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'2017 Examination Package' -
Trial Examination 6 of 9

STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Units 3 & 4 - Written examination

(TSSM's 2013 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	106
			Total 136

- 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.
- No calculator is permitted in this examination.

Materials supplied

- Question and answer book of 27 pages.

Instructions

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

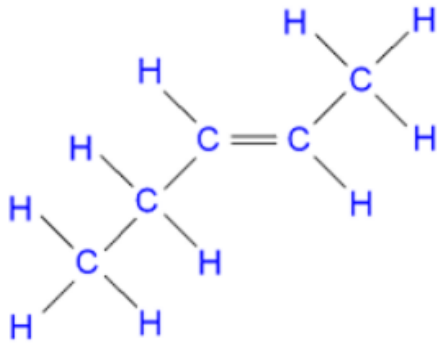
Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

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

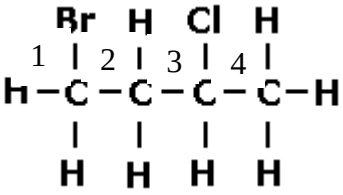


The correct name for the molecule shown above is:

A. Cis-pent-2-ene
B. Cis-prop-2-ene
C. Trans-prop-2-ene
D. Trans-pent-2-ene

Question 2

Which of the numbered carbons in the following molecule is a chiral centre?



A. 1
B. 2
C. 3
D. 4

SECTION A - continued

Question 3

The by-product of a car that runs solely on a fuel cell using pure hydrogen are:

A. Oxygen
B. Carbon dioxide
C. Methane
D. Heat and water vapour

Question 4

Which of the following statements about rechargeable batteries is incorrect?

A. Rechargeable batteries are also called secondary cells
B. During recharge the polarities of the electrodes are the same as when the battery is discharging
C. Rechargeable batteries can be used indefinitely
D. During discharge cations in the electrolyte move toward the anode

Question 5

The correct order for the basic processes in a mass spectrometer is:

A. Fragmentation, detection, ionization deflection
B. Ionization, fragmentation, deflection, detection
C. Detection, deflection, ionization, fragmentation
D. Deflection, ionization, fragmentation, detection

Question 6

How many low resolution peaks does the acid $(CH_3)_3CCH_2COOH$ have in ^{1}H NMR and ^{13}C NMR spectra?

	^{1}H NMR	^{13}C NMR
A.	5	6
B.	3	4
C.	5	4
D.	3	6

Question 7

When propene reacts with hydrochloric acid, there are two possible products. The products are

A. 1-chloropropane and 1,2-dichloropropane

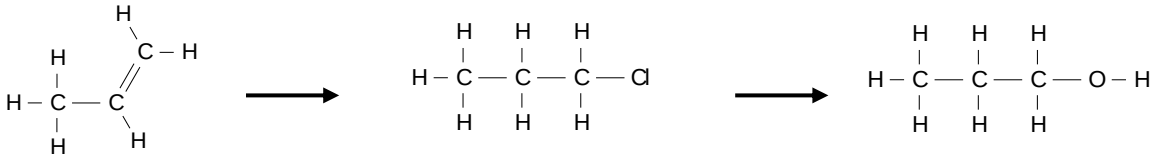
B. polypropene and hydrogen gas

C. 1-chloropropane and 2-chloropropane

D. 1-chloropropene and 2-chloropropene

Question 8

The chemical pathway shown is for the manufacture of 1-propanol.



In this pathway,

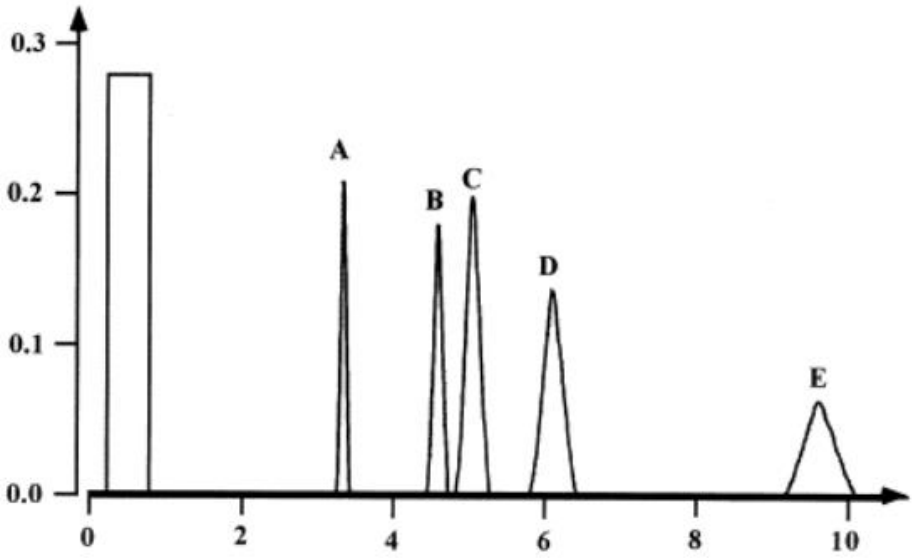
A. a substitution reaction is followed by an addition reaction

