TSSM
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'2017 Examination Package' -
Trial Examination 7 of 9

STUDENT NUMBER

									Letter
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

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
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

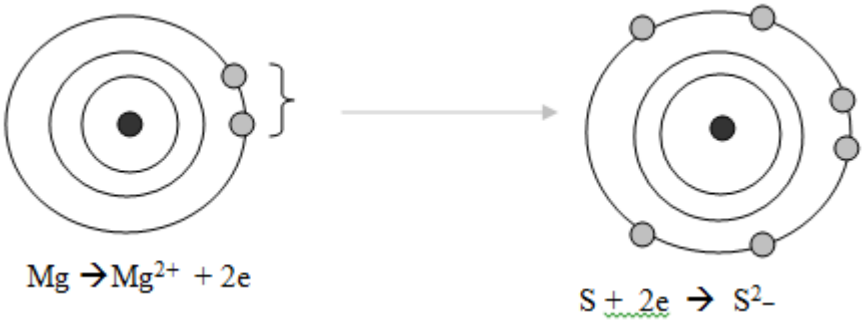
Question 2

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.



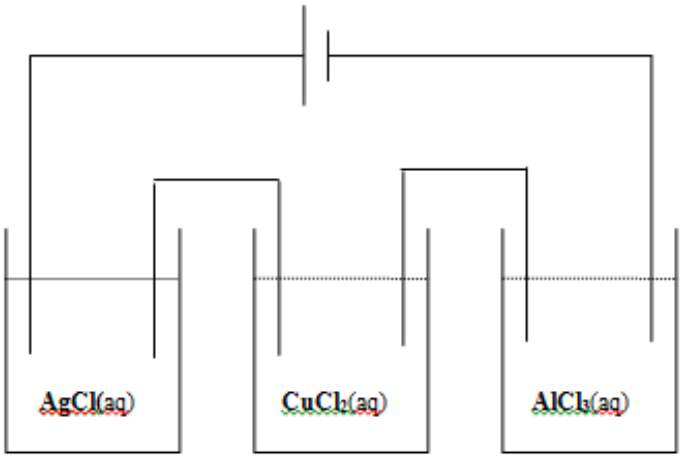
The electron transfer shown could be the

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 AgCl, $CuCl_2$ and $AlCl_3$ 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

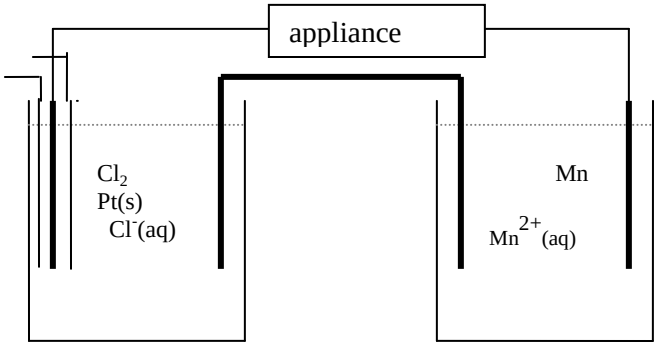
B. 0.60 Ag, 0.30 Cu, 0.20 Al

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.	Mn^{2+}	Cl^-	Pt	Mn
B.	Mn	Cl_2	Mn	Pt
C.	Cl_2	Mn	Mn	Pt
D.	Cl^-	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

$2Li + 2SO_2 \rightarrow Li_2S_2O_4$

Question 6

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

A. $Li \rightarrow Li^+ + e$

B. $2SO_2 + 2e \rightarrow S_2O_4^{2-}$

C. $SO_2 + 2OH^- + 2e \rightarrow S_2O_4^{2-}$

D. $SO_2 + O_2^- + 2e \rightarrow S_2O_4^{2-}$

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 SLC?

