is approximately 0.09 g L^{-1}. The Earth's oceans contain about 1.4×10^{12} GL of water.

Calculate the total mass of CO_2, in grams, dissolved in the Earth's oceans.

(2 marks)

(3) Explain why a small increase in the average temperature of the Earth's oceans could further enhance the greenhouse effect.

_____

_____

_____

_____ (2 marks)

(iii) Corals consist largely of $CaCO_3$. The $CaCO_3$ in corals reacts with $CO_{2(aq)}$ in the Earth's oceans, as shown in Equation 2 below:

Equation 2 $$CaCO_{3(s)} + CO_{2(aq)} + H_2O \rightleftharpoons Ca^{2+}_{(aq)} + 2HCO^{-}_{3(aq)}$$

Using Equation 2, explain why an increase in the concentration of $CO_{2(aq)}$ in the Earth's oceans could have an undesirable effect on corals.

_____

_____

_____

_____ (2 marks)

TOTAL: 16 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(b)(ii)(1) continued).