B. an addition reaction is followed by a substitution reaction

C. two addition reactions are performed and only one product is formed

D. two substitution reactions are performed and three products will be formed

Question 9



The printout from a sample passing through a HPLC is shown above. (The rectangular peak is not part of the sample). The following possible conclusions refer to the chromatogram

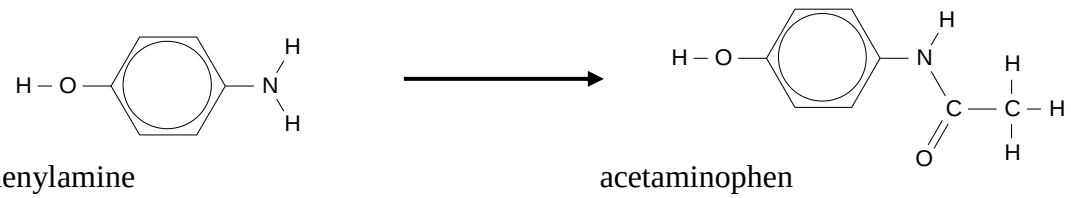
I there are at least 5 different substances in the sample
II there are only 5 different substances in the sample
III the concentration of substance E is lower than that of substance D
IV substance E is heavier than substance D

Which conclusions are valid?

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

Question 10

The molecule shown is acetaminophen, used for pain relief.



phenylamine acetaminophen

One of the reactants used to make acetaminophen is phenylamine.

Acetaminophen could be formed from the

A. condensation reaction between phenylamine and ethanoic acid

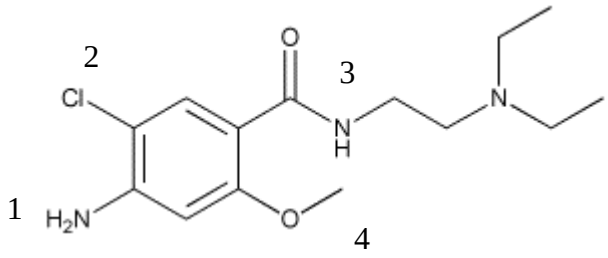
B. esterification reaction between phenylamine and ethanoic acid

C. polymerisation reaction between phenylamine and ethanol

D. substitution reaction between phenylamine and ethanol

Question 11

The molecule drawn below is known as metoclopramide. It is used to treat nausea and vomiting and is often used in conjunction with paracetamol.



The four functional groups numbered on this molecule are, in order,

A. amine, chloro, amide and carboxyl

B. amine, chloro, amine and ester

C. amide, chloro, amine and ether

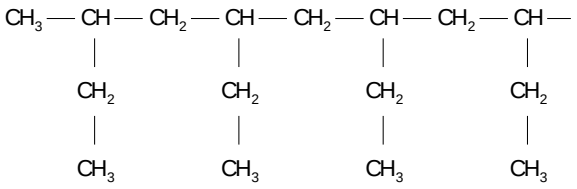
D. amine, chloro, amide and ether

SECTION A – continued

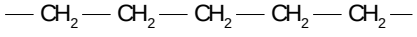
Question 12

A segment of the polymer that can be formed from 1-butene is

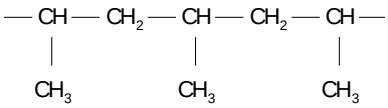
A.



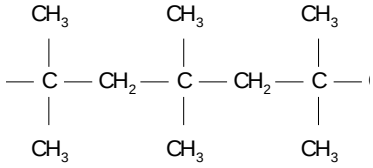
B.



C.

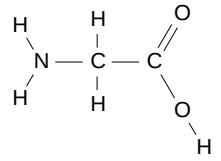


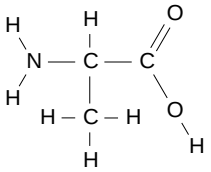
D.

