

**‘2017 Examination Package’ -  
Trial Examination 7 of 9**

**STUDENT NUMBER**

Letter

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|---------|--|--|--|--|--|--|--|--|--|
| Figures |  |  |  |  |  |  |  |  |  |
|         |  |  |  |  |  |  |  |  |  |
| Words   |  |  |  |  |  |  |  |  |  |

# CHEMISTRY

## Units 3 & 4 - Written examination

**(TSSM’s 2014 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

| <i>Section</i> | <i>Number of questions</i> | <i>Number of questions to be answered</i> | <i>Number of marks</i> |
|----------------|----------------------------|-------------------------------------------|------------------------|
| A              | 30                         | 30                                        | 30                     |
| B              | 11                         | 11                                        | 93                     |
|                |                            |                                           | Total 123              |

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- A scientific calculator 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 number of mole of electrons required to obtain 0.12 mole of aluminium from a molten electrolytic cell will be

- A. 0.04
- B. 0.12
- C. 0.24
- D. 0.36

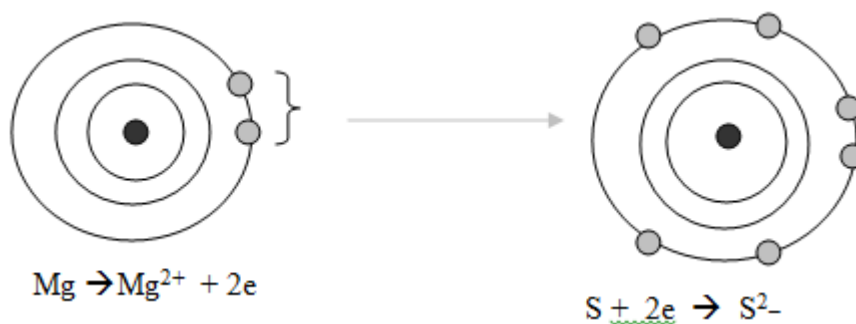
**Question 2**

In electrolysis,

- A. oxidation occurs at the anode and the anode is negative
- B. oxidation occurs at the anode and the anode is positive
- C. the weakest oxidant reacts with the weakest reductant
- D. reduction occurs at the cathode and the cathode is positive

**Question 3**

The diagram below shows the outer shell electron movement in a reaction.



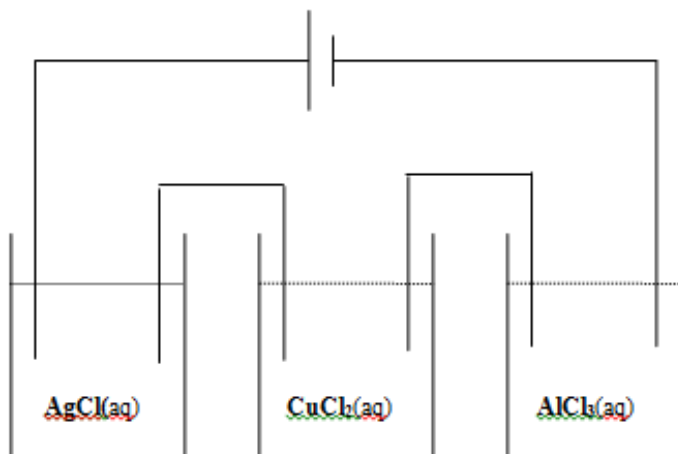
The electron transfer shown could be the

- A. electrolysis of a molten solution of magnesium sulfide
- B. precipitation of magnesium sulfide from an aqueous solution
- C. reaction occurring in a galvanic cell between magnesium and sulfur
- D. reduction of magnesium metal by sulfur

**SECTION A - continued**

**Question 4**

Aqueous solutions of  $\text{AgCl}$ ,  $\text{CuCl}_2$  and  $\text{AlCl}_3$  are connected in series to a power supply.

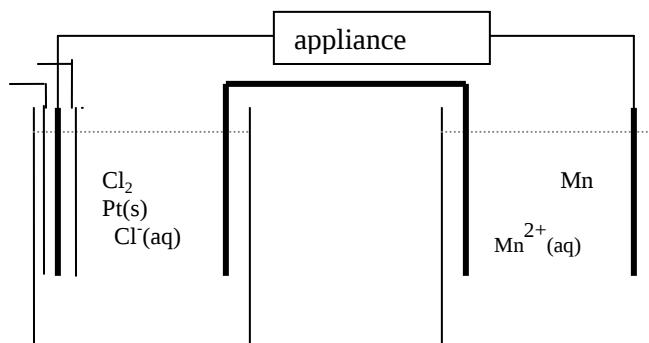


After 0.60 mole of electrons has passed through this circuit the amounts of metal deposited will be, in mole,

- A. 0.20 Ag, 0.20 Cu, 0.20 Al
- B. 0.60 Ag, 0.30 Cu, 0.20 Al
- C. 0.60 Ag, 0.30 Cu, 0 Al
- D. 0.60 Ag, 1.20 Cu, 1.80 Al

**Question 5**

A galvanic cell is constructed from a chlorine half cell connected to a manganese half-cell.



