TSSM™
Creating VCE Success

THIS BOX IS FOR ILLUSTRATIVE PURPOSES ONLY

'2017 Examination Package' -
Trial Examination 4 of 9

STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Units 3 & 4 - Written examination

*(*TSSM's 2011 trial exam updated for the current study design*)*

Reading time: 15 minutes
Writing time: 2 hours and 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	11	11	90
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- VCAA data book is permitted in this examination.

Materials supplied

- Question and answer book of 24 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions.
Choose the response that is **correct** or **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
No mark will be given if more than one answer is completed for any question.
Marks will **not** be deducted for incorrect answers.

Question 1

The substance that gains electrons:

A. Undergoes oxidation
B. Is the reductant
C. Decreases it oxidation number
D. Gains oxygen

Question 2

Which of the following statements are true for a fuel cell:

I. It has a constant supply of reactants
II. It converts electrical energy to chemical energy
III. During discharge the anode is negative

A. I only
B. II only
C. II and III
D. I and III

Question 3

A sample of chloromethane is passed through a mass spectrometer. The peak with the highest mass visible on the mass spectrum is likely to have a mass of

A. 15
B. 47
C. 50.5
D. 52

Question 4

Particles which move towards the anode in an electrolytic cell are called:

A. Electrons
B. Anions
C. Cations
D. Protons

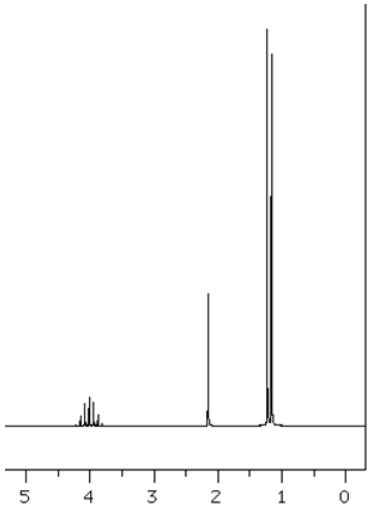
SECTION A - continued

Question 5
A strong signal at a wavenumber of 1750 cm^{-1} on an IR spectroscopy machine could indicate the presence of an:
A. Alcohol
B. Amine
C. Ester
D. C-H bend

Question 6
Which one of the following conditions is least likely to denature an enzyme?
A. a high temperature
B. an extreme pH
C. heavy metal ions
D. a low temperature

Question 7
2 mole of ethene is reacted to form ethanol. The mass, in grams, of ethanol formed will be
A. 46
B. 56
C. 92
D. 128

Question 8
The high resolution ^{1}H NMR spectrum drawn could belong to

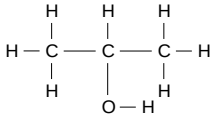


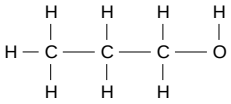
A. 1-propanol
B. 2-propanol
C. propanoic acid
D. propane

Question 9
The combustion of Naphthalene (M = 128.2 g/mol) can be used to calibrate a bomb calorimeter. The heat of combustion of naphthalene is -5140 kJ/mol. When 0.8210 g of naphthalene was burned in a bomb calorimeter, a temperature rise of 4.21°C was observed. What is the calibration factor of the bomb calorimeter?
A. 32.9 kJ/°C
B. 7.82 kJ/°C
C. 3.64 kJ/°C
D. 1.76 kJ/°C

SECTION A – continued
TURN OVER

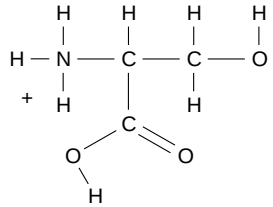
Question 10
Which test would NOT distinguish samples of the two molecules shown?





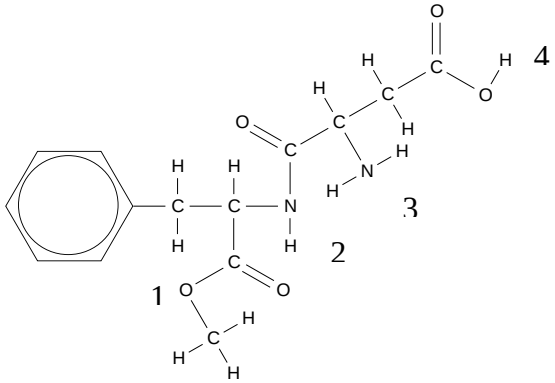
A. Proton NMR
B. Solubility in water
C. Reaction with $Cr_2O_7^{2-}$ in acid conditions
D. The finger print region of an infrared spectrum

Question 11
The molecule drawn below is



A. serine in acid solution
B. the zwitterion of valine
C. the zwitterion of serine
D. the product of the reaction between ethanoic acid and ammonia

Question 12
The structure of aspartame is shown below. Aspartame, commercially known as Nutrasweet or Equal, is an artificial sweetener that is about 169 times sweeter than sucrose.



