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'2017 Examination Package' -
Trial Examination 1 of 9

STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Units 3 & 4 - Written examination

*(*TSSM's 2008 trial exams 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	102
			Total 131

- 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 23 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

What pressure (in atm) would be exerted by 76 g of nitrogen gas in a 1.50 L container at -37°C?

A. 70.2 atm
B. 35.1 atm
C. 69.1 atm
D. 3548 atm

Question 2

A 1.00 g sample of ice at 0°C gains 560 J of heat. What is the resultant state of the water?
(Latent heat of fusion = -6.0 kJ/mol and Latent heat of vaporisation = -44.0 kJ/mol)

A. Solid
B. Liquid
C. Gas
D. Solid/Liquid

Question 3

In a redox reaction, ClO^- was converted to Cl^- in a basic solution. The balanced half-reaction for this process is:

A. $ClO^- + 2H^+ + 2e^- \rightarrow Cl^- + H_2O$
B. $ClO^- + H_2O + 2e^- \rightarrow Cl^- + 2OH^-$
C. $ClO^- + 2OH^- \rightarrow Cl^- + H_2O + 2e^-$
D. $ClO^- + H_2O \rightarrow Cl^- + 2H^+ + 2e^-$

Question 4

The oxidation of ethanol by permanganate ions can be represented by the half equations:

$$CH_3CH_2OH\ (aq) + H_2O\ (l) \rightarrow CH_3COOH\ (aq) + 4H^+\ (aq) + 4e^-$$
$$MnO_4^-\ (aq) + 8H^+\ (aq) + 5e^- \rightarrow Mn^{2+}\ (aq) + 4H_2O\ (l)$$

What volume (in mL) of 0.02 M $KMnO_4$ is required to oxidise completely a solution containing 0.02 mol of ethanol?

A. 80
B. 800
C. 1000
D. 4000

SECTION A – continued

Question 5
Which of the following techniques would be most useful to identify and quantify the presence of a known drug in a urine sample?

A. NMR
B. IR
C. MS
D. HPLC

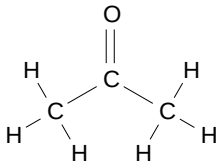
Question 6
Which of the following statements regarding mass spectrometry is wrong?

A. In a mass spectrometer, a molecule loses an electron and becomes positively charged, it can then further fragment into smaller pieces.
B. Only positively charged particles can be detected by a mass spectrometer.
C. A compound that contains a chlorine atom shows two parent molecular ion peaks.
D. Peaks produced from a mass spectrometer will always have even-numbered values of m/z.

Question 7
Which is the correct order of increasing energy of the vibrations of (1) O-H (alcohol), (2) C-H, (3) C=C, (4) C=O?

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

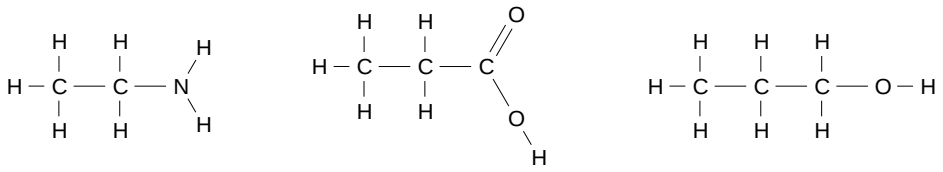
Question 8
The molecule propanone is drawn below



Select the option that correctly lists the number of peaks expected in the ^{1}H NMR and ^{13}C NMR of propanone

	^{1}H NMR	^{13}C NMR
A.	1	2
B.	1	3
C.	3	2
D.	6	3

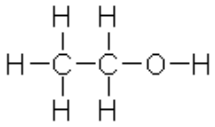
Question 9



The systematic names for the molecules drawn above are, respectively:

A. ethylamine, propanoic acid, 1-propanol
B. ethylamine, 1-propanoic acid, propanol
C. ethylamine, 1-propanoic acid and 1-propanol
D. propylamine, propanoic acid and 1-propanol

Question 10



The molecule shown could be formed from the reaction of

A. ethylamine and water
B. chloroethane and potassium hydroxide
C. ethene and oxygen
D. ethane and water

Question 11

When methane reacts with chlorine in the presence of *uv* light,

A. an addition reaction occurs to form CH_3Cl
B. a substitution reaction occurs to form CH_3Cl
C. the products are CH_3Cl and HCl only
D. the products include CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 and HCl

Question 12

1- propanol is produced in the process outlined below.