In this cell

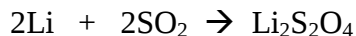
|    | oxidant          | reductant        | anode | cathode |
|----|------------------|------------------|-------|---------|
| A. | $\text{Mn}^{2+}$ | $\text{Cl}^-$    | Pt    | Mn      |
| B. | Mn               | $\text{Cl}_2$    | Mn    | Pt      |
| C. | $\text{Cl}_2$    | Mn               | Mn    | Pt      |
| D. | $\text{Cl}^-$    | $\text{Mn}^{2+}$ | Mn    | Pt      |

**SECTION A – continued**

**TURN OVER**

*Use the following information to answer Questions 6 and 7*

A cell that is popular in military uses is the cell formed from the reaction of lithium and sulfur dioxide. The cell is expensive but is capable of producing a voltage of almost 3 volts. The overall equation for this cell is

**Question 6**

The half equation for the reaction at the cathode in this cell will be

- A.  $\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$
- B.  $2\text{SO}_2 + 2\text{e}^- \rightarrow \text{S}_2\text{O}_4^{2-}$
- C.  $\text{SO}_2 + 2\text{OH}^- + 2\text{e}^- \rightarrow \text{S}_2\text{O}_4^{2-}$
- D.  $\text{SO}_2 + \text{O}_2^- + 2\text{e}^- \rightarrow \text{S}_2\text{O}_4^{2-}$

**Question 7**

In this reaction, the oxidation number of sulfur

- A. remains unchanged
- B. changes from +2 to +4
- C. changes from +4 to +6
- D. changes from +4 to +3

**Question 8**

Which one of the following fuels is the most sustainable?

- A. bioethanol
- B. diesel
- C. natural gas
- D. uranium

**Question 9**

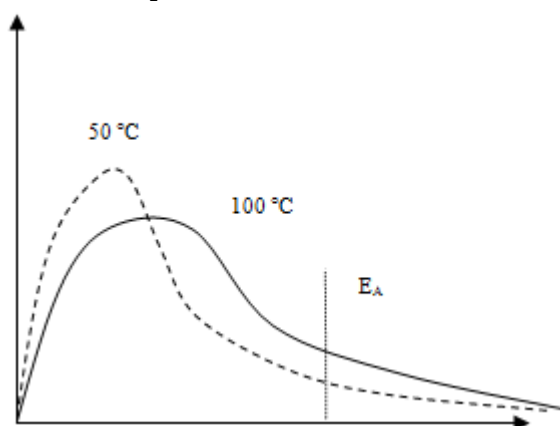
What volume does 3.0 moles of Kr gas occupy at STC?

- A. 24.8 L
- B. 49.6 L
- C. 74.4 L
- D. 89.6 L

**SECTION A – continued**

**Question 10**

The diagram below represents the distributions of kinetic energy of reactant particles at two different temperatures, 50 °C and 100 °C.

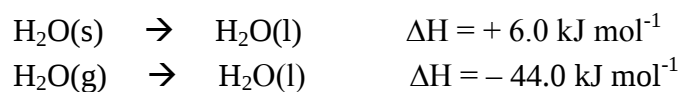


From this diagram, it can be concluded that

- A. more reactants particles have sufficient energy to react at 100 °C than 50 °C
- B. all reactant particles at 100 °C have more kinetic energy than those at 50 °C
- C. the activation energy for the reaction is higher at 100 °C
- D. the reaction in question is an exothermic one

**Question 11**

Enthalpy changes for the phase changes of water are provided below;



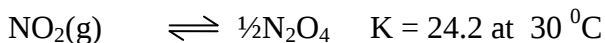
The enthalpy change for the reaction  $\text{H}_2\text{O(g)} \rightarrow \text{H}_2\text{O(s)}$  will be, in  $\text{kJ mol}^{-1}$ ,

- A. + 50.0
- B. + 38.0
- C. - 38.0
- D. - 50.0

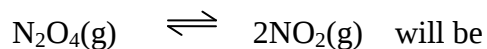
**SECTION A – continued**  
**TURN OVER**

**Question 12**

The numerical value of  $K$  at  $30\text{ }^{\circ}\text{C}$  for the reaction below is 24.2.



The numerical value of the equilibrium constant at  $30\text{ }^{\circ}\text{C}$  of the reaction



- A.  $1.71 \times 10^{-3}$
- B. 0.0413
- C. 0.203
- D. 586

**Question 13**

A 1.00 g sample of  $\text{NH}_4\text{NO}_3$  is decomposed in a bomb calorimeter. The temperature of the calorimeter increases by 6.12 K. The heat capacity of the system is  $1.23\text{ kJg}^{-1}\text{K}^{-1}$ . What is the molar heat of decomposition for ammonium nitrate?