The functional groups numbered 1 to 4 in aspartame are
A. ester, amide, amine and carboxyl
B. ester, amine, amine and carboxyl
C. carboxyl, amine, amine and carboxyl
D. ester, amide, amide and ester

SECTION A – continued

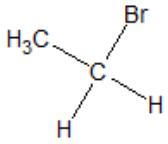
Question 13
The correct chemical name of the molecule drawn below is 9,12-octadecadienoic acid.

$$CH_3CH_2CH_2CH_2CH_2CH{=}CHCH_2CH{=}CHCH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$$

This molecule is better known as
A. linoleic acid
B. linolenic acid
C. palmitic acid
D. biodiesel

Question 14
Four substances were run on a TLC plate and obtained the following R_f values:
A = 0.15
B = 0.68
C = 0.23
D = 0.91
If the same four components were run through HPLC under similar conditions, what would the order of elution from the column be?
A. A, B, C, D
B. B, A, D, C
C. D, B, C, A
D. A, C, B, D

Question 15
How many enantiomers exist of the following substance?



A. 0
B. 1
C. 2
D. 3

SECTION A – continued
TURN OVER

Questions 16 and 17 refer to the following information

Methanol can be produced from the reaction between carbon monoxide gas and hydrogen gas. The equation is;

$$\mathbf{CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -91\ kJ\ mol^{-1}}$$

At 200 °C, the value of the equilibrium constant is 12.5 M^{-2}.

Question 16
The values of ΔH and of the equilibrium constant for the **reverse** reaction at 200 °C are, respectively,
A. -91 kJ mol^{-1} and 12.5
B. -9.4 kJ mol^{-1} and 0.08
C. +91 kJ mol^{-1} and -12.5
D. +91 kJ mol^{-1} and 0.08

Question 17
The effect of an increase in temperature and a decrease in pressure on an equilibrium mixture of the above gases will be
A. a lower yield of methanol
B. unclear as one change favours the forward reaction and the other the reverse
C. a higher yield of methanol
D. an unchanged value for K but a shift in the position of equilibrium

Question 18
In balancing the following unbalanced chemical equation using the redox half equation method, the respective coefficients will be:

$$SO_4^{2-} + Br_2 + H^+ \rightarrow S_2O_3^{2-} + BrO_3^- + H_2O$$

A. 2, 1, 10, 5, 2, 25
B. 10, 4, 2, 5, 8, 1
C. 5, 4, 10, 5, 4, 2
D. 2, 4, 2, 5, 2, 1

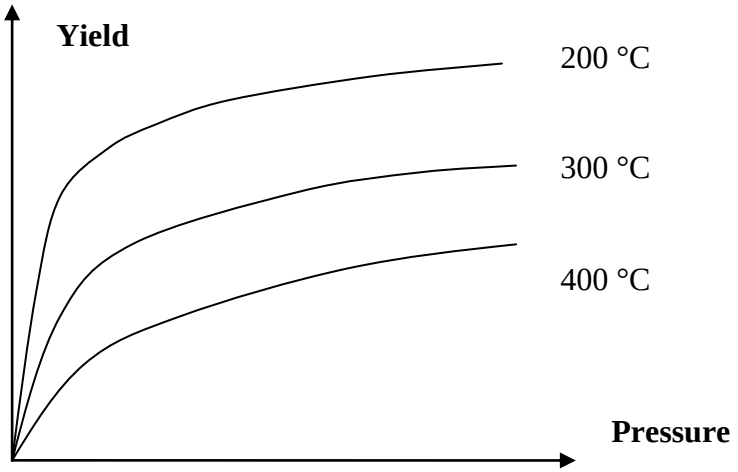
Question 19
What is the density (in g/L) of ammonia gas at 2.00 atm pressure and a temperature of 25.0°C?
A. 0.0137
B. 1.47
C. 0.095
D. 1.39

SECTION A – continued

Question 20
The mass of ethanol, in g, required to heat 100 mL of water from 20 °C to 60 °C will be closest to
A. 0.56
B. 1.40
C. 570
D. 1400

Question 21
Emissions produced from the combustion of coal to generate electricity include
A. SO_2 only
B. CO_2 only
C. SO_2 and CO_2 only
D. SO_2, NO and CO_2

Question 22
The yield of a reaction at a particular temperature varies as the pressure increases. The results are graphed below and then the process is repeated at two different temperatures. All results are shown on the one graph.



From the graph it can be concluded that the reaction is a reversible one that is
A. exothermic with more product molecules than reactant molecules
B. endothermic with less product molecules than reactant molecules
C. exothermic with less product molecules than reactant molecules
D. endothermic with more product molecules than reactant molecules

Question 23
Which of the following statements would apply to how various countries produce electricity from nuclear sources?