The name of compound A is

A. propane
B. 1-propane
C. propene
D. chloropropane

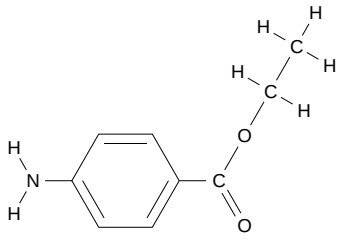
SECTION A – continued

Question 13

Which of the following devices does not use chemical energy?

A. Primary cell
B. Secondary cell
C. Fuel cell
D. Electroplating cell

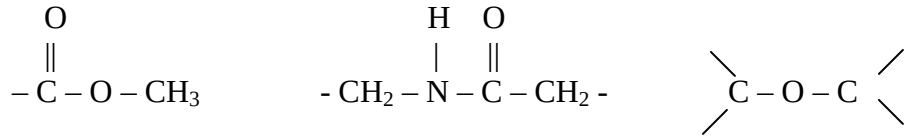
Question 14



The molecule drawn is the local anaesthetic, ethyl-aminobenzoate. The functional groups in this molecule are

A. amine and carboxy
B. amine, hydroxy and carboxy
C. amine and ester
D. carboxy and ester

Question 15



The linkages drawn above are most likely to be found in, respectively:

A. biodiesel, protein and carbohydrate
B. lipid, protein and glucose
C. fatty acid, amino acid and polysaccharide
D. lipid, protein and carbohydrate

Questions 16 and 17 refer to the following information

Hydrochloric acid can react with sodium thiosulfate solution to form a sulfur precipitate. The equation is:

$Na_2S_2O_3$ (aq) + 2HCl (aq) → 2S (s) + SO_2 (g) + 2NaCl (aq) + H_2O (l)

Question 16
Which list below contains only changes that will decrease the rate of this reaction?

A. Increase the temperature, increase the hydrochloric acid concentration and add a catalyst
B. Decrease the temperature and add a catalyst
C. Decrease in temperature, decrease in concentration of the hydrochloric acid, addition of water to the sodium thiosulfate
D. Decrease the concentration of the sodium thiosulfate solution and increase the temperature

Question 17
In a second experiment, an extra 50 mL of water is added to the hydrochloric acid. As a result of this change, the

A. rate of evolution of the sulfur dioxide decreases
B. precipitate will form more quickly
C. more fruitful collisions will occur
D. reaction will not be affected because water is not a reactant

Question 18
Consider the following equilibrium:

$$2SO_2\ (g) + O_2\ (g) \rightarrow 2SO_3\ (g),\ \Delta H = \text{-ve}$$

Which of the following will cause this equilibrium to shift to the right?

A. adding a catalyst
B. removing some SO_2
C. increasing the volume
D. decreasing the temperature

Question 19
The value of the equilibrium constant, K for a reaction is found to have the same value as K for its reverse reaction. If this is the case, it means that

A. the numerical value of K must be 1.
B. the reaction is not actually reversible.
C. the rate of the forward reaction and back reaction is always equal
D. the number of mole of products must equal the number of mole of reactants.

Question 20
The formation of nitrogen oxide is a reversible reaction:

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$ ΔH = negative

The temperature is increased in a particular equilibrium mixture and the amount of N_2 changes by 0.01 mol. The changes occurring would be

	N_2	O_2	NO
A.	increased by 0.01	increased by 0.01	decreased by 0.02
B.	increased by 0.01	decreased by 0.01	decreased by 0.02
C.	decreased by 0.01	increased by 0.01	increased by 0.02
D.	decreased by 0.01	decreased by 0.01	decreased by 0.01

Question 21
The range of methods available for producing electricity is increasing as many countries investigate ways of meeting their energy demands in the future. Choose the correct option from the list below

A. The efficiency of a solar cell is greater than the efficiency of a steam turbine used in the manufacture of electricity from coal.
B. Nuclear power involves harnessing the energy released from the fusion of uranium atoms
C. Natural gas is a mainly methane together with smaller amounts of alkanes such as ethane and propane.
D. All fuel cells convert the energy released from the reaction of hydrogen and oxygen gases to electrical energy.