- A. -7.53 kJ/mol
- B. -16.1 kJ/mol
- C. -398 kJ/mol
- D. -602 kJ/mol

**Question 14**

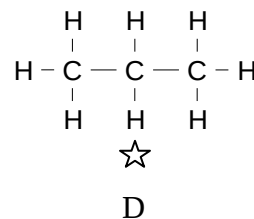
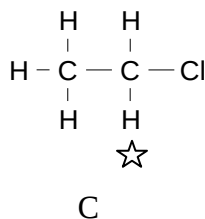
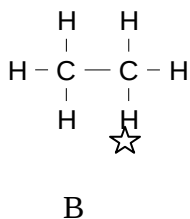
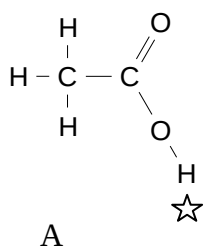
Which of the following will increase the rate of a reaction?

- A. Increase the activation energy required
- B. Add a catalyst
- C. Decrease the concentration of the reactants
- D. Cool the reaction mixture

**SECTION A – continued**

**Question 15**

Four different carbon compounds are drawn below and labelled from A to D. A hydrogen atom has been marked in each compound.

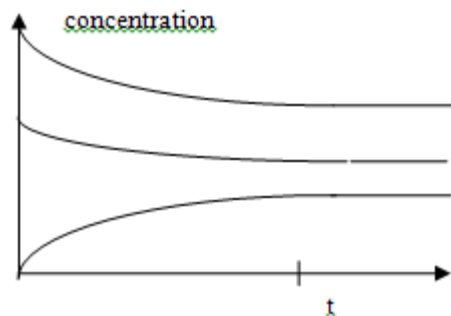


The ranking of the shift of the marked hydrogen atom in proton-NMR will be (from lowest to highest)

- A. A, C, D, B
- B. B, D, A, C
- C. D, B, C, A
- D. B, D, C, A

**Question 16**

The concentrations of the components of a reversible reaction are graphed below.



The equilibrium system in the graph could be

- A.  $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
- B.  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
- C.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
- D.  $\text{COBr}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{Br}_2(\text{g})$

**SECTION A – continued**  
**TURN OVER**

**Question 17**

Which of the following compounds is/are chiral?

- I. 1,1-dichloropentane
- II. 1,2-dichloropentane
- III. 3-chloropentane
- IV. 2,3-dichloropentane

- A. II
- B. II and IV
- C. III
- D. II, III and IV

**Question 18**

Molecules of 1-bromopropan-1-ol and 1-bromopropan-2-ol have different:

- A. Percentage compositions
- B. Molecular masses
- C. Molecular formulas
- D. Chirality

**Question 19**

The empirical formula of a molecule is  $\text{CH}_2\text{O}$ .

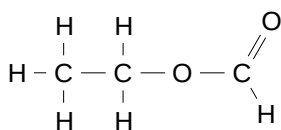
Consider the following molecules.

- I glycerol
- II glucose
- III fructose
- IV ethanoic acid

The molecule could be

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

**SECTION A – continued**

**Question 20**

The systematic IUPAC name for the molecule shown above is

- A. ethyl propanoate
- B. methyl propanoate
- C. propanoic acid
- D. ethyl methanoate

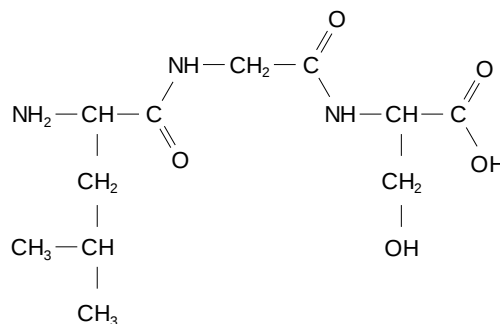
**Question 21**

An organic compound reacts with both dilute hydrochloric acid and dilute sodium hydroxide. The molecule could be

- A. propanoic acid
- B. glucose
- C. glycine
- D. glycerol

**Question 22**

A tripeptide is drawn below



The amino acids in this molecule are, from left to right,

- A. leucine, glycine and serine
- B. leucine, alanine and threonine
- C. valine, alanine and cysteine
- D. valine, glycine and serine

**SECTION A – continued**  
**TURN OVER**

**Question 23**

Which of the following is the definition of the base peak of a mass spectrum?

- A. The peak corresponding to the most abundant ion
- B. The peak corresponding to the ion with lowest mass to charge ratio
- C. The peak corresponding to the molecular ion peak
- D. The peak corresponding to the ion arising to loss of a proton from the molecular ion

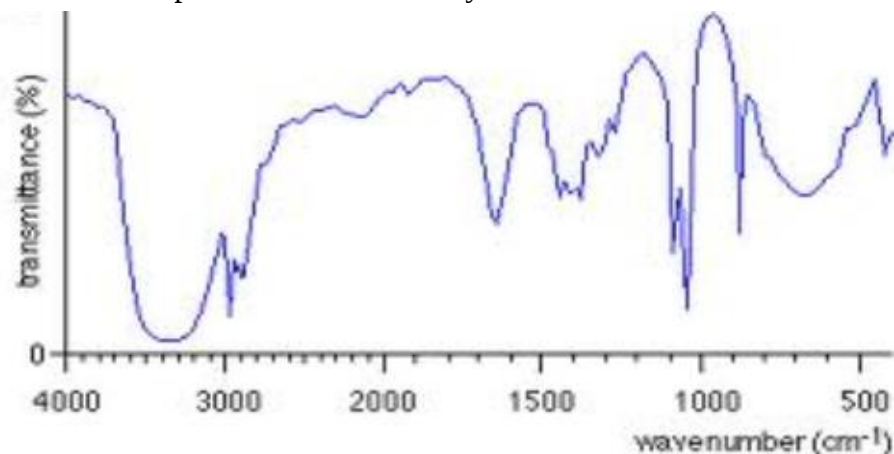
**Question 24**

Which of the following statements is correct?