I no waste is produced
II the nuclei of small atoms join together
III uranium contains excess electrons
IV the nuclei of large atoms are split

A. **I** only
B. **IV** only
C. **I, III** and **IV** only
D. **I, II, III** and **IV**

Question 24
The reaction between table sugar and sulfuric acid is a very exothermic one. The reaction rate is very slow in the initial stages of the reaction when the concentration of the sulfuric acid is very high. The reaction rate is often much higher three or four minutes after the reaction has started. A possible reason for this increased rate might be that
A. sulfuric acid is a diprotic acid
B. the energy released is significantly increasing the temperature of the reactants
C. the activation energy of the sugar molecules decreases with time
D. the pressure in the flask is increasing as the reaction proceeds

Question 25
Nitrogen gas can be converted to nitrogen dioxide gas, NO_2 in a twostep process. The overall equation for this process is

$$N_{2v}(g) + 2O_{2v}(g) \rightarrow 2NO_{2v}(g)$$

The ΔH value for this reaction, given the following information, will be, in kJ mol^{-1},

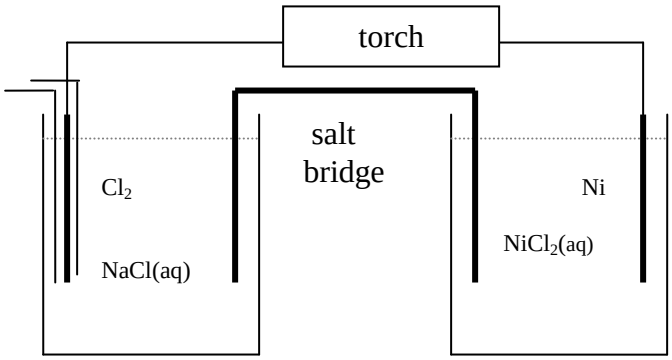
$$N_2(g) + O_2(g) \rightarrow 2NO(g) \quad \Delta H = +180 \text{ kJ mol}^{-1}$$
$$2NO_2(g) \rightarrow 2NOv(g) + O_{2v}(g) \quad \Delta H = +112 \text{ kJ mol}^{-1}$$

A. +292
B. +68
C. -68
D. -292

SECTION A – continued

Questions 26 and 27 refer to the following information

A galvanic cell is established to power a torch, as shown below



Question 26

For this cell, the

A. electrons will flow from the chlorine to the nickel
B. nickel electrode will be the negative anode
C. concentration of nickel ions in solution will be falling
D. chlorine electrode will be the negative cathode

Question 27

For this cell, the overall equation will be

A. $Cl_2(g) + Ni^{2+}(aq) \rightarrow 2Cl^-(aq) + Ni(s)$
B. $2Cl^-(aq) + Ni(s) \rightarrow Cl_2(g) + Ni^{2+}(aq)$
C. $2Cl^-(aq) + Ni^{2+}(aq) \rightarrow Cl_2(g) + Ni(s)$
D. $Cl_2(g) + Ni(s) \rightarrow 2Cl^-(aq) + Ni^{2+}(aq)$

Questions 28 and 29 refer to the following information

One of the types of lithium battery now in production is the lithium-iron cell. It has the same voltage as a typical alkaline cell but it copes better in high current demand uses. The overall equation for one version of this cell is

$2FeS + 4Li \rightarrow Fe + 2Li_2S$ (note: phases not shown for polymer electrolytes)

Question 28

The half equations occurring during discharge in the lithium-iron cell are

	Anode	**Cathode**
A.	$Li \rightarrow Li^+ + e^-$	$Fe^{2+} + 2e^- \rightarrow Fe$
B.	$Fe \rightarrow Fe^{2+} + 2e^-$	$Li \rightarrow Li^+ + e^-$
C.	$Li^+ + e^- \rightarrow Li$	$Fe \rightarrow Fe^{2+} + 2e^-$
D.	$S + 2e^- \rightarrow S^{2-}$	$Fe^{2+} + 2e^- \rightarrow Fe$

SECTION A – continued
TURN OVER

Question 29

When this cell is being recharged, the

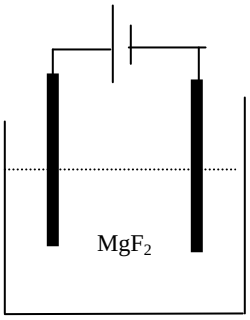
A. reduction reaction will occur at the same electrode as during discharge
B. oxidation reaction will be at the negative electrode as an external power source is used
C. iron electrode will be connected to the positive terminal of the recharger
D. lithium electrode will be connected to the positive terminal of the recharger

Question 30

Electrodes are placed into a molten solution of magnesium fluoride and the power supply switched on. A current of 4.0 amp flows for 24125 secs.