Question 22

A	**B**	**C**	**D**
thermal energy → mechanical energy	mechanical energy → electrical	chemical energy → thermal energy	thermal energy coal → thermal energy steam

The boxes above refer to different steps involved in the process of producing electrical energy from coal. The correct sequence for the production of electrical energy is

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

SECTION A – continued
TURN OVER

Question 23
0.60 g of ethanol is burnt in a bomb calorimeter. The temperature of the calorimeter contents rises from $12.8^{\circ}C$ to $24.5^{\circ}C$. $\triangle$H for the reaction is -1364 kJ/mol.
The calibration factor of the calorimeter (in J $^{o}C^{-1}$) is:
A. 550
B. 760
C. 1520
D. 3040

Question 24
The equation for the combustion of hydrogen is:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) \quad \Delta H = -484 \text{ kJ mol}^{-1}$

The energy released when 2.40 g of hydrogen reacts is:
A. 145 J
B. 290 J
C. 145 kJ
D. 290 kJ

Question 25
The following two half cells are connected to form a galvanic cell.

$Fe^{3+}(aq)/Fe^{2+}(aq)$ and $I_2(aq)/I^-(aq)$

When the cell is closed,
A. no reaction will occur
B. the iodine will react to form iodide ions
C. the iodine half cell will form the positive electrode
D. the electrons will flow from the iodine half cell to the iron ions

Question 26
The number of mole of electrons passing through a cell is 0.9 mol. For this cell,
A. the voltage must have been 10 volts and the time 145 mins.
B. 0.15 mole of metal will be obtained
C. 1.8 mole of metal will be obtained
D. the current was 10 amps and the cell was in operation for 145 mins.

Question 27
In an electrolytic cell,
A. electrons move to the negative cathode, where reduction occurs
B. electrons move to the positive cathode, where reduction occurs
C. oxidation occurs at the negative cathode
D. oxidation occurs at the positive cathode

SECTION A – continued

Question 28

Beaker A contains a molten solution of copper iodide, CuI_2. Beaker B contains a dilute aqueous solution of CuI_2. If both solutions are subjected to electrolysis

A. copper and iodine will form in Beaker A, while copper and hydrogen will form in Beaker B

B. the products will be the same in both cells

C. copper and iodine will form in Beaker A, but hydrogen and oxygen will form in Beaker B

D. copper will form at the anode in both cells

Questions 29 and 30 refer to the following information.

The overall equation for the methane – oxygen fuel cell, operating in acid conditions, is:

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(l)$$

Question 29

The half equation for the reaction occurring at the cathode will be

A. $CH_4\,(g) + 2H_2O\,(l) + 8e^- \rightarrow CO_2\,(g) + 8H^+\,(aq)$

B. $CO_2\,(g) + 2H_2O\,(l) \rightarrow CH_4\,(g) + 2O_2\,(g)$

C. $O_2\,(g) + 4H^+\,(aq) + 4e^- \rightarrow 2H_2O\,(l)$

D. $CH_4\,(g) + 2H_2O\,(l) \rightarrow CO_2\,(g) + 8H^+\,(aq) + 8e^-$

Question 30

This cell will require

A. porous electrodes and potassium hydroxide as the electrolyte

B. hydrogen gas at one electrode and oxygen at the other

C. porous electrodes and a continuous supply of reactants

D. non reactive and non porous electrodes

END OF SECTION A
TURN OVER

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 (12 marks)
In a high school chemistry experiment students were required to make a biodiesel using the starting materials of oleic acid and methanol.

a. Using semi-structural formula, write the equation for the production of the biodiesel.

2 marks

_____

b. To test the energy content of the biodiesel, a 1.00 g sample of the biodiesel was burnt underneath a beaker containing 50.0 g of distilled water. The initial temperature of the water was 18.4 °C and the final temperature was 26.2 °C.

i. Calculate the amount of energy (in J) produced from the combustion of 1.00 g of the biodiesel.

2 marks

_____

_____

_____

ii. Using semi-structural formula, write the balanced chemical equation for the combustion of the biodiesel.

2 marks

_____

SECTION B – Question 1 – continued

iii. Assuming that the biodiesel is 100% pure, calculate the ΔH for the above reaction.

3 marks

_____

_____

_____

iv. Would you expect this result to be higher or lower than the actual value? Explain.