A. 24.8 L

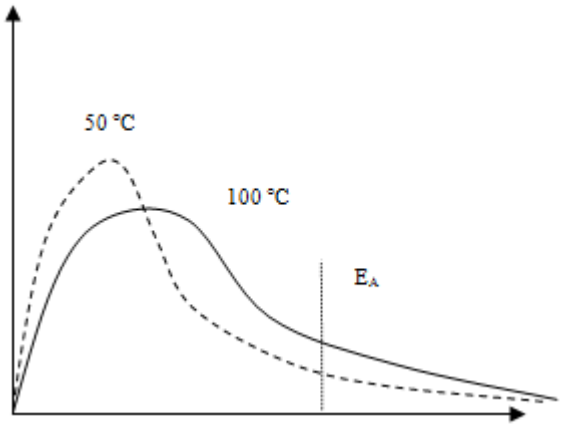
B. 49.6.L

C. 74.4 L

D. 89.6 L

Question 10

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



From this diagram, it can be concluded that

A. more reactants particles have sufficient energy to react at 100 ^{o}C than 50 ^{o}C

B. all reactant particles at 100 ^{o}C have more kinetic energy than those at 50 ^{o}C

C. the activation energy for the reaction is higher at 100 ^{o}C

D. the reaction in question is an exothermic one

Question 11

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

$H_2O(s) \rightarrow H_2O(l) \qquad \Delta H = +6.0 \text{ kJ mol}^{-1}$

$H_2O(g) \rightarrow H_2O(l) \qquad \Delta H = -44.0 \text{ kJ mol}^{-1}$

The enthalpy change for the reaction $H_2O(g) \rightarrow H_2O(s)$ will be, in kJ mol^{-1},

A. + 50.0

B. + 38.0

C. – 38.0

D. – 50.0

Question 12

The numerical value of K at 30 ^{0}C for the reaction below is 24.2.

$NO_2(g) \rightleftharpoons \frac{1}{2}N_2O_4$ K = 24.2 at 30 ^{0}C

The numerical value of the equilibrium constant at 30 ^{0}C of the reaction

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$ will be

A. 1.71×10^{-3}

B. 0.0413

C. 0.203

D. 586

Question 13

A 1.00 g sample of NH_4NO_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 $kJg^{-1}K^{-1}$. 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

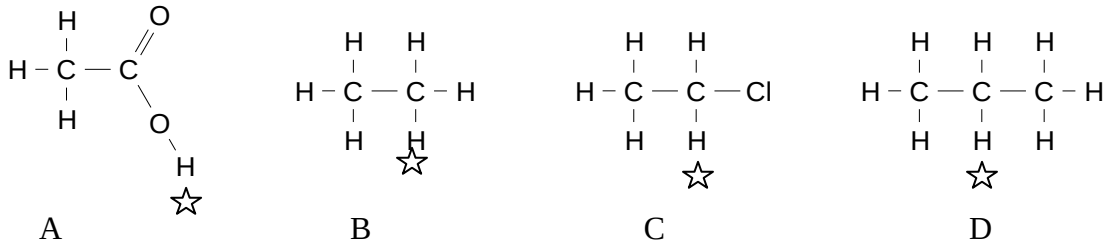
B. Add a catalyst

C. Decrease the concentration of the reactants

D. Cool the reaction mixture

Question 15

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



A B C D

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

A. A, C, D, B

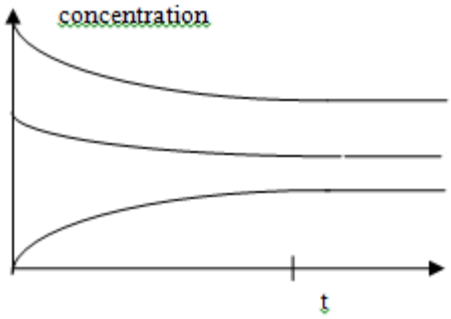
B. B, D, A, C

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. $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

B. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

C. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

D. $COBr_2(g) \rightleftharpoons CO(g) + Br_2(g)$

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 CH_2O.

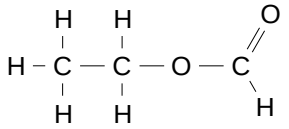
Consider the following molecules.

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

Question 20



The systematic IUPAC name for the molecule shown above is

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

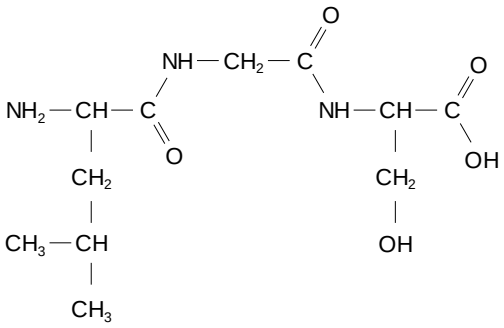
Question 21

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.