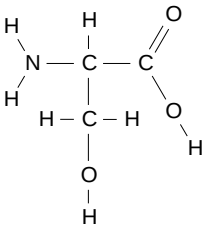


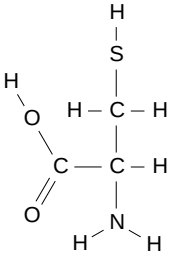
Question 13

Four different amino acids are shown here









The most soluble amino acid in water is likely to be

A. glycine

B. alanine

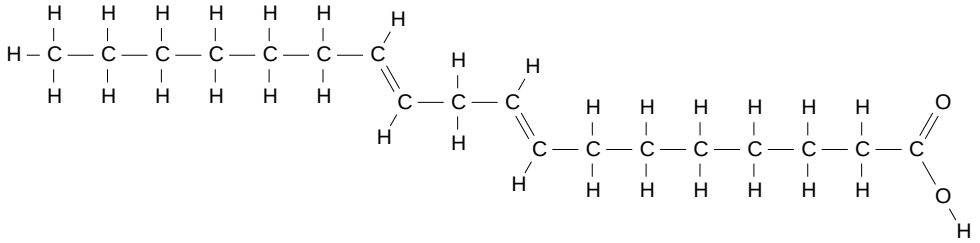
C. serine

D. cysteine

SECTION A – continued

TURN OVER

Question 14



The molecule shown here could be

A. linoleic acid

B. linolenic acid

C. oleic acid

D. stearic acid

Question 15

Which of the following statements about enzymes is correct?

A. Enzymes can distinguish between optical isomers of a substrate

B. All enantiomers of a substrate will be biologically active

C. Intermolecular forces such as hydrogen bonds and dispersion forces are involved in binding the substrate to the enzyme active site.

D. The shape of the active site can change by the binding of a substrate

Question 16

If during a reaction in an inflexible container, the pressure is found to decrease and the number if particles remains constant. Which of the following options is correct?

A. The reaction is exothermic

B. The reaction is endothermic

C. The enthalpy of the products is less than the reactants

D. The product particles have more kinetic energy than the reactants

Use the following information to answer Questions 17 and 18

The decomposition of NOCl gas is a reversible, endothermic reaction.

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$ $\quad K = 1.2 \times 10^{-5}$ M at 30^0C

Question 17

A high yield in this reaction is best favoured by

A. low temperature and the addition of a catalyst

B. high temperature and low pressure

C. the addition of argon gas and the use of high pressure

D. low temperature and high pressure

Question 18

NOCl is added to an empty reactor. At equilibrium, the mixture of these gases sits at 30^0C. In this mixture, the

A. $[NO] = \frac{1}{2}\ [Cl_2]$

B. $[NOCl] < [NO]$

C. $[NOCl] > [NO]$

D. $[NOCl] = [NO]$

Question 19

Methanol can be produced from carbon monoxide and hydrogen gases. The equation is

$H_2(g) + \frac{1}{2}CO(g) \rightleftharpoons \frac{1}{2}CH_3OH(g)$ $\quad K = 2.40\ M^{-1}$ at 250^0C.

What is the value of the equilibrium constant, at 250^0C, for the reaction?

$CH_3OH \rightleftharpoons 2H_2(g) + CO(g)$

A. -4.80

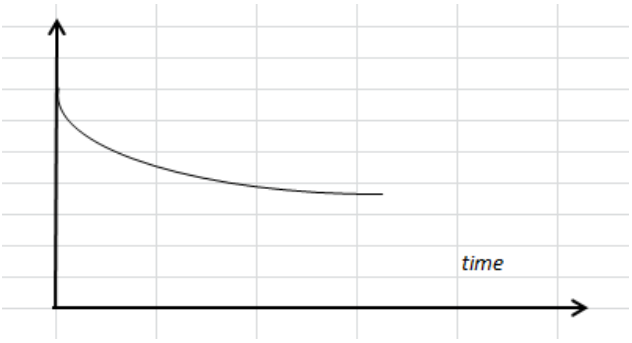
B. 0.174

C. 0.417

D. 1.550

Question 20

The following graph is drawn from data collected from the reaction of marble chips, $CaCO_3$ reacting in a flask with hydrochloric acid.



The graph could be the

A. mass of the gas evolved from the flask

B. pH of the flask contents

C. volume of the gas evolved from the flask

D. mass of the flask over a period of time

Question 21

The following reaction has reached equilibrium:

$$Cu^{2+}(aq) + Sn^{2+}(aq) \leftrightarrow Cu(s) + Sn^{4+}(aq); \Delta H < 0$$

Which one of the following would cause precipitation of more copper?