- A. Ultraviolet radiation has a longer wavelength than infrared radiation.
- B. Infrared radiation has a shorter wavelength than visible light.
- C. Infrared radiation has a lower wavenumber than visible light.
- D. Microwave radiation possesses more energy than infrared radiation.

**Question 25**

The infrared spectrum shown is likely to be that of



- A. ethanoic acid
- B. ethanol
- C. 1-chloropropane
- D. ethane

**Question 26**

Which of the following equations represents sulfur dioxide acting as an oxidant?

- A.  $\text{Fe}^{3+} + \text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{Fe}^{2+} + \text{SO}_4^{2-} + \text{H}^+$
- B.  $\text{Fe} + \text{SO}_2 \rightarrow \text{FeO} + \text{FeS}$
- C.  $\text{MnO}_4^- + \text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{Mn}^{2+} + \text{H}^+ + \text{SO}_3^-$
- D.  $\text{Cr}_2\text{O}_7^{2-} + \text{H}^+ + \text{SO}_2 \rightarrow \text{Cr}^{3+} + \text{S}_2\text{O}_6^{2-} + \text{H}_2\text{O}$

**SECTION A – continued**

**Question 27**

Which of the following molecules represents a monounsaturated fatty acid?

- A. linolenic acid
- B.  $C_{17}H_{34}O_2$
- C. stearic acid
- D.  $C_{18}H_{34}O_2$

**Question 28**

The number of different hydrogen environments in a glycerol molecule will be

- A. 3
- B. 4
- C. 5
- D. 8

**Question 29**

It is determined that  $8.30 \times 10^4$  J of energy are evolved when 1.50 g of  $CH_4$  are burned in the presence of excess oxygen in a bomb calorimeter. What is the molar heat of combustion of  $CH_4$  in kJ/mol?

- A. -7.78
- B. -135
- C. -830
- D. -885

**Question 30**

A sample of butane is found to contain 2.00 g of carbon. The mass of hydrogen in the sample will be, in gram,

- A. 0.16
- B. 0.42
- C. 2.0
- D. 5.0

**END OF SECTION A**  
**TURN OVER**

## SECTION B

**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,  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$

**Question 1** (10 marks)

Living things are capable of converting monosaccharides to disaccharides and to polysaccharides.

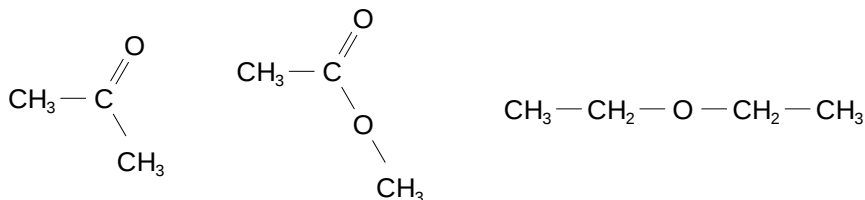


Example: \_\_\_\_\_

Molecular  
formula: \_\_\_\_\_

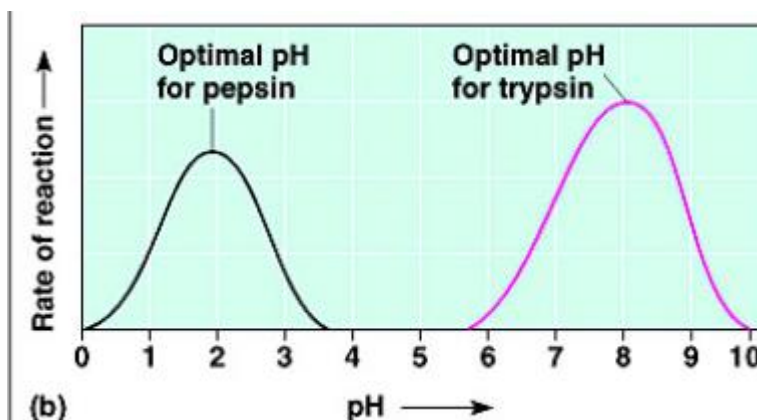
Structural  
isomer : \_\_\_\_\_

- a. i.** Use the spaces provided to give an example of each type of carbohydrate 1 mark
- ii.** Use the spaces provided to write the molecular formula of the monosaccharide and the disaccharide you chose. 2 marks
- iii.** Use the space provided to name a structural isomer of the monosaccharide you chose 1 mark
- b.** Circle the molecule drawn that has the same functional group as the linkage in a disaccharide. 1 mark



**SECTION B – Question 1-** continued

- c. Enzymes are proteins that catalyse specific reactions. Pepsin and trypsin both serve to hydrolyse proteins back to the amino acids they were formed from. They act, however, in different parts of the body. The graph below compares the performance of both catalysts at different pH values.