2 marks

_____

_____

_____

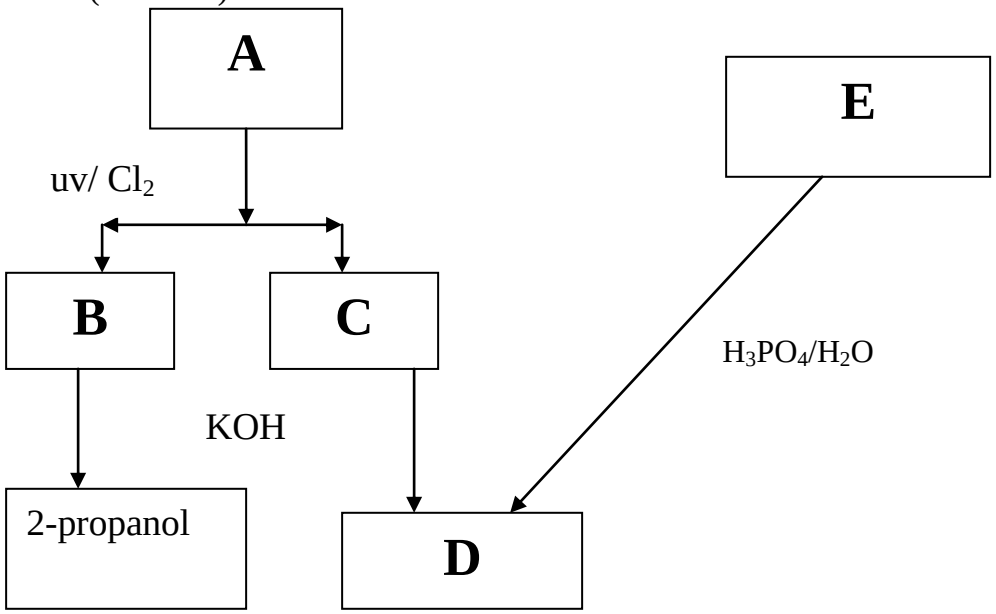
c. The production and use of biodiesel fuel is considered to be carbon neutral. What is meant by this term?

1 mark

_____

_____

Question 2 (13 marks)



SECTION B – Question 2 – continued
TURN OVER

a. **i**. Draw structural diagrams of the molecules A to E. 5 marks

A _____ B _____

C _____ D _____

E _____

ii. Name each molecule A to E, using the lines provided above. 2 marks

iii. Name the type of reaction that is responsible for: 2 marks

A → B _____

E → D _____

b. **i**. Name an instrument that could be used to distinguish molecule B from C. 1 mark

_____

ii. For the instrument you have chosen, explain how the print-out will differ for each molecule. 2 marks

_____

_____

_____

c. The reaction of E to D could produce another product. 1 mark
Name this product. _____

SECTION B – continued

Question 3 (11 marks)
A mass spectrometer can be used to help identify a substance or to help deduce the structure of a substance.

a.

i. What form must the sample be in when it is enters the evacuated tube used? 1 mark

_____

ii. How is each substance changed to enable it to be accelerated? 1 mark

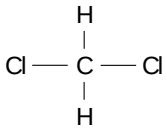
_____

iii. What two factors dictate the degree to which a particles path is curved? 1 mark

_____

b.

Dichloromethane has the structure shown.
Give two reasons why this molecule has several different peaks on a mass spectrum.
2 marks



_____

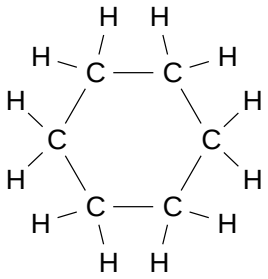
_____

c.

i. Draw a structural diagram of 1-hexene. 1 mark

ii. Cyclohexane has the structure drawn .

How will the parent molecular ion for cyclohexane compare to that of 1-hexene?



1 mark

_____

SECTION B – Question 3 – continued
TURN OVER

iii. Name one peak likely to be present on a 1-hexene mass spectrum that will not be present in cyclohexane. 1 mark

_____

iv. Which molecule would have the most peaks on ^{1}H NMR? Explain your answer. 2 marks

