TSSM™
Creating VCE Success

'2017 Examination Package' -
Trial Examination 9 of 9

STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Units 3&4 - Written examination

(TSSM's 2016 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	92
			Total 122

- 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 28 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 volume of CH_4 at STP contains the same number of atoms as 0.50 L of N_2 measured at 27°C and 1.50 atm?

A. 0.50 L
B. 0.68 L
C. 0.20 L
D. 0.54 L

Question 2

If 1584 J of heat is gained by 60 g of oil [specific heat capacity = 2.4 J/(g°C)] at 23 °C, the final temperature of the oil is:

A. 29 °C
B. 167 °C
C. 89 °C
D. 34 °C

Question 3

In a reaction between $ZnSO_4(s)$ and Pb(s):

A. Zinc ions gain electrons
B. Zinc ions undergo reduction
C. Lead is the reductant
D. No reaction will occur

Question 4

A cell that cannot be recharged is:

A. A dry cell
B. A wet cell
C. A primary cell
D. A secondary cell

SECTION A - continued

Question 5

Which of the following is not a use for mass spectrometry?

A. calculating the isotopic abundance in elements

B. investigating the basic structure of organic compounds

C. confirming the presence of O-H and C=O in organic compounds

D. calculating the molecular mass of organic compounds

Question 6

In HPLC, the concentration of an unknown substance can be determined by:

A. Comparison of the area under the peak produced by the substance with the areas under the peaks produced by multiple standards of differing concentrations.

B. From the Rt value of the substance.

C. Measurement of the height of the peak produced by the substance.

D. Comparison of the Rt of the substance with that of a single standard

Question 7

Glycine can react with itself to form a tripeptide. The molar mass of the tripeptide will be, in g mol^{-1},

A. 171

B. 189

C. 207

D. 225

Question 8

Enzymes are:

A. Proteins

B. Fats

C. Carbohydrates

D. Inorganic

Question 9

The molar enthalpy of formation of liquid water is -285.8 kJ. For which of the following reactions would the change in enthalpy be equal to -285.8 kJ?

A. $2H\ (g) + O\ (g) \rightarrow H_2O\ (l)$

B. $H_2O\ (s) \rightarrow H_2O\ (l)$

C. $2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l)$

D. $H_2\ (g) + ½O_2\ (g) \rightarrow H_2O\ (l)$

SECTION A – continued

TURN OVER

Question 10

The alcohol concentration (ethanol concentration) of a wine can be determined from a redox titration with an orange solution of potassium dichromate, $K_2Cr_2O_7$. The endpoint can be judged when the orange colour is no longer evident. The equation for the reaction is

$$2Cr_2O_7^{2-}(aq) + 3CH_3CH_2OH(aq) + 16H^+(aq) \rightarrow 4Cr^{3+}(aq) + 3CH_3COOH(aq) + 11H_2O(l)$$

In a particular titration, 20.0 mL aliquots of 0.100 M $K_2Cr_2O_7$ require a titre of 16.0 mL of an ethanol solution. The concentration of the ethanol is closest to, in M,

A. 0.083

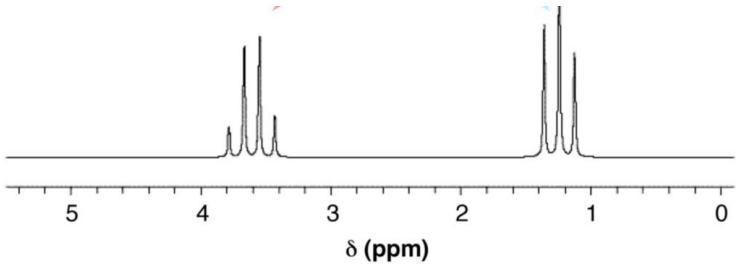
B. 0.125

C. 0.150

D. 0.188

Question 11

The spectrum below is a proton NMR.