- i. The pH in a typical human stomach is around 1.8. Comment on the performance of both enzymes at this pH.

2 marks

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- ii. If pepsin passes into the small intestine where the pH is around 8, it is permanently destroyed as a catalyst. Explain how the bonding in pepsin changes at this pH.

1 mark

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- iii. If a protein containing 20000 amino acids is completely hydrolysed back to amino acids, how will the mass of the amino acids formed compare to the mass of the original protein? Explain your answer.

2 marks

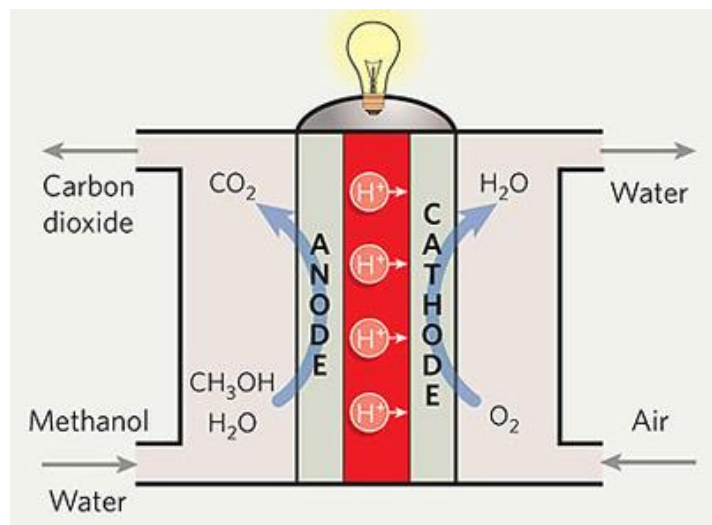
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**SECTION B- continued**  
**TURN OVER**

**Question 2** (7 marks)

Methanol fuel cells produce electricity by reacting methanol and oxygen gas from the air. A simplified diagram of a methanol fuel cell is shown below.



- a. When the equation for the overall reaction in the methanol fuel cell is balanced with the lowest whole number coefficients, the coefficient for:

$O_2(g)$  \_\_\_\_\_

$H_2O(l)$  \_\_\_\_\_

$CO_2(g)$  \_\_\_\_\_

$CH_3OH(l)$  \_\_\_\_\_

4 marks

- b. If the cell potential for the methanol fuel cell is +0.80 V. Calculate the reduction potential for the half-reaction involving  $CH_3OH(l) + H_2O(l)$ .

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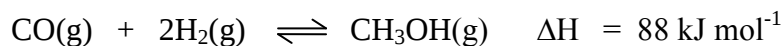
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3 marks

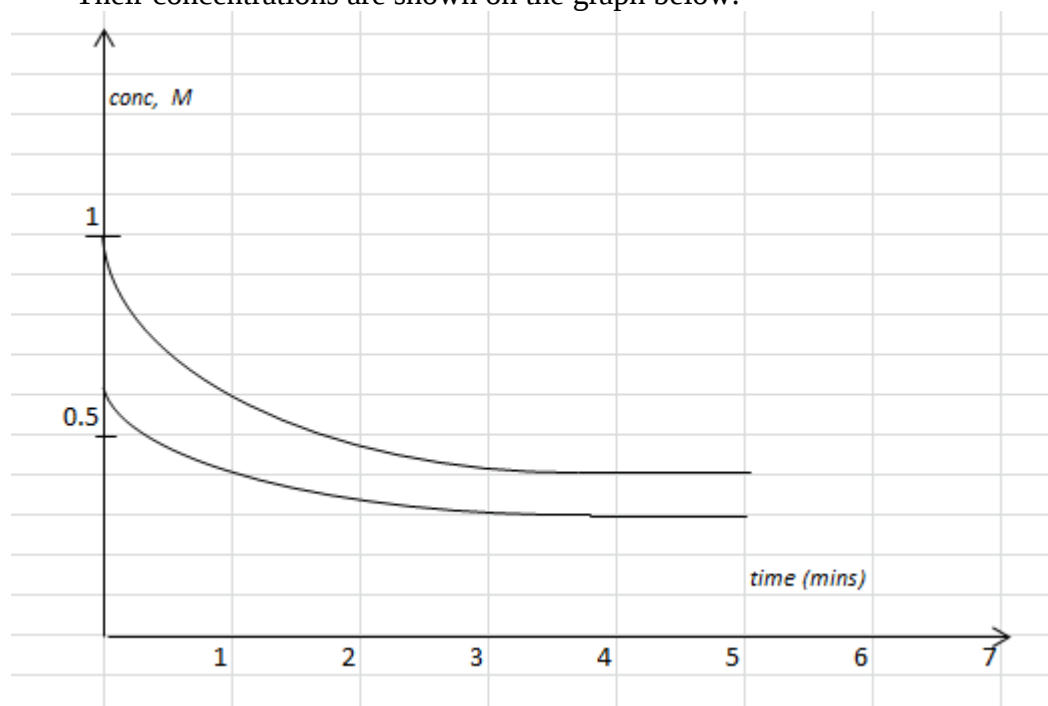
**SECTION B** – continued

**Question 3** (10 marks)

Methanol can be formed from the reversible reaction between carbon monoxide and hydrogen gases.