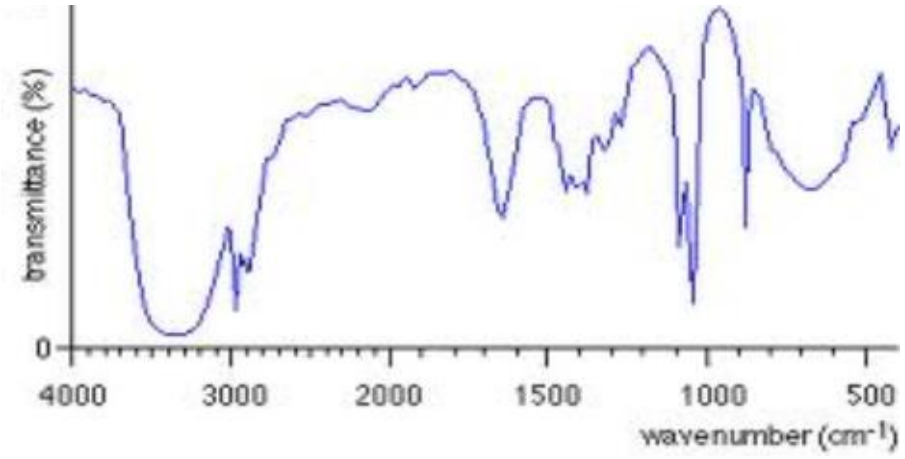
B. Infrared radiation has a shorter wavelength than visible light.

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. $Fe^{3+} + SO_2 + H_2O \rightarrow Fe^{2+} + SO_4^{2-} + H^+$

B. $Fe + SO_2 \rightarrow FeO + FeS$

C. $MnO_4^- + H_2O + SO_2 \rightarrow Mn^{2+} + H^+ + SO_3^-$

D. $Cr_2O_7^{2-} + H^+ + SO_2 \rightarrow Cr^{3+} + S_2O_6^- + H_2O$

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 8.30×10^4 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, $H_2(g)$; NaCl(s)

Question 1 (10 marks)
Living things are capable of converting monosaccharides to disaccharides and to polysaccharides.

Example: _____ _____ _____

Molecular formula: _____ _____

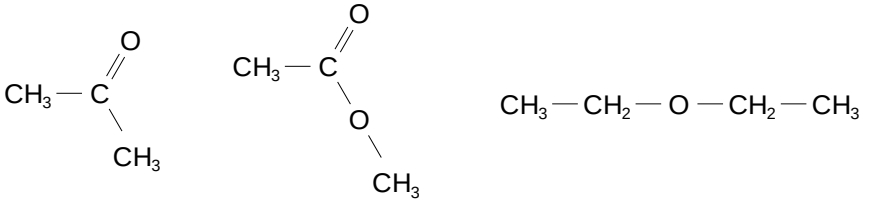
Structural isomer : _____

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

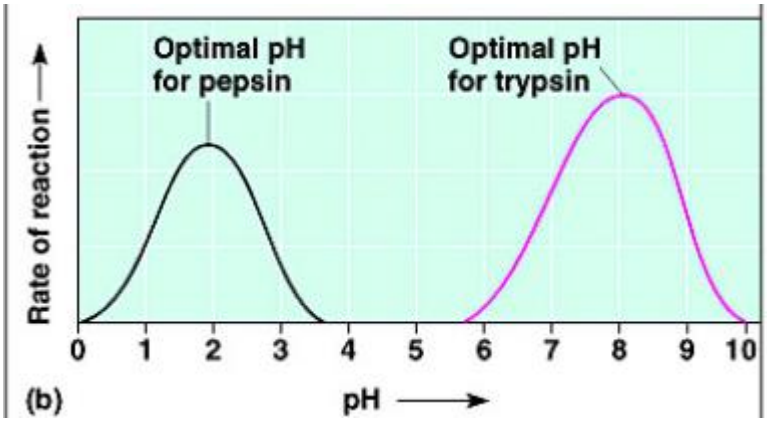
iii. Use the space provided to name a structural isomer of the monosaccharide you chose 1 mark

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 an typical human stomach is around 1.8. Comment on the performance of both enzymes at this pH.