The number of mole of magnesium that will be produced in this cell will be

A. 0
B. 0.5
C. 1.0
D. 2.0



END OF SECTION A

SECTION B – Short answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.
To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.

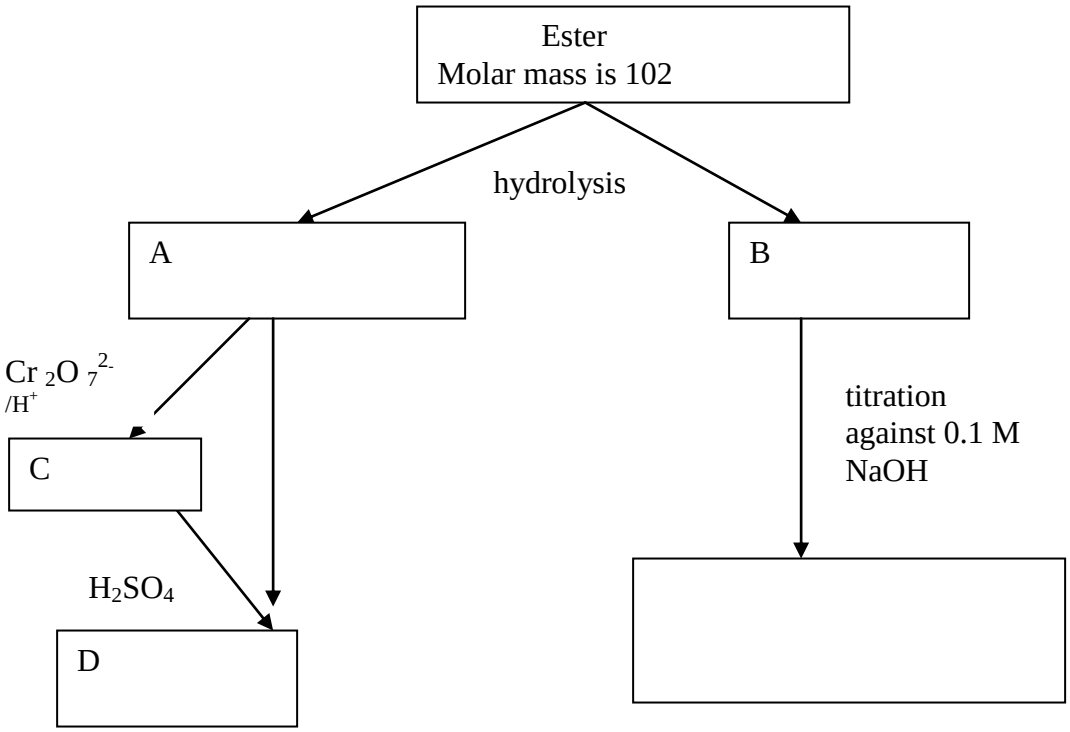
Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1 (4 marks)
Students in Unit 3 Chemistry are expected to know limitations of particular analytical techniques and instruments. The table below contains a series of typical analytical tasks. For each task a method of analysis has been chosen that is unlikely to be very suitable. Use the second column of the table to give one important reason why the technique mentioned is not particularly suitable.

Analytical task and technique chosen	**Reason the chosen method is unlikely to be suitable**
Gravimetric analysis to determine the mass of sodium nitrate in a 100 mL solution of sodium nitrate	
Separation of a mixture of monosaccharides using GC	
Determination of the concentration of an ethanoic acid solution using a titration against sodium carbonate	
Determination of the concentration of ethanol solutions using infrared spectroscopy	

Question 2 (10 marks)
The flowchart below starts with the hydrolysis of an ester molecule to form two molecules labelled A and B. The molar mass of the ester is 102 g. Substances A and B are separated.

Some of product A is reacted further to form product C.
The remainder of product A is reacted with product C, using sulfuric acid as a catalyst, to form product D
Product B is titrated against 0.100 M sodium hydroxide using phenolphthalein as an indicator.



a. **i**. The reaction of compound A to form compound C is an example of _____
1 mark

ii. Compound D is an example of what type of molecule? _____
1 mark

b. **i.** Compound D contains 6 carbon atoms. Draw a structural diagram of compound D and name it.