- a. Samples of carbon monoxide and hydrogen are added to an empty 2.00 L reactor at 120 °C. Their concentrations are shown on the graph below.



- i. Show on the graph which curve represents the concentration of hydrogen gas and which curve represents the concentration of carbon monoxide gas 2 marks
  - ii. Draw in carefully the curve for the concentration of methanol 1 mark
- b. i. Calculate a value for K at 120 °C for this reaction. 2 marks

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**SECTION B – Question 3- continued**  
**TURN OVER**

- ii. What amount of methanol gas is present at equilibrium? 1 mark

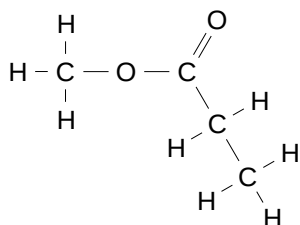
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- c. At the 5 minute mark, the volume of the reactor is doubled. Show on the graph,
- i. the immediate impact upon the reactant concentrations 2 marks
- ii. the movement in the reactant concentrations after the 5 minute mark. 2 marks

**Question 4** (6 marks)

The molecule below is an ester.



- a. i. Name this ester \_\_\_\_\_ 1 mark
- ii. What is the empirical formula of the ester? \_\_\_\_\_ 1 mark
- b. The ester is hydrolysed back to the alkanol and carboxylic acid that it was formed from.
- i. Write a balanced chemical equation for the hydrolysis reaction. 1 mark

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- ii. Write a balanced equation for the complete combustion of the alkanol that was formed. 1 mark

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- iii. Determine the amount of energy released from the combustion of 1.00 g of alkanol 2 marks

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**SECTION B** – continued

**Question 5** (7 marks)

Three aqueous solutions are connected in series and an electric current is passed through the solutions. The solutions are  $\text{CuCl}_2(\text{aq})$ ,  $\text{MgBr}_2(\text{aq})$  and  $\text{KCl}(\text{aq})$ .

- a. A student observes the following in the middle cell; a colourless gas evolved at the anode and a colourless gas evolved at the cathode. The rate gas is evolved at the cathode is faster than the rate of that at the anode.

Identify the cell which is in the middle and write half equations and an overall reaction for this cell.

Cell contents: \_\_\_\_\_ 3 marks

Anode half equation: \_\_\_\_\_

Cathode half equation: \_\_\_\_\_

- b. A metal is deposited in one of the cells. What mass of metal will be deposited in 20.0 minutes if the current is 2.55 amps? 4 marks

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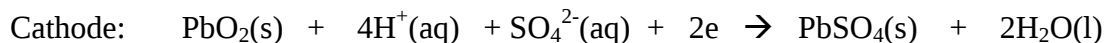
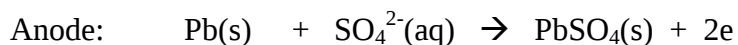


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**Question 6** (9 marks)

A traditional car battery uses sulfuric acid as an electrolyte.

The half equations for this cell are



- a. i. Write an overall equation for the cell. 1 mark

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- ii. Explain how a pH reading on the electrolyte could be used to determine the degree to which this cell is charged. 1 mark

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**SECTION B – Question 6- continued**  
**TURN OVER**

- iii. This cell is a secondary cell. Give one important difference between a secondary cell and a primary cell.

1 mark

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- iv. Suggest two reasons why the research into electric cars has involved finding alternatives to this traditional car battery.

2 marks

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- b. Write a half equation for the reaction occurring at the anode when this cell is recharging.

1 mark

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- c. An alternative cell that has been trialled in cars in Britain is the sodium-sulfur cell. This cell is of interest because it uses abundant and cheap materials and the voltage is a promising 2.08 V.

One of the disadvantages of the cell is that it needs to be at temperatures of over 300 °C for the sulfur to be molten.

The overall equation for this cell is



- i. Use the spaces provided to write balanced half equations for the reactions occurring in this cell.

2 marks

anode: \_\_\_\_\_

cathode: \_\_\_\_\_

- ii. The cell does not operate in an aqueous environment. Suggest one reason for this.

1 mark

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**SECTION B** –continued

**Question 7** (12 marks)

A 3.600 g sample of an organic molecule is found to contain 1.650 g of carbon and 0.322 g of hydrogen. The remainder is chlorine.