A. Increasing the temperature of the reaction

B. Taking out some of the solid copper

C. Addition of more Sn^{2+} (aq) ions

D. Increasing the concentration of Sn^{4+} (aq) ions

Question 22

Enthalpy changes for two reactions of copper are shown below;

$Cu(s) \rightarrow Cu^{+}(aq)$ $\quad \Delta H = +602$ kJ mol^{-1}

$Cu(s) \rightarrow Cu^{2+}(aq)$ $\quad \Delta H = +795$ kJ mol^{-1}

Use these values to calculate the enthalpy change for the reaction

$2Cu^{+}(aq) \rightarrow Cu(s) + Cu^{2+}(aq)$

A. + 193 kJ mol^{-1}

B. - 193 kJ mol^{-1}

C. - 409 kJ mol^{-1}

D. + 409 kJ mol^{-1}

SECTION A - continued

Question 23

1.0 g of a hydrocarbon fuel produces 49.6 kJ of energy when combusted. The fuel is likely to be

A. propane

B. butane

C. hexane

D. octane

Question 24

The term 'carbon neutral' refers to fuel sources

A. that do not use carbon dioxide

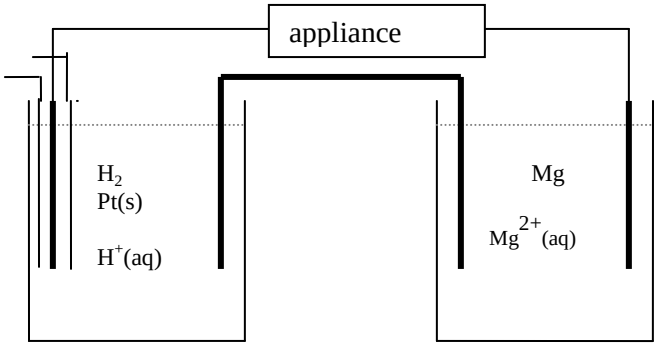
B. that do not produce carbon dioxide

C. that use a similar volume of carbon dioxide to the amount they produce

D. that produce less carbon dioxide than the amount they produce

Question 25

A galvanic cell is constructed from a hydrogen half cell connected to a magnesium half cell.



In this cell

	oxidant	reductant	anode	cathode
A.	Mg^{2+}	H^+	Pt	Mg
B.	Mg	H_2	Mg	Pt
C.	H_2	Mg^{2+}	Pt	Mg
D.	H^+	Mg	Mg	Pt

SECTION A – continued

TURN OVER

Question 26

The electrochemical series is used to help predict the outcome in redox reactions. When two particular half cells are connected, their half equations are found on this series.

$A^{2+}(aq) + 2e \rightarrow A(s)$
$B^{2+}(aq) + 2e \rightarrow B(s)$

If A^{2+} has the higher E^0 value, it will be the

A. oxidant and the positive electrode

B. oxidant and the negative electrode

C. reductant and the negative electrode

D. reductant and the positive electrode

Use the following information to answer Questions 27 and 28

The term 'lithium cell' refers to a wide range of modern cells that use lithium as lithium metal or lithium ions. A typical example is the cell formed between lithium and aluminium alloy and manganese dioxide, MnO_2,

The half equations for this cell are;

$Li/Al \rightarrow Al + Li^+ + e$
$MnO_2 + Li^+ + e \rightarrow LiMnO_2$

Question 27

The overall equation for this cell can be expressed as

A. $Li + MnO_2 \rightarrow Li^+ + MnO_2$

B. $2Li + MnO_2 \rightarrow LiMnO_2 + Li^+$

C. $Li + MnO_2 \rightarrow LiMnO_2$

D. $Li^+ + MnO_2 \rightarrow Li + MnO_2$

Question 28

In this cell, the

A. oxidation number of manganese changes from $^+4$ to $^+3$ at the cathode

B. lithium ions are converted to lithium metal at the cathode

C. lithium ions are converted to lithium metal at the anode

D. lithium is oxidised at one electrode and reduced at the other

Question 29

When a 4 M aqueous solution of NaCl is subjected to electrolysis the products will be

A. sodium metal and chlorine gas

B. hydrogen gas, chlorine gas and sodium hydroxide solution

C. hydrogen gas and oxygen gas

D. hydrogen gas, oxygen gas and sodium chloride solution

Question 30

A current of 4 amps is passed through a molten metal solution for 400 minutes. The mass of metal obtained is 9.0 g. The metal is most likely to be

A. lithium

B. sodium

C. aluminium

D. lead

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 (7 marks)

a. Alanine has two enantiomers.

i. Draw the structures of the two enantiomers of alanine in the space provided below.