Structure Name _____
2 marks

ii. Draw a structural diagram of molecule A. 1 mark

c. Draw a structural diagram of the original ester molecule (shown at the top of the flowchart) 1 mark

SECTION B – Question 2 - continued

d. Draw a structural diagram of molecule B. 1 mark

e. **i**. Write a balanced equation for the titration occurring between B and sodium hydroxide. 1 mark

_____

ii. 20.0 mL of an aqueous solution of molecule B is neutralised by 8.6 mL of the NaOH. Calculate the concentration of the aqueous solution. 2 marks

_____

_____

Question 3 (8 marks)
The empirical formulas of several biomolecules are shown below

A	**B**	**C**
CH_2O	**$C_3H_7NO_3$**	**$C_8H_{16}O$**

a. Molecule A has a molar mass of 180 g.

i. What is its molecular formula? _____ 1 mark

ii. Suggest a possible name for this molecule? _____ 1 mark

iii. Are there any other biomolecules with this molecular formula? Explain your answer. 1 mark

_____

SECTION B – Question 3 - continued
TURN OVER

b. Molecule B is an amino acid

i. Do you think the molecular formula will be the same as the empirical formula? Explain your answer. 1 mark

_____

ii. Draw a structural diagram of Molecule B. 1 mark

iii. Name Molecule B. _____ 1 mark

c. Molecule C is a saturated fatty acid.

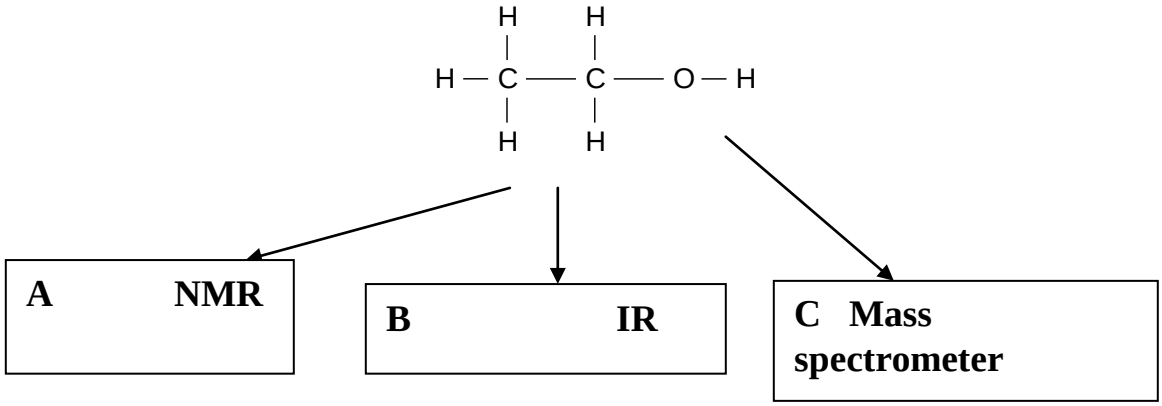
i. Do you think the molecular formula will be the same as the empirical formula? Explain your answer. 1 mark

_____

ii. Suggest a possible name for Molecule C _____ 1 mark

Question 4 (11 marks)

Chemical instruments play an important role in chemical analysis. In the case of organic molecules, instruments can help scientists deduce the structure of an unknown molecule. The instruments are often used in tandem.



SECTION B – Question 6 – continued

The following questions refer to the testing of ethanol using three different instruments

a. High resolution H NMR is conducted on ethanol.

i. How many sets of peaks will there be? _____

1 mark

SECTION B – Question 4 - continued

ii. What will the ratio of the peak areas be? _____

1 mark

iii. Describe the splitting that will occur with each peak. 3 marks

_____

_____

_____

b. A sample of ethanol is passed through an infrared spectrometer.

i. List two frequencies at which you will expect to see absorption occur and state the bonding present that causes each peak. 2 marks

_____

_____

ii. The infrared spectrum for ethanol is compared to that of propanol. State one similarity and one difference between the two spectra. 2 marks

Similarity _____

Difference _____

c. A mass spectrum of ethanol is obtained.

i. There is a small peak at 48. Suggest a possible explanation for a peak at this value.

1 mark

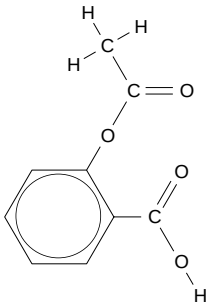
_____

ii. Ethanol forms two fragments, one of which is a methyl free radical.
Draw the other fragment. 1 mark

SECTION B – continued
TURN OVER

Question 5 (7 marks)

An aspirin molecule is shown below.



Aspirin can also be represented as $CH_3COOC_6H_4COOH$

a. Aspirin is a weak acid. Write a balanced equation for the reaction of aspirin and water.

1 mark

_____

b. The concentration of an aspirin solution can be determined by titration against dilute sodium hydroxide, NaOH

i. Write a balanced equation for the reaction of aspirin and NaOH. 1 mark

_____

ii. The product of this reaction is often used in preference to aspirin. Why is this? 1 mark

_____

c. If five aspirin tablets, weighing 5.23 g, are crushed and reacted with a 0.0250 M solution of sodium hydroxide, 12.32 mL of sodium hydroxide solution is required to neutralise the acid in the tablets. What is the mass of aspirin in one tablet?