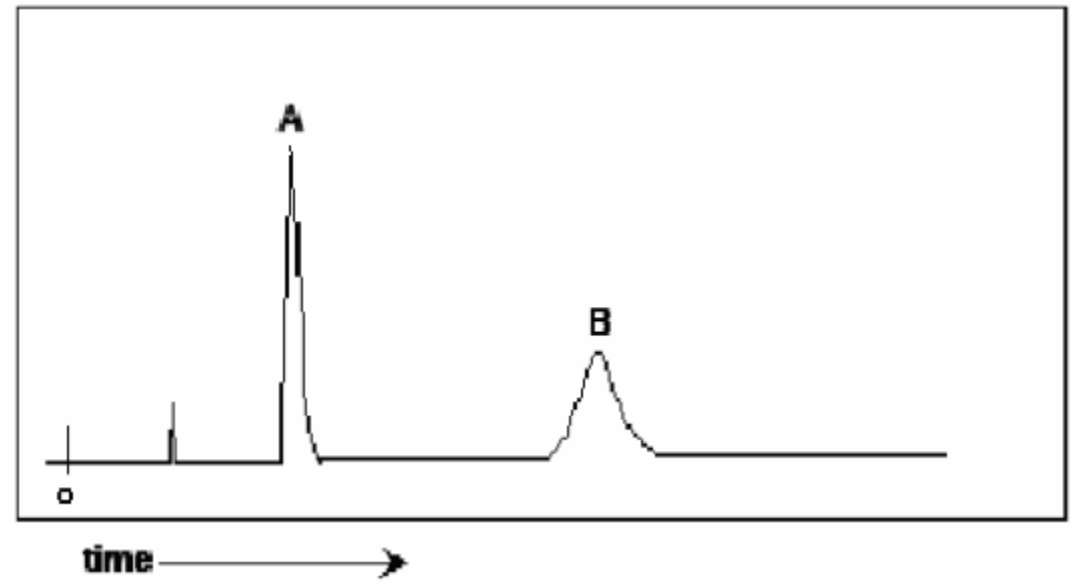
_____

_____

v. Name one infrared absorption peak 1-hexene will have that cyclohexane does not. 1 mark

_____

Question 4 (7 marks)
The following HPLC chromatogram was obtained using a non-polar stationary phase.



a. If compound B is propene, and compound A is a product of a single reaction starting with compound B. Provide one possibility for the identity of compound A.

1 mark

_____

SECTION B – Question 4 – continued

b. Explain your answer to part (a).

2 marks

_____

_____

c. Using seni-structural formula, write the reaction for the production of compound A from compound B (show states and conditions required for the reaction, if any).

2 marks

_____

d. Provide two ways that you could determine the identity of compound A using HPLC.

2 marks

_____

_____

Question 5 (4 marks)

The monounsaturated fatty acid, oleic acid, has an empirical formula, $C_9H_{17}O$. It has nine carbon atoms joined by single covalent bonds.

a.

i. Draw a semi-structural diagram of oleic acid. 1 mark

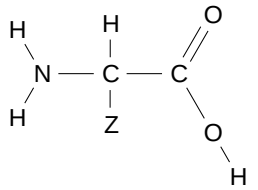
ii. Oleic acid can react with methanol to form a biodiesel molecule. Draw a semi-structural diagram of this biodiesel molecule. 1 mark

iii. Write a balance equation for the combustion of this biodiesel molecule. 1 mark

_____

SECTION B – Question 5 – continued
TURN OVER

b. α-Amino acids have a general formula shown below, where the Z- group varies.
Depending upon the nature of the Z- group, the interactions between the neighbouring parts of a protein chain may vary.



Draw the alternative form (i.e. Zwitterion) that this molecule can take. 1 mark

Question 6 (8 marks)
Give concise explanations for each of the following.

a. The same amount of charge flowing through different molten ionic solutions does **not** always lead to the same number of mole of metal being extracted. 2 marks

_____

_____

b. When the temperature is increased in most industrial processes, the products form more quickly. The amount of product formed in any given time, however, is not always greater. 2 marks

_____

_____

c. The calibration factor for a calorimeter can be determined without any measurement of voltage or current. 2 marks

_____

_____

d. The chemical potential energy of 1 mole of diesel is many times greater than that of 1 mole of ethanol. The efficiency of ethanol as a fuel, however, is only marginally less than that of diesel. 2 marks

_____

_____

SECTION B - continued

Question 7 (9 marks)

Ethyne, C_2H_2, is a gas used in industry to produce a high temperature flame. The flame is used to cut through metal. Ethyne can be produced from ethane in a reversible reaction.