2 marks

_____

_____

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

_____

_____

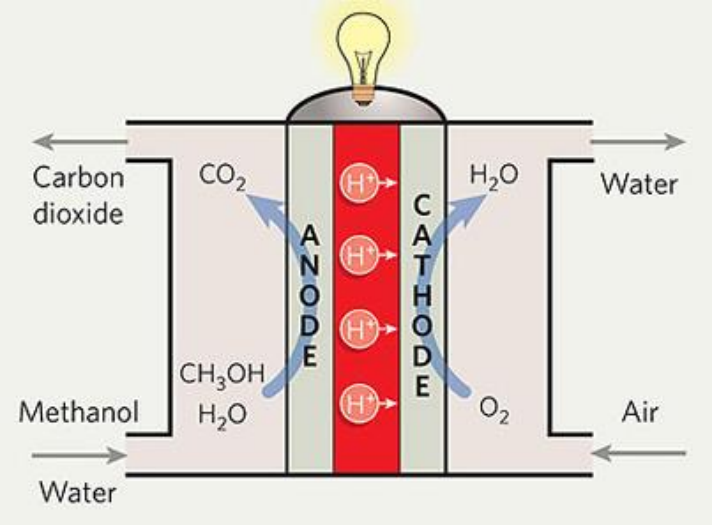
iii. If a protein containing 20000 amino acids is completely hydrolysed back to amino acids, how will the mass of the amino acids formed compare to the mass of the original protein? Explain your answer. 2 marks

_____

_____

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).

_____

_____

_____

_____

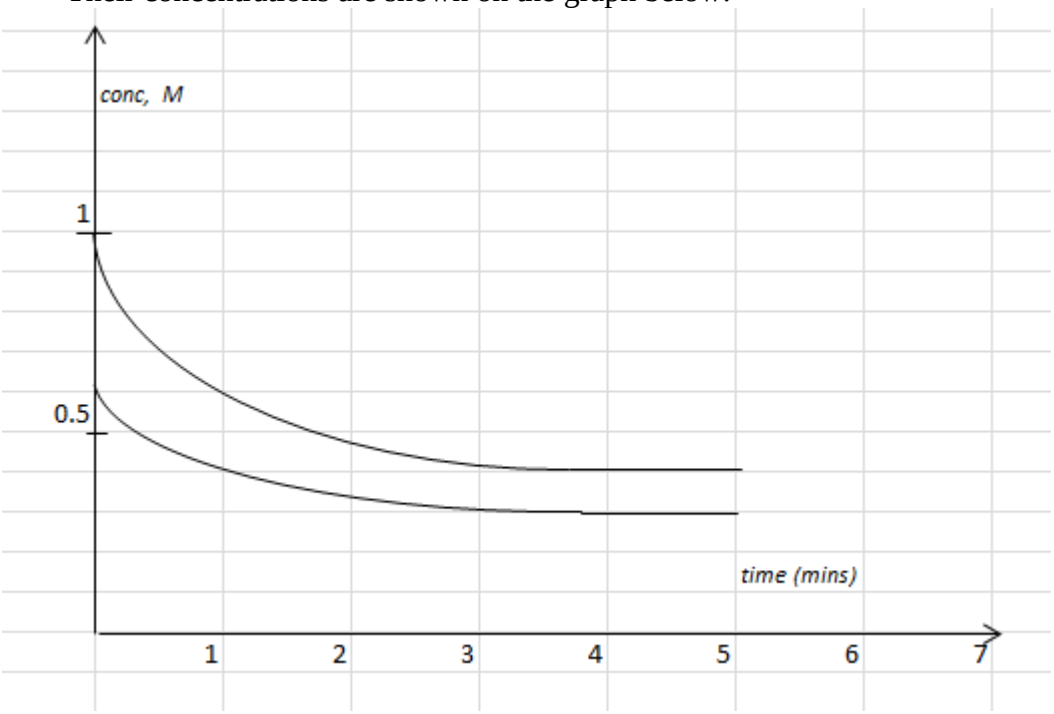
3 marks

SECTION B – continued

Question 3 (10 marks)
Methanol can be formed from the reversible reaction between carbon monoxide and hydrogen gases.

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = 88 \text{ kJ mol}^{-1}$

a. Samples of carbon monoxide and hydrogen are added to an empty 2.00 L reactor at 120 ^oC. 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 ^oC for this reaction. 2 marks

_____

_____

_____

SECTION B – Question 3- continued
TURN OVER

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

_____

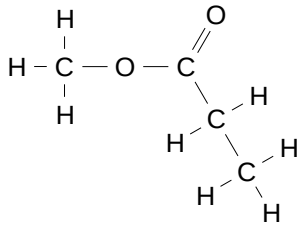
_____

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

_____

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

_____

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

_____

_____

_____

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 $CuCl_2(aq)$, $MgBr_2(aq)$ and KCl(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

_____

_____

_____

Question 6 (9 marks)
A traditional car battery uses sulfuric acid as an electrolyte.
The half equations for this cell are

Anode: $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e$

Cathode: $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e \rightarrow PbSO_4(s) + 2H_2O(l)$

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

_____

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

_____

_____

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

_____

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

2 marks

_____

_____

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

1 mark

_____

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 ^{0}C for the sulfur to be molten.