_____

_____

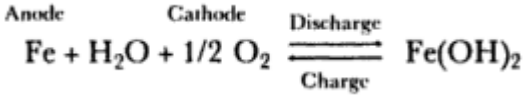
_____

_____

4 marks

SECTION B – continued

Question 6 (6 marks)
Iron-air rechargeable batteries are an attractive technology. The iron-air battery comprises an anode made of iron and a cathode taking oxygen from the air. The overall reactions taking place in this cell are as follows:



a. Write the half-equations for the reactions occurring at the anode and the cathode during discharge.

i. Anode:

_____

1 mark

ii. Cathode:

_____

1 mark

b. These cells are rechargeable, calculate the time required to recharge the battery if 5.00 g of iron needs to be restored using 20.0 amps.

_____

_____

_____

_____

4 marks

SECTION B – continued
TURN OVER

Question 7 (12 marks)

The enzyme amylase is found in saliva and its role is to break down starch. The major product of this reaction is maltose. The following data was collected when 5.0 mL of a starch solution was reacted with 1.0 mL of an amylase solution and then incubated at 25 °C and the amount of maltose measured every 5 minutes for 30 minutes.

Time (mins)	Maltose concentration (μM)
0	0
5	5.1
10	8.6
15	10.4
20	11.1
25	11.2
30	11.5

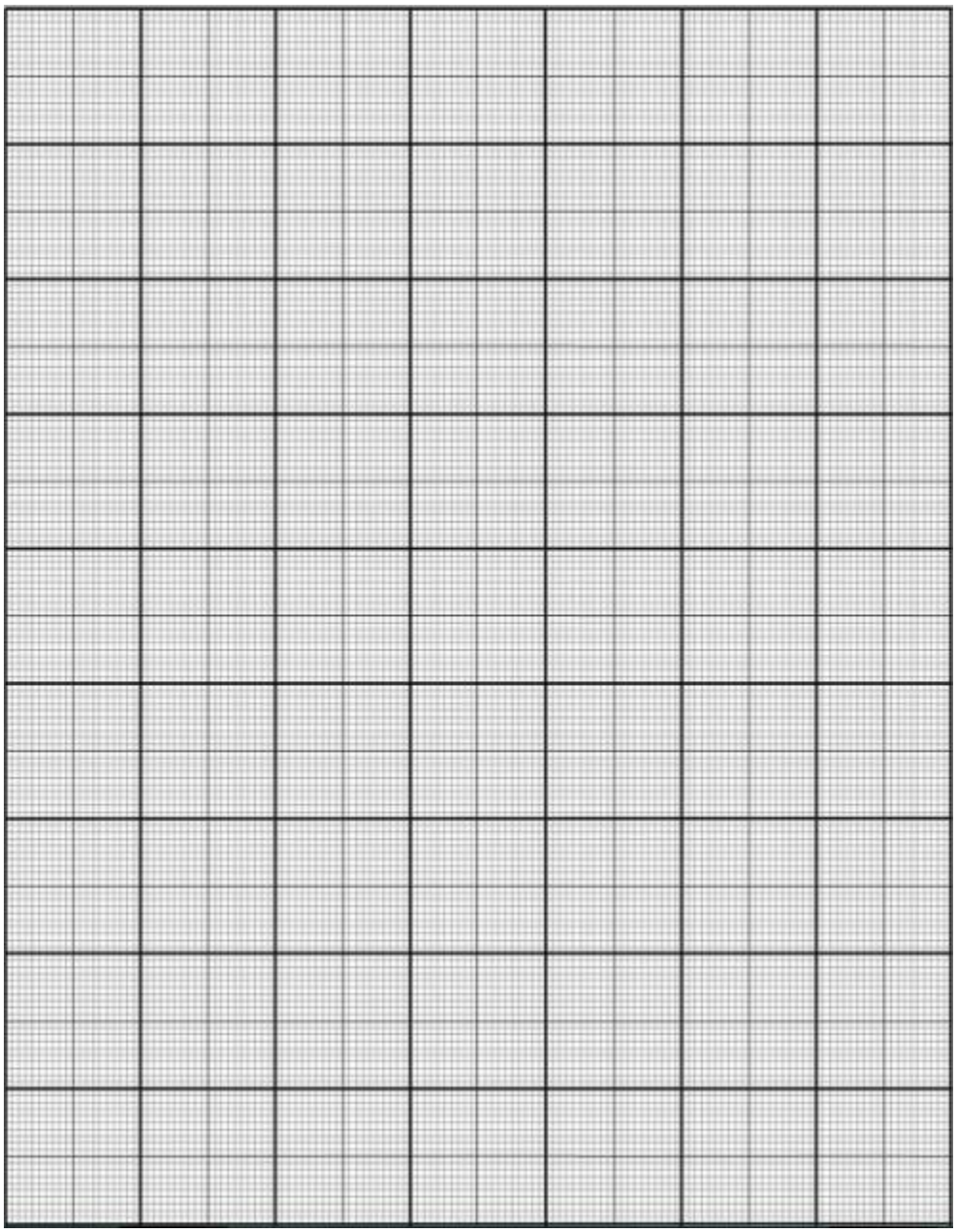
a. Maltose is a disaccharide composed of two glucose units. Draw a structural diagram of maltose.