$C_2H_6(g) \Leftrightarrow C_2H_2(g) + 2H_2(g) \quad \Delta H = +355$ kJ mol

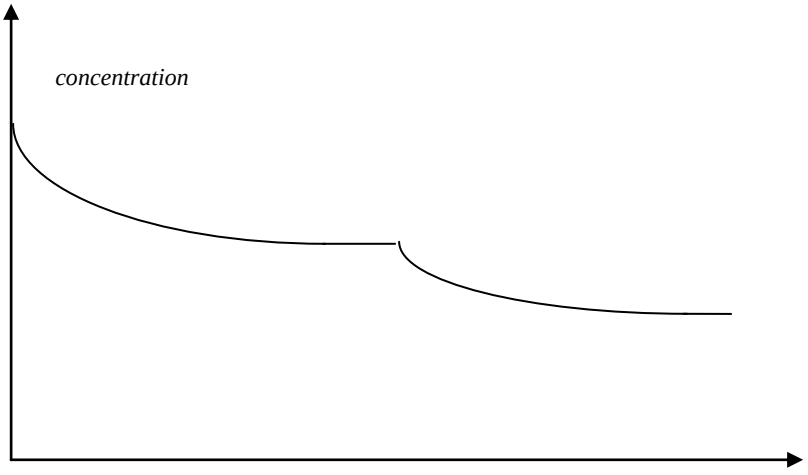
a. Draw a structural formula for ethyne. 1 mark

b. At mild conditions of temperature and pressure, the yield of ethyne is low. Chemical engineers change the conditions to improve the yield. Complete the table below to predict the impact on this process of each change listed. 3 marks

For each space in the table, choose from **decrease**, **unchanged** or **increase**

change	**value of K**	**equilibrium yield of ethyne**	**rate of reaction**
decrease in temperature			
increase in pressure			
addition of a catalyst			

c. A sample of ethane is added to an empty reactor at 800^0C. The graph shown is of the concentration of ethane in the reactor. At the 12 minute mark, the temperature of the system is changed.



SECTION B – Question 7— continued

TURN OVER

i. Use the graph provided to draw the concentration of ethyne up to the 12 minute mark. 1 mark

ii. Add to the graph, the concentration of the hydrogen. Label each gas carefully. 1 mark

iii. Was the temperature change an increase or a decrease? Explain your answer. 1 mark

_____

_____

d. From a green chemistry point of view, it is important to be able to use all products of a reaction. Give a possible use of the hydrogen gas produced in this process. 1 mark

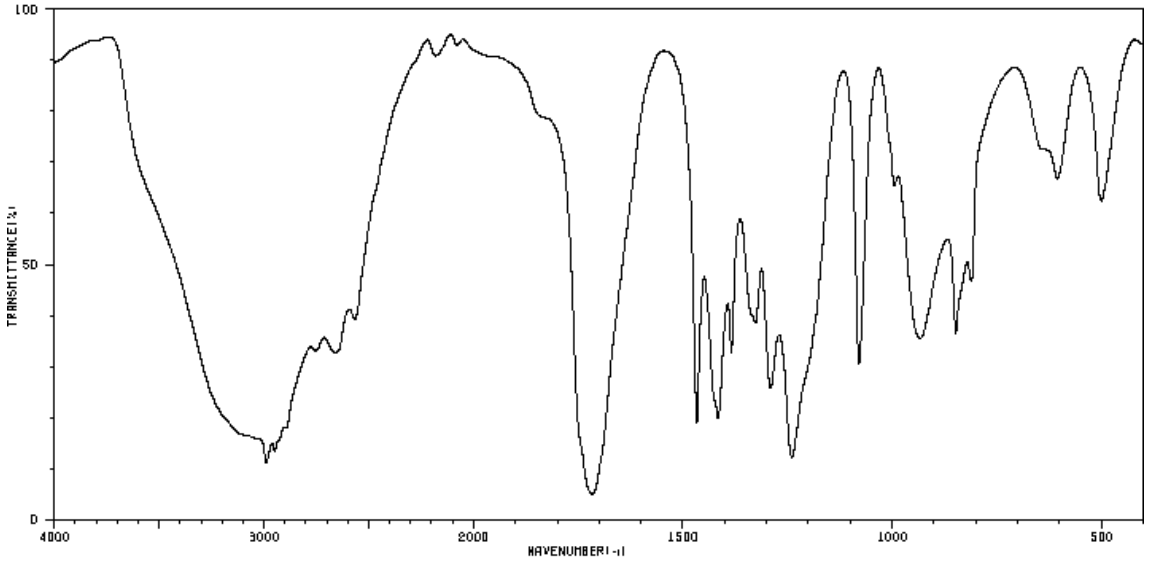
_____

e. The torch used to cut metal uses a mixture of ethyne and oxygen. Write a balanced equation for the reaction of ethyne and oxygen. 1 mark