The overall equation for this cell is

$2Na + 3S \rightarrow Na_2S_3$

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

_____

_____

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

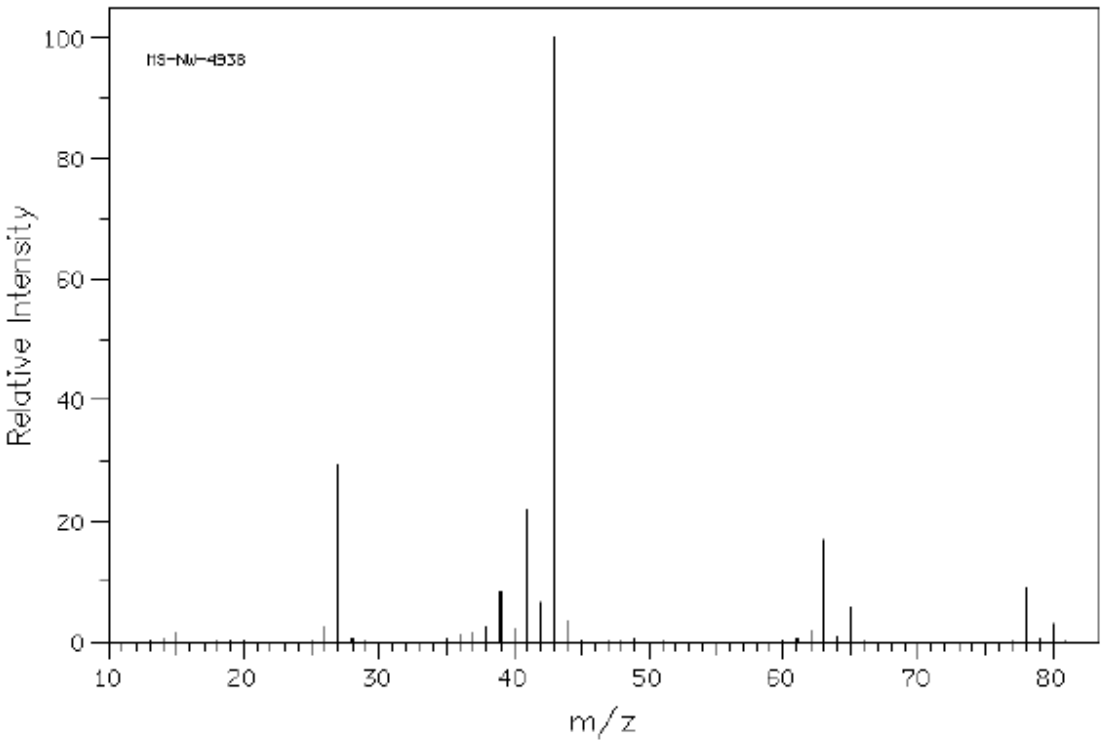
ii. Determine the empirical formula of the compound. 2 marks