2 marks

ii. Alanine is a chiral molecule. Explain what is meant by the term chiral molecule and how can you tell if a molecule will be chiral?

_____

_____

_____

_____

2 marks

b. An enantiomer will rotate plane polarised light, why then does a mixture of alanine enantiomers have no effect on plane polarised light?

_____

_____

1 mark

SECTION B – **Question 1** - continued

c. Are all amino acids chiral? Explain?

_____

_____

2 marks

Question 2 (12 marks)
A 2.000 g sample of an ester molecule is found to contain 1.091 g of carbon and 0.727 g of oxygen.

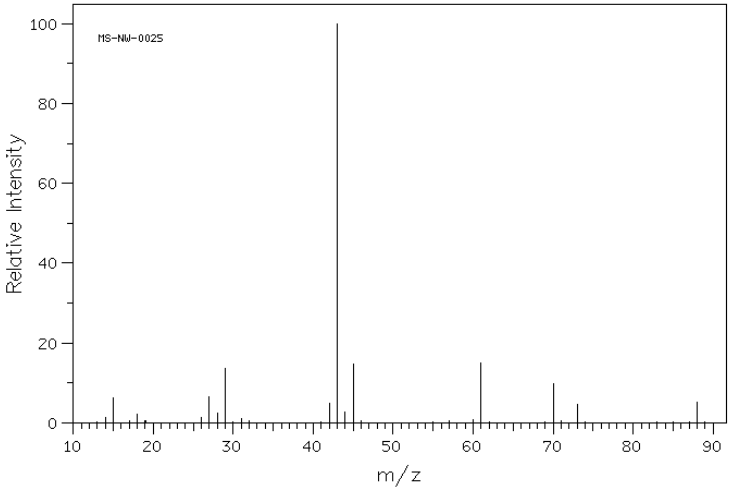
a. Determine the empirical formula of the molecule. 3 marks

_____

_____

_____

The mass spectrum of the molecule is shown below



b. **i**. What is the mass of the parent molecular ion? _____ 1 mark

ii. What is the molecular formula of the molecule? _____ 1 mark

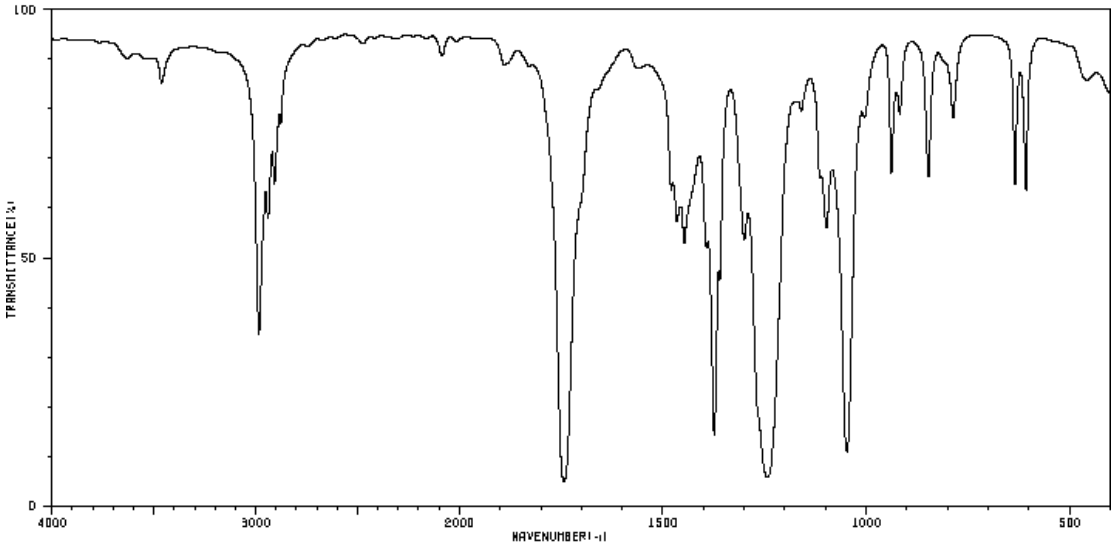
iii. What possible fragment could cause the peaks - at 15 _____ 1 + 1 = 2 marks

- at 29? _____

The infrared spectrum of the molecule is shown over the page.