_____

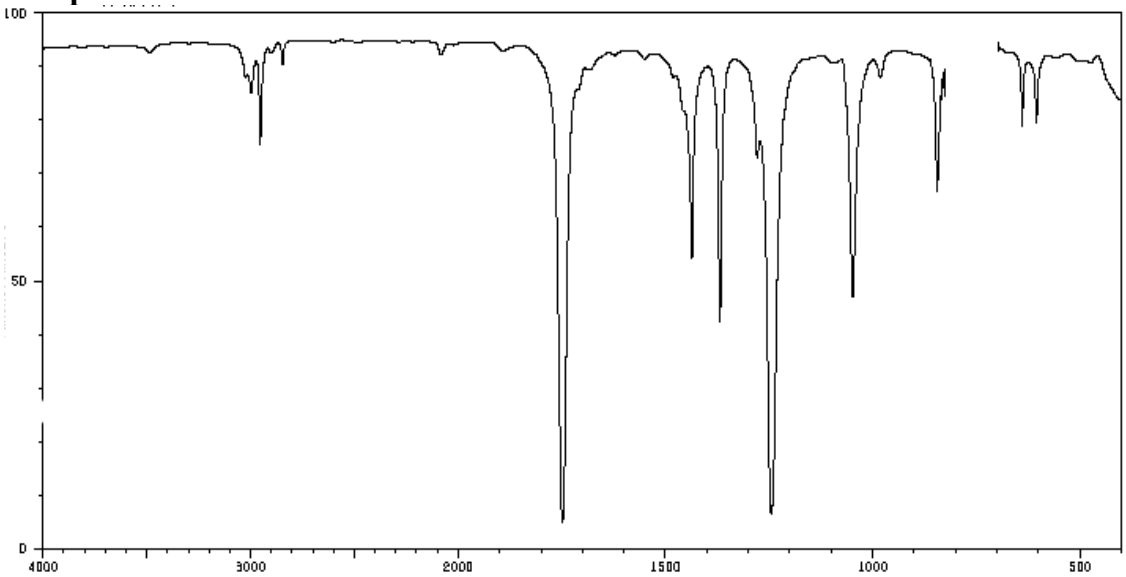
Question 8 (11 marks)
Two isomers (A and B) with the formula, $C_3H_6O_2$, produce the following IR spectrum:

Compound A:



SECTION B – Question 8— continued

Compound B:



a. Using the data provided by the IR spectrum, identify the functional groups present in both compounds.

2 marks

Compound A: _____

Compound B: _____

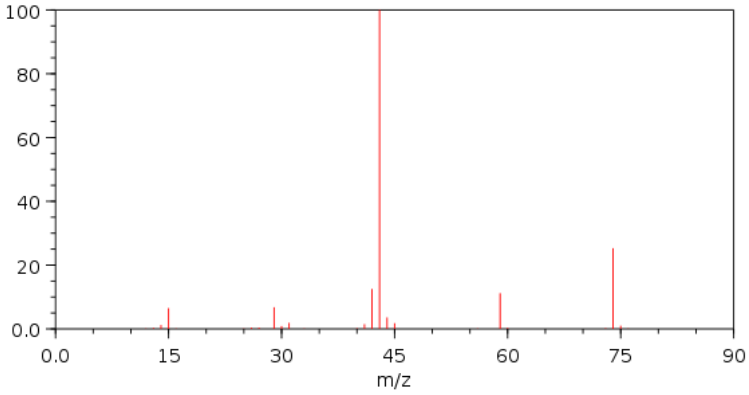
b. What is the name of Compound A? Provide a structural diagram of compound A.

2 marks

_____

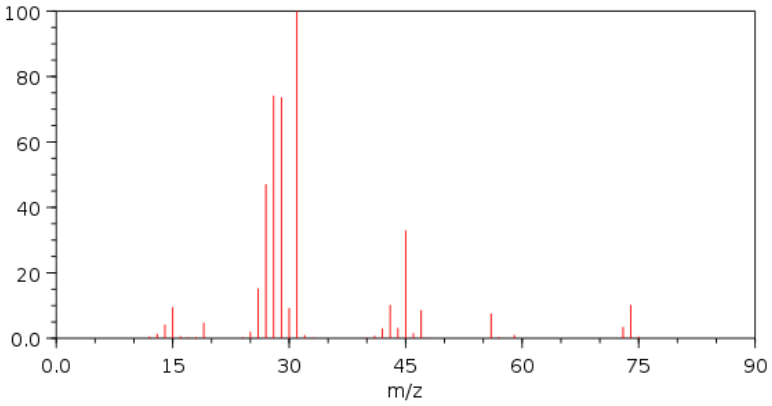
There are two options available for compound B. The following two mass spectrums are produced from compound B and the other option.