a. i. What is the mass of chlorine? \_\_\_\_\_ 1 mark

ii. Determine the empirical formula of the compound. 2 marks

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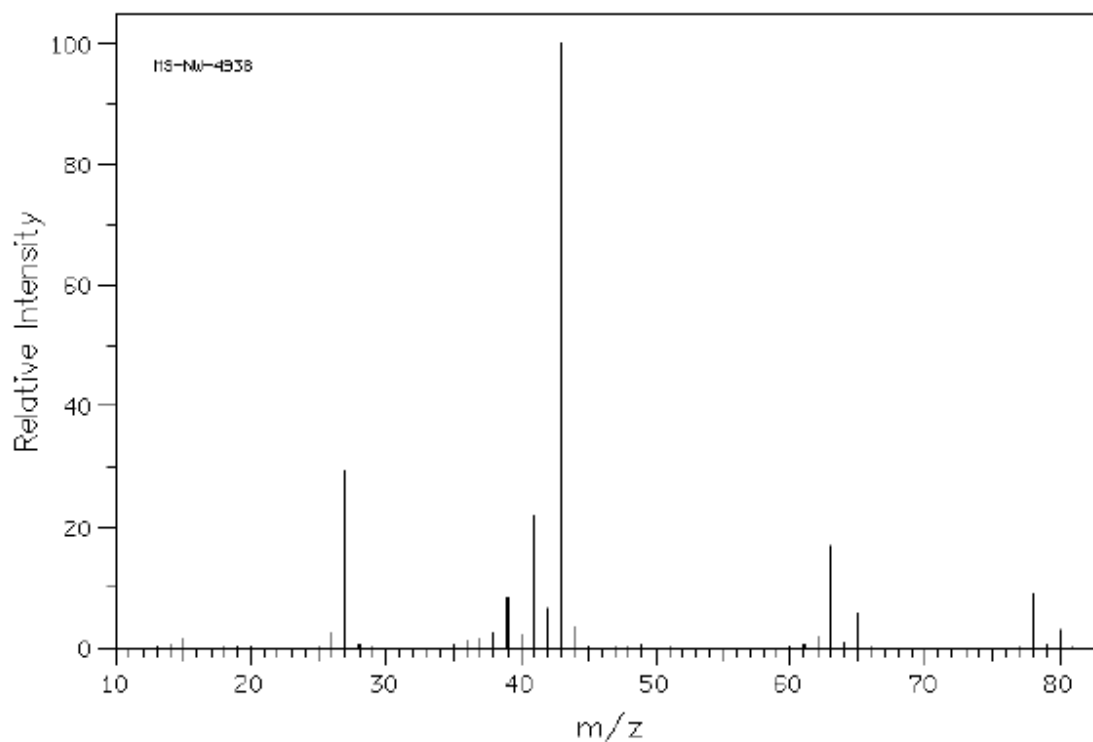


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The mass spectrum of the molecule is shown below.



b. i. Explain why the molecule has two parent molecular ions, one with a  $m/z$  ratio of 78 and the other 80.

1 mark

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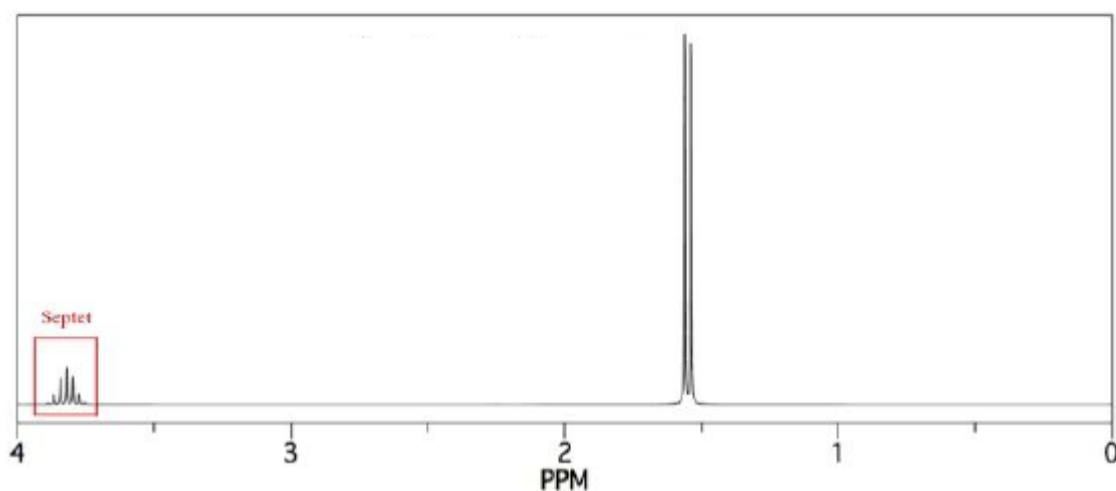
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**SECTION B – Question 7- continued**  
**TURN OVER**

- ii. What fragment might have been knocked off the compound to have caused the peak at  $m/z$  ratio of 63? \_\_\_\_\_ 1 mark
- iii. What is the molecular formula of the compound? \_\_\_\_\_ 1 mark
- c. The molecule has two possible isomers. Draw and name both 4 marks

Isomer 1: \_\_\_\_\_ Isomer 2: \_\_\_\_\_

The proton-NMR is supplied below.