SECTION B – Question 2 – continued

TURN OVER



c. **i**. Explain how the infrared spectrum shows that this is not an alcohol molecule? 1 mark

_____

_____

ii. The C = O bond causes one of the absorption peaks. Identify this peak. 1 mark

_____

d. There are three possible structural isomers that have this molecular formula. Draw and name the three isomers. 3 marks

Isomer 1: _____ Isomer 2: _____ Isomer 3: _____

SECTION B - continued

Question 3 (6 marks)

Diabetics often rely on carrying around snake lollies in case of moments of hypoglycemia, where there blood sugar is too low. A 7.21 g snake lolly is burned in a bomb calorimeter. The temperature started at 17.4 °C and leveled off at 23.5 °C. The manufacturer of the bomb calorimeter determined the heat capacity of the calorimeter to be 9.32 kJ/°C.

a. Calculate the energy released from the combustion of the jelly baby.

_____

_____

_____

2 marks

b. If we assume that the jelly baby contains only glucose, calculate the amount of glucose (in mol) present in the jelly baby.

_____

_____

_____

_____

2 marks

c. Calculate % m/m of glucose in the jelly baby.

_____

_____

_____

2 marks

SECTION B – continued

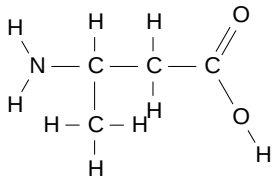
TURN OVER

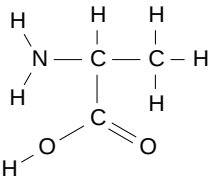
Question 4 (11 marks)

Proteins are very long molecules formed when many amino acid molecules react together.

a. Two molecules, A and B, are drawn below.

A





B

i. One of these molecules in an α-amino acid and the other is not. Identify the molecule that is **not** an α-amino acid and explain why it is not an α-amino acid. 2 marks

_____

_____

ii. If a molecule of A and a molecule of B react to form an amide linkage, how many different products are possible? 1 mark

_____

iii. Tripeptides are formed when three different amino acids react together.
How many different products can form when the following combinations of amino acids react to form tripeptides? 2 marks

amino acids	**number of possible tripeptides**
serine serine serine	
serine glycine serine	
serine glycine alanine	

b. A lipid molecule is formed from the reaction between linoleic acid and glycerol.

i. What is the molecular formula of this lipid molecule? 2 marks

_____

ii. Write a balanced equation for the combustion of linoleic acid. 2 marks

_____

SECTION B – Question 4 - continued

iii. Linoleic acid is an oil, but it is not a biodiesel molecule. Explain how biodiesel is made from linoleic acid. 1 mark

_____

_____

c. The combustion of biodiesel produces carbon dioxide. Explain why biodiesel is considerable preferable for the environment than diesel. 1 mark

_____

_____

Question 5 (10 marks)

Hydrogen gas can be formed from the reaction between calcium and hydrochloric acid. The equation for this reaction is

$$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$$

A series of experiments is conducted between calcium and hydrochloric acid. Each experiment is conducted in a flask and a gas syringe is attached to collect the gas evolved.

Experiment	mass Ca g	HCl	temperature, ^{0}C
1	0.4	250 mL of 0.1 M	20
2	0.4	250 mL of 0.2 M	20
3	0.4	250 mL of 0.1 M	40
4	0.8	250 mL of 0.1 M	20

a. In comparing experiment 1 and experiment 2,

i. how will the final volume of gas evolved compare?

_____

_____

ii. How will the initial rate of gas production compare?

_____

2 + 1 = 3 marks

SECTION B – Question 5 - continued

TURN OVER

b. In comparing experiment 1 and experiment 4,

i. how will the final volume of gas evolved compare?

_____

ii. How will the initial rate of gas production compare?

_____

1 + 1 = 2 marks

Question 6 (11 marks)

Methanol can be manufactured from carbon monoxide and hydrogen gases. The reaction is a reversible one.