Compound B:



SECTION B – Question 8— continued
TURN OVER

Other option:



c. Using the two spectrums provided above deduce the structure of compound B and provide a name. Explain.

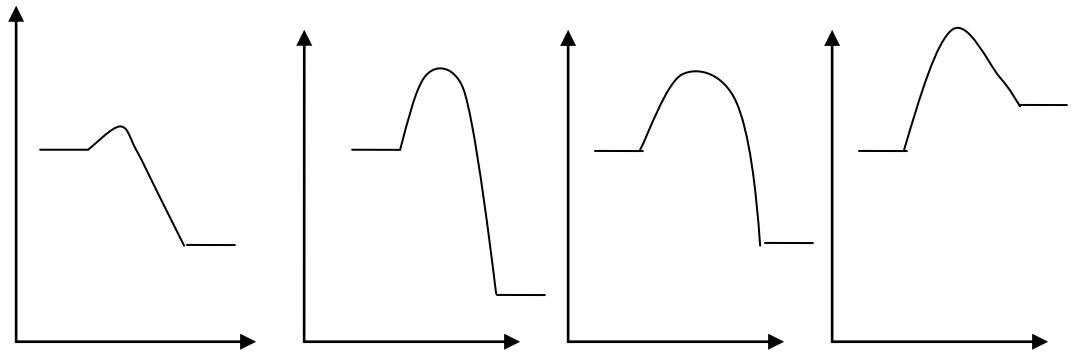
3 marks

d. Using the space provided below. Draw the ^{1}H-NMR spectrum that would be expected for Compound B.

4 marks

SECTION B - continued

Question 9 (7 marks)
The diagram below contains four energy profile diagrams labelled A to D.



A **B** **C** **D**

a.

i. Pick two graphs that represent the same reaction, with and without a catalyst. 1 mark

_____

ii. Explain the difference between the two graphs that you chose. 1 mark

_____

_____

b.

i. Which graphs represent reactions with positive activation energy? 1 mark

_____

ii. Which graph represents the reaction with the greatest activation energy? 1 mark

_____

c. Respiration is a highly exothermic reaction occurring in body cells.

$C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g) \quad \Delta H = -2803 \text{ kJ mol}^{-1}$

Calculate the amount of energy released from the combustion of 4.80 g of oxygen. 3 marks

_____

_____

SECTION B - continued
TURN OVER

Question 10 (8 marks)

The vanadium redox cell is a newly developed cell that uses oxides of vanadium at both electrodes. The cell is an example of a redox flow battery; it is a rechargeable fuel cell.
The half equations for the cell during discharge, are:

polarity

$2VO(aq) + H_2O(l) \rightarrow V_2O_3(aq) + 2H^+(aq) + 2e^-$ _____

$V_2O_5(aq) + 2H^+(aq) + 2e^- \rightarrow 2VO_2(aq) + H_2O(l)$ _____

a. Use the spaces provided to label the polarity of each electrode. 1 mark

b. Write an overall equation for the reaction occurring in this cell. 1 mark

_____

c. For each of the vanadium compounds below, indicate the oxidation number of the vanadium. 2 marks

VO ____ V_2O_3 _____ V_2O_5 _____ VO_2 _____

d. The operating voltage of the cell is 1.40 volts.

i. How much energy is produced by this cell if it runs for 8.0 hours with a current of 3.50 amps? 2 marks

_____

_____

ii. What mass of VO would react in this time? 2 marks

_____

_____

SECTION B - continued

Question 11 (12 marks)

English scientist, Sir Humphry Davy, first isolated potassium in 1807 by electrolysis of molten potassium hydroxide.

a.

i. Write balanced half equations for the reactions that will occur at the anode and the cathode in this cell. 2 marks

anode _____

cathode _____

ii. What is the polarity of each electrode? 2 marks

anode _____ cathode _____

b. Give two reasons why this reaction was a very dangerous one. 2 marks

_____

_____

c. A current of 6.20 amps flows for 4.00 minutes. Calculate the mass of potassium that will be produced. 2 marks

_____

_____

d. This potassium hydroxide electrolysis cell is operated for about 15 minutes. The power supply is then removed and replaced with an ammeter. The ammeter indicates that a current is flowing.

i. Explain why a current is flowing even though the power supply has been removed. 2 marks

_____

_____

ii. Give the half equation of the reaction occurring at the anode. 1 mark

_____

iii. What is the polarity of the anode? _____ 1 mark

END OF QUESTION AND ANSWER BOOK