_____

_____

_____

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

_____

_____

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? _____

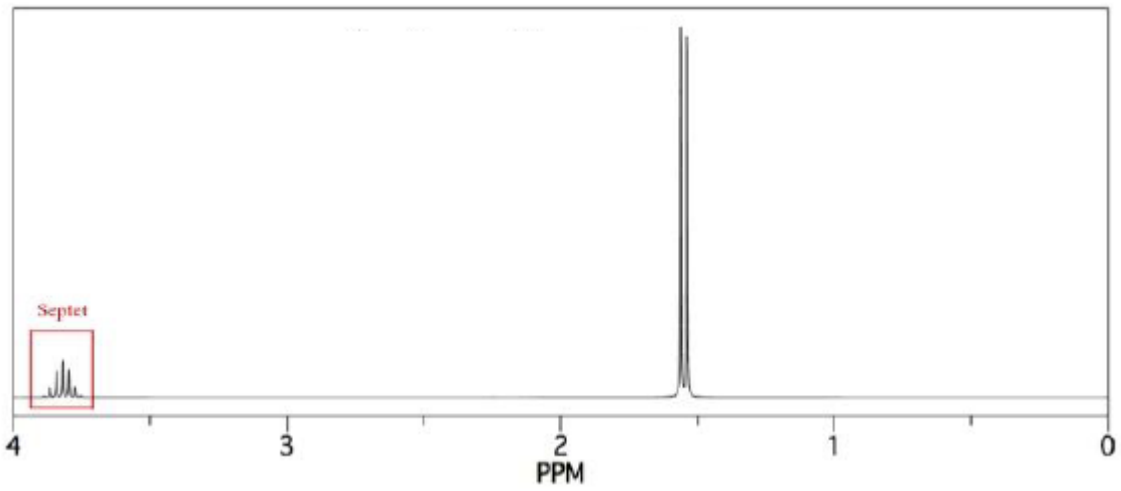
1 mark

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

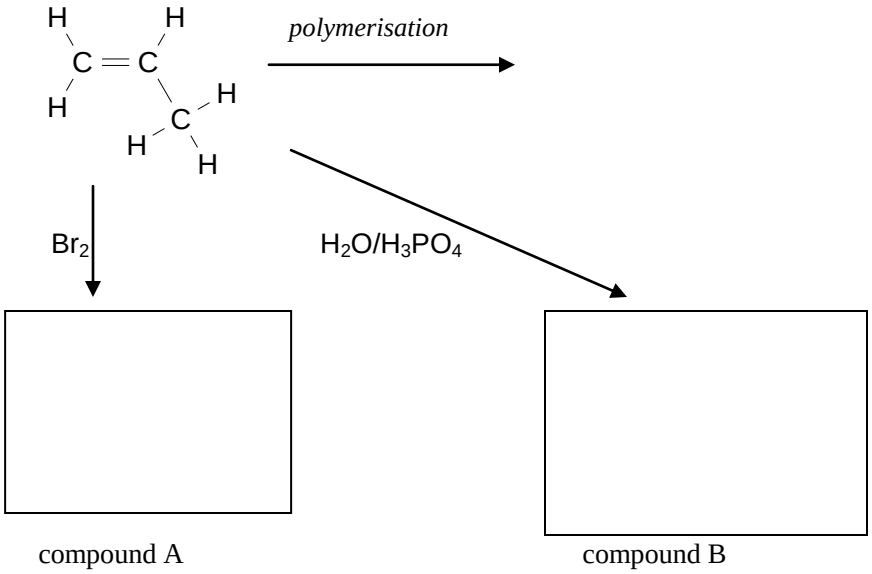
_____

_____

_____

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.



compound A compound B

a. Explain why propene has the following properties

i. Low solubility in water 1 mark

_____

ii. Low boiling point 1 mark

_____

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

_____

_____

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

_____

_____

Question 9 (7 marks)

Hydrogen peroxide decomposes to produce oxygen and water.

a. What would you observe during this reaction?

1 mark

_____

_____

b. Write an equation for this reaction?

1 mark

_____

_____

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

3 marks

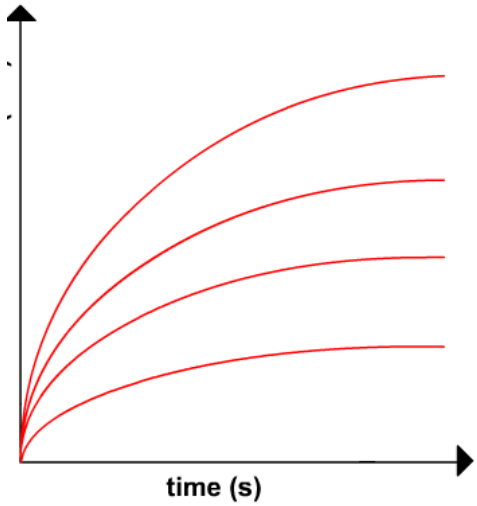
_____

_____

_____

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 ^{0}C to 31.3 ^{o}C.

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

_____

_____

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

_____

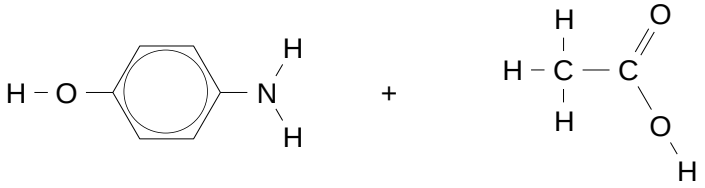
b. A sample of sodium is added to the calorimeter. The mass of the sodium is 0.145 g. The temperature rise is 0.87 ^{o}C.
Calculate ΔH for the reaction between sodium and water. 4 marks

_____

_____

_____

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

_____

_____

END OF QUESTION AND ANSWER BOOK