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH \quad K = 3.4\ M^{-2} \quad \text{at} \quad 440^0C$

Methanol is added to a 1 litre reactor at 440^0C. The system is allowed to reach equilibrium where the concentration of methanol is found to be 0.32 M.

a. Determine the carbon monoxide concentration. 3 marks

_____

_____

_____

b. An equilibrium mixture of the three gases is at 440^0C. The volume of the reactor is halved. Explain the impact of this change on each of the following;

i. the value of the equilibrium constant: _____ 1 mark

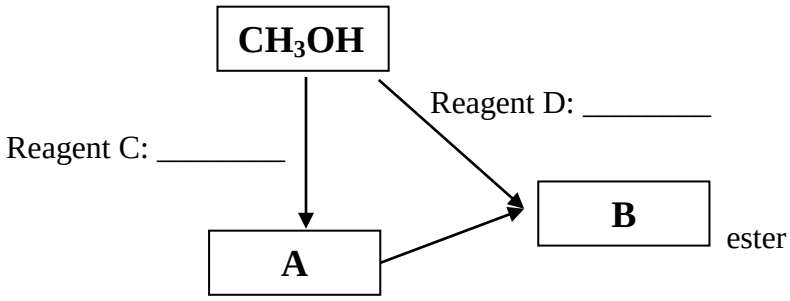
ii. the position of equilibrium: _____ 1 mark

iii. the amount of carbon monoxide: _____ 1 mark

iv. the concentration of the carbon monoxide: _____ 1 mark

c. Some of the methanol is to be used to manufacture an ester.

SECTION B – **Question 6** - continued



Assuming methanol is the only available reactant for this ester,

i. Draw the structure of molecule A. 1 mark

ii. What is the formula of the reagent, C, required to convert methanol to molecule A? _____ 1 mark

iii. Draw the structure of the ester, molecule B. 1 mark

iv. Name the catalyst used for the esterification. _____ 1 mark

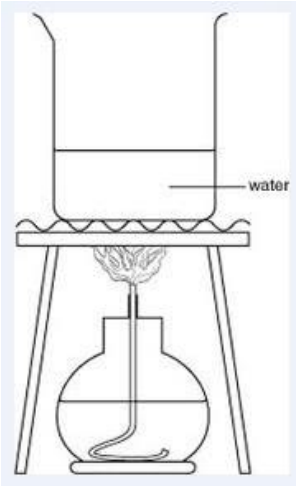
SECTION B - continued

TURN OVER

Question 7 (13 marks)

A burner containing ethanol is placed under a beaker containing 450 mL of water**.** The burner is lit and the following data is recorded;

Initial temperature water: 21.0^0C
Initial mass of ethanol: 46.82 g
Final mass of ethanol: 46.18 g



a. Calculate the energy released by the ethanol. 3 marks

_____

_____

_____

b. Determine the expected final temperature of the water if the transfer of energy to the water is 100% efficient. 2 marks

_____

_____

SECTION B – **Question 7** - continued

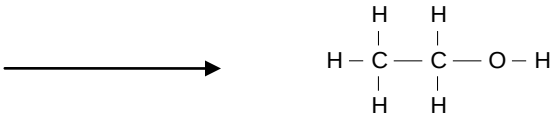
c. Ethanol can be formed from non renewable sources or from renewable sources.

Non renewable

i. Name a non renewable source of ethanol _____

1 mark

ii. Use the template provided below to show the final step in the production of ethanol from this source. 1 mark



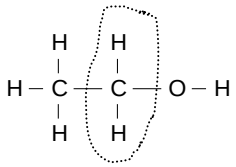
Renewable

iii. Name a renewable source of ethanol _____ 1 mark

iv. Write a balanced equation for the formation of ethanol from this source 1 mark

_____

d. A sample of ethanol is subjected to NMR spectroscopy.



i. How many different hydrogen environments does ethanol have? _____ 1 mark

ii. The $-CH_2-$ group circled above will be subject to splitting. Explain what the splitting arrangement will be? 2 marks

_____

_____

iii. What shift would you expect on this circled group? 1 mark

_____

SECTION B - continued
TURN OVER

Question 8 (8 marks)

The aluminium/air cell is unusual in that the aluminium electrode can be replaced. In this way it referred to as 'mechanically rechargeable'. This cell produces a relatively high voltage of 2.75 volts. The electrolyte used in an alkaline one containing OH^- ions.

The overall equation for this cell is;

$4Al(s) + 6H_2O(l) + 3O_2(g) \rightarrow 4Al(OH)_3(aq)$

a. Give two reasons why this cell might be popular. 2 marks

_____

_____

b. The overall equation for this reaction is provided. One of the half equations is in the Data Book.