2 marks

b. Graph the data on the axes provided below.

4 marks

SECTION B – **Question 7** - continued



c. Explain why a change in rate was observed around the 20 minute mark.

_____

_____

1 mark

SECTION B – **Question 7** - continued
TURN OVER

d. Draw and label another line on the graph that would be obtained if the concentration of the amylase solution was doubled.

1 mark

e. Identify two factors that can change the rate of the amylase reaction. Provide a reason as to why these affect the rate.

_____

_____

_____

_____

4 marks

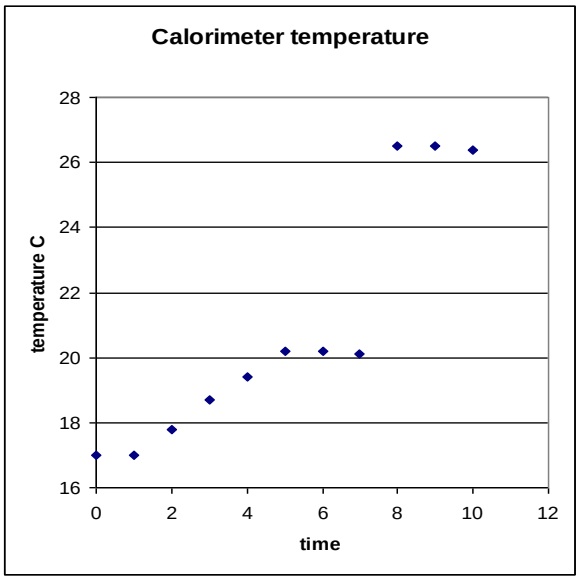
Question 8 (10 marks)

A student investigating a chemical reaction follows the procedure outlined below:
1. Add 100 mL of distilled water to a calorimeter and allow the temperature to settle.
2. The student then passes a current of 3.60 amps through the calorimeter, measuring the temperature every minute. The potential difference is 5.80 V.
3. Add 5.00 g of anhydrous copper sulfate to the calorimeter and record the temperature change.

The reaction occurring is:

$CuSO_4(s)$ → $CuSO_4(aq)$

The temperature changes during the experiment are recorded in the graph shown.



a.
i. From the graph, how long was calibration conducted? 1 mark

_____

SECTION B – Question 8 - continued

ii. Calculate the calibration factor for the calorimeter. 2 marks

_____

b. If the experiment was repeated using the same values of voltage and current, but the time interval was double that evident in the graph, what would be the likely impact upon

i. the change in temperature during calibration. Explain your answer. 1 mark

_____

ii. the calibration factor? Explain your answer. 2 marks

_____

c. i. What was the temperature change for the reaction of copper sulfate in water? 1 mark

_____

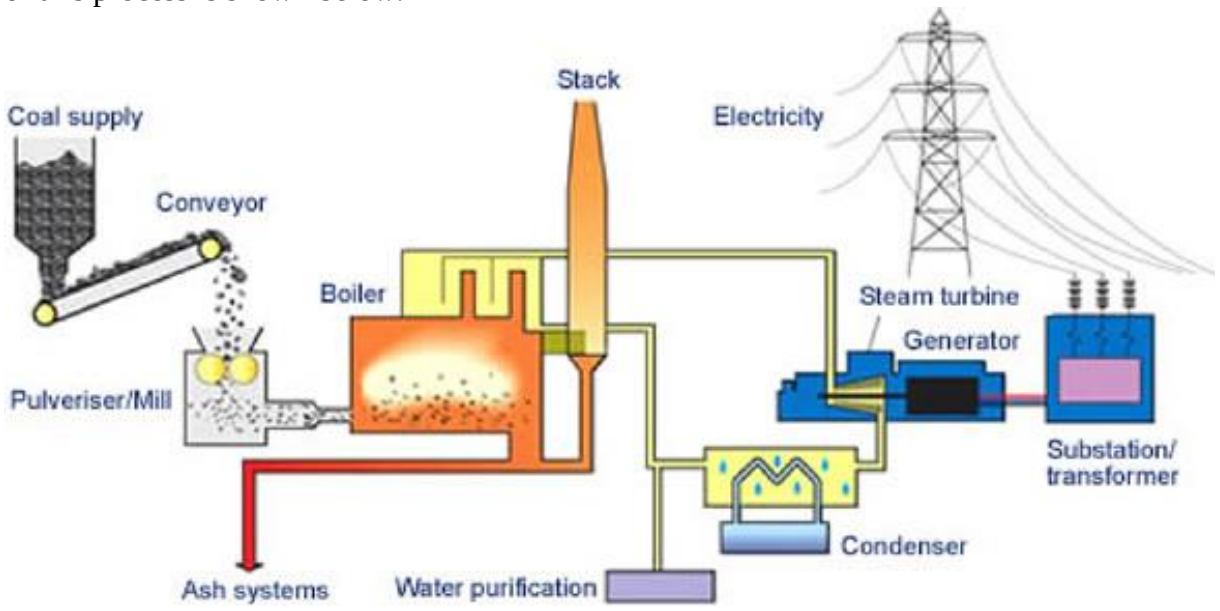
ii. Calculate ΔH for the reaction of copper sulfate and water. 3 marks