- d. Use this spectrum to explain which isomer is the molecule in question. 2 marks

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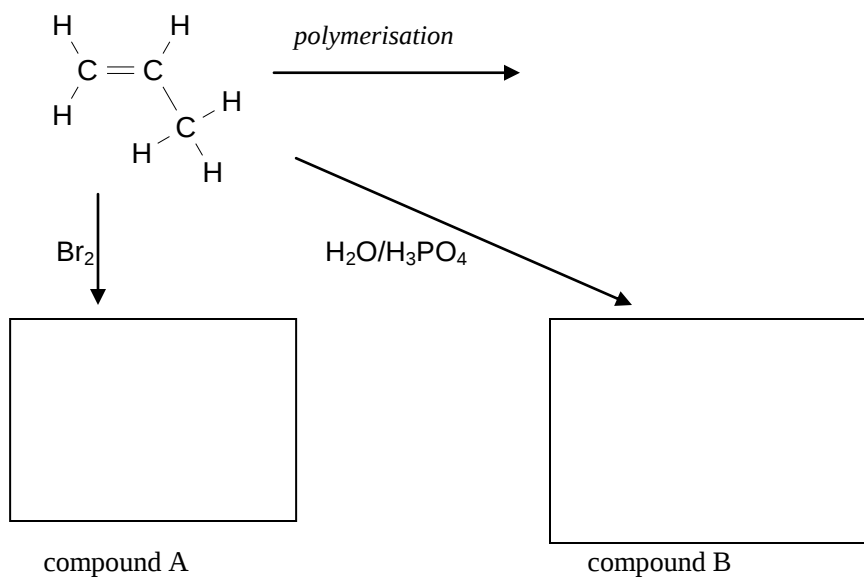


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**SECTION B** – continued

**Question 8** (9 marks)

The second member of the alkene series is propene. It can be used as a starting point in the synthesis of many organic molecules.



a. Explain why propene has the following properties

i. Low solubility in water

1 mark

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ii. Low boiling point

1 mark

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b. Propene can react with itself to form a polymer. Use the space provided on the flow chart to draw in a segment of this polymer.

1 mark

c. i. Use the box provided to draw a structural formula for compound A.

1 mark

ii. Use the reaction that forms compound A to explain what a 'bromine test' is.

2 marks

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**SECTION B – Question 8- continued**  
**TURN OVER**

- d. i.** Use the box provided to draw a structural formula for compound B. 1 mark
- ii.** Suggest one method that could be used to distinguish between compound A and compound B. Explain how this test will distinguish between the two molecules. 2 marks

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**Question 9** (7 marks)

Hydrogen peroxide decomposes to produce oxygen and water.

- a.** What would you observe during this reaction? 1 mark

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- b.** Write an equation for this reaction? 1 mark

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- c.** Provide 3 ways the rate of this reaction could be increased? 3 marks

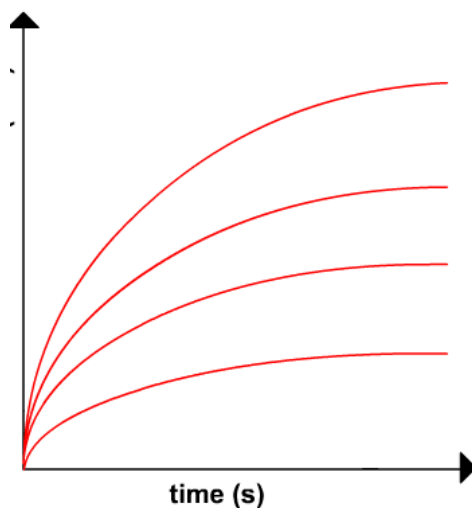
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**SECTION B – Question 9-** continued

- d. The following graphs were obtained in an experiment to look at the decomposition reaction of hydrogen peroxide.



- i. On the graph above, label the Y-axis 1 mark
- ii. Which graph best represents the experiment with the highest concentration of hydrogen peroxide? 1 mark

**Question 10** (7 marks)

The combustion of 1.500 g of ethanol in a bomb calorimeter causes the temperature of the calorimeter to change from 22.4 °C to 31.3 °C.

- a. i. Calculate the energy released by the ethanol 2 marks

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- ii. Calculate the calibration factor for the calorimeter. 1 mark

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**SECTION B – Question 10 – continued**  
**TURN OVER**

- b. A sample of sodium is added to the calorimeter. The mass of the sodium is 0.145 g. The temperature rise is 0.87 °C.  
Calculate  $\Delta H$  for the reaction between sodium and water. 4 marks

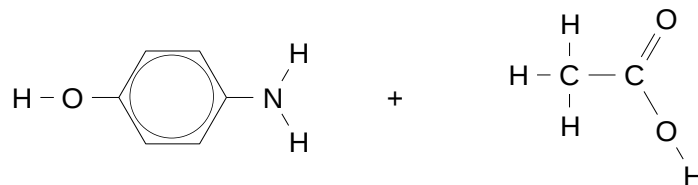
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**Question 11** (6 marks)

The anti-inflammatory drug paracetamol is formed from the reaction between the two molecules shown. Paracetamol contains an amide linkage.



- a. Circle and name three functional groups present in the molecules above. 3 marks
- b. i. Draw the structure of paracetamol. 1 mark
- ii. What other molecule is formed when paracetamol is formed? \_\_\_\_\_ 1 mark
- iii. What is the name and molecular formula of the molecule represented as a hexagon in the structure above? 1 mark

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**END OF QUESTION AND ANSWER BOOK**