Given this information, write a balanced half equation for the reaction

i. occurring at the anode _____

1 mark

ii. occurring at the cathode _____

1 mark

c. Which electrode will be the positive electrode? _____

1 mark

d. This cell is described as 'mechanically rechargeable'. Explain how this cell is different from a typical secondary cell. 1 mark

_____

_____

e. When this cell is sold it has a piece of tape on the back that covers a small hole. To make the cell operational this tape has to be removed. Explain the role of the tape. 2 marks

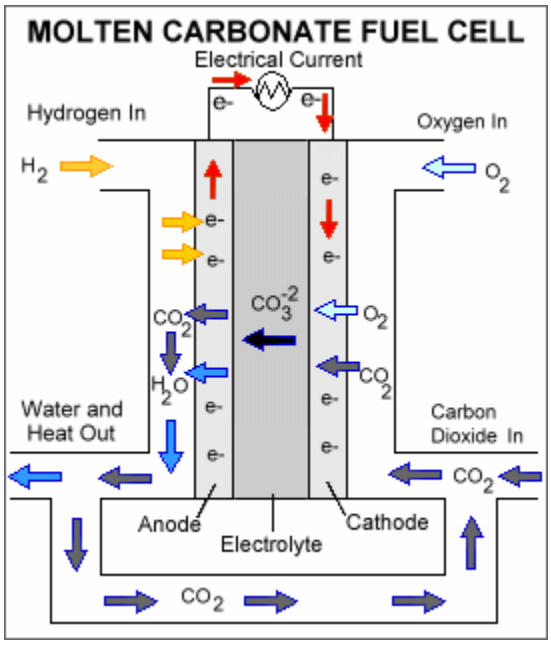
_____

_____

SECTION B - continued

Question 9 (5 marks)

One popular type of fuel cell is the MCFC, the molten carbonate fuel cell. It is so named because it operates at temperatures over 650^0C where the lithium potassium carbonate salt is molten. The molten carbonate ions allow the movement of charge. The attraction of these cells is that they can use indirect sources of hydrogen gas like natural gas or biogas. This eliminates the need to prepare pure hydrogen as a reactant.



The half equations for this cell are;

$CO_3^{2-} + H_2 \rightarrow H_2O + CO_2 + 2e$

Polarity: _____

$CO_2 + ½O_2 + 2e \rightarrow CO_3^{2-}$

Polarity: _____

a. **i.** Use the lines provided to state the polarity of both half equations

ii. Do the carbonate ions flow towards the anode or cathode? _____

1 + 1 = 2 marks

b. Write an overall equation for this cell. 1 mark

_____

c. Does this cell contribute to the levels of carbon dioxide in the atmosphere? Explain your answer. 1 mark

_____

_____

d. Is this cell rechargeable? Explain your answer. 1 mark

_____

SECTION B - continued
TURN OVER

Question 10 (8 marks)
Copper can form two different compounds when it reacts with chlorine, CuCl or $CuCl_2$.
A student performs an electrolysis experiment to verify which compound she has a sample of.
She adds the solid to a crucible, places the crucible on a Bunsen and conducts an electrolysis of the molten solution using inert electrodes.
The mass of the cathode is recorded and the volume of gas produced at the anode is also recorded.

Initial mass of cathode: 54.606 g
Final mass of cathode: 54.898 g
Volume of gas collected: 0.0920 L at 450^0C and 150 kPa

a. **i**. Calculate the number of mole of copper produced at the cathode. 2 marks

_____

_____

ii. Calculate the number of mole of chlorine gas generated at the anode. 2 marks

_____

_____

_____

iii. What conclusion can you draw about the chemical formula of the copper compound used? 1 mark

_____

b. Write balanced half equations for the reactions occurring at each electrode.

anode: _____ cathode: _____

1 + 1 = 2 marks

c. Benedict's reagent is used to detect the presence of reducing sugars. Benedict's solution is blue in colour due to the presence of $CuSO_4$. When Benedict's reagent is heated in the presence of a reducing sugar like glucose, the copper compound turns orange red.

Given that this is a test for a reducing sugar, what do you think is causing this colour change in the Benedict's reagent? 1 mark

_____

SECTION B - continued

Question 11 (15 marks)

Complete the following table by writing forward, reverse or no change for equilibrium shift, and decreases, increases or remains the same for the concentrations of reactants and products and for the value of K.

$$2H_2\,(g) + O_2\,(g) \leftarrow > 2H_2O\,(g) \quad \Delta H = -286\ kJ/mol$$

Action	Equilibrium shift	$[H_2]$	$[O_2]$	$[H_2O]$	K
Add H_2					
Add H_2O					
Remove O_2					
Increase temperature					
Increase pressure					
Add catalyst					

30 x ½ = 15 marks

END OF QUESTION AND ANSWER BOOK