_____

_____

Question 9 (6 marks)

The majority of Australia's electrical energy is generated from the combustion of coal. An outline of this process is shown below.



SECTION B – Question 9 - continued

TURN OVER

a. Several gaseous products are released from the stack.

i. Name two gases produced. 1 mark

_____

ii. Write a balanced equation for the formation of one of these gases. 1 mark

_____

b. What energy conversion is occurring

i. in the generator? _____ 1 mark

ii. in the boiler? _____ 1 mark

c. Give one reason why the coal is crushed before entering the furnace. 1 mark

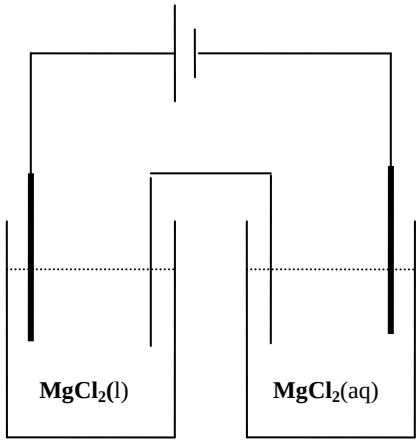
_____

d. Coal is made from dead organisms. Why is it not considered to be a renewable form of energy? 1 mark

_____

Question 10 (12 marks)

Two cells are connected in series as shown below and a current is passed through the circuit. Cell A is kept at a temperature high enough to maintain a molten solution of magnesium chloride, $MgCl_2$ and cell B contains a dilute aqueous solution of the same substance.



SECTION B – **Question 10** - continued

a. Use the table below to show the half equations and products that will form in each cell. 6 marks

	Cell A	**Cell B**
Anode half equation		
Cathode half equation		
Products		

b. 4.40 mole of electrons passes through the circuit. The table below shows several species that may be products of this electrolysis. For each species, indicate how many mole will be produced from the 4.40 mole of electrons flowing through the circuit. 4 marks

Species	**Number of mole produced**
magnesium	
chlorine gas	
oxygen gas	
hydrogen gas	

c. What volume of gas is produced in this circuit if the gas is cooled to STP? 2 marks

_____

_____

Question 11 (7 marks)
Carbon monoxide is a poisonous gas. Fortunately, it can react with oxygen gas to form the less toxic gas, carbon dioxide. The reaction between carbon monoxide and oxygen is a reversible one.

$$\mathbf{2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g) \qquad \Delta H = -546\ kJ\ mol^{-1}}$$

a. 10 mole of carbon monoxide is added to an empty reactor.

i. When equilibrium is reached, will the amount of energy released be 2730 kJ? Explain your answer. 1 mark

_____

ii. When equilibrium is reached, the amount of oxygen found to have reacted is 1.6 mole. How many mole of carbon monoxide remains? 1 mark

_____

SECTION B – **Question 11** - continued
TURN OVER

b. At 25 °C, the value of K for this reaction is $3.4 \times 10^3 M^{-1}$.

i. CO_2 gas is pumped into an empty room held at 25 °C. When equilibrium is reached, is the level of CO likely to be a dangerous one? 1 mark

_____

ii. An engine runs for a long time in a sealed room and builds up a high level of CO gas. The engine is turned off and the gas mixture allowed to reach equilibrium. Given the high value of K, is it possible at equilibrium for the level of CO to still be dangerously high? 1 mark

_____

c. An equilibrium mixture of gases has a high level of CO. List three possible changes that could be made to the system to lower the concentration of CO. 3 marks

_____

_____

END OF QUESTION AND ANSWER BOOK