The NMR shown could be that of

A. ethane

B. ethanol

C. chloroethane

D. ethanoic acid

Question 12

At 375 °C, K for the following reaction is 0.015.

$$2HI(g) \rightleftarrows H_2(g) + I_2(g)$$

A mixture of H_2, I_2, and HI in a vessel at 375 °C has the following concentrations: [HI] = 1.9 M, [H_2] = 0.60 M and [I_2] = 0.07 M. Which one of the following statements concerning the reaction is TRUE?

A. The system is at equilibrium.

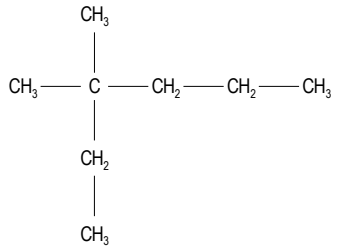
B. More H_2 and I_2 will be produced.

C. More HI will be produced.

D. The temperature will increase

SECTION A – continued

Question 13



The correct systematic name for this molecule is:

A. 2-ethyl-2-methylpentane
B. 3-methylheptane
C. 4,4-dimethylhexane
D. 3,3-dimethylhexane

Question 14

A reaction pathway is shown below.

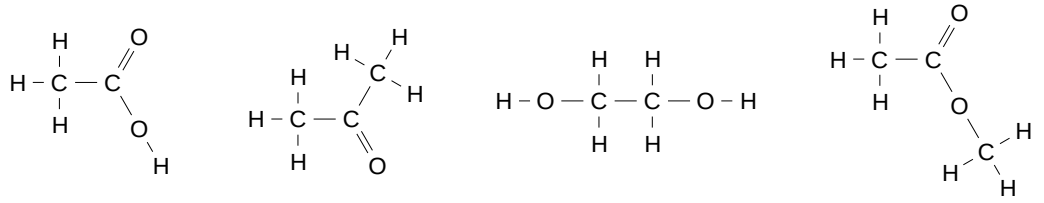
$CH_2CHCH_3 + H_2O \rightarrow X$
$X + CH_3COOH \rightarrow Y$

Chemical Y could be:

A. pentanoic acid
B. pentan-1-ol
C. propylethanoate
D. ethylpropanoate

SECTION A – continued
TURN OVER

Question 15



A B C D

Which of the molecules above will show an infrared absorption band around 3300 cm^{-1}?

A. A

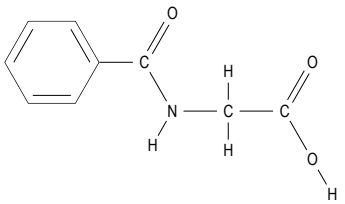
B. B

C. C

D. D

Use the following information to answer Questions 16 and 17

The molecule drawn below is hippuric acid, a component of urine. Its concentration in urine increases with consumption of tea and wine.



Question 16

A hippuric acid molecule contains

A. an ester group, a benzene ring and a carboxyl group

B. an amide group, a benzene ring and a carboxyl group

C. an amine group, a benzene ring and a hydroxyl group

D. an amide group, a benzene ring and a hydroxyl group

Question 17

A molecule of hippuric acid could be formed from the reaction between

A. ethanoic acid and benzoic acid

B. glycine and benzoic acid

C. ethanamine and benzoic acid

D. propanoic acid and benzoic acid

SECTION A – continued

Question 18

Lightning can cause the following reaction to occur between nitrogen and oxygen in air;

$N_2(g) + O_2(g) \rightleftarrows 2NO(g)$ $\quad K = 5.00 \times 10^{-3}$ at $3000\ ^0C$

The value of the equilibrium constant for the reaction of

$2NO(g) \rightleftarrows N_2(g) + O_2(g)$ at $3000\ ^0C$ will be

A. 200
B. 342
C. 360
D. 378

Question 19

Calculate the enthalpy change, in kJ, of the reaction:

$$N_2H_4\ (l) + 2H_2O_2\ (l) \rightarrow N_2\ (g) + 4H_2O\ (l)$$

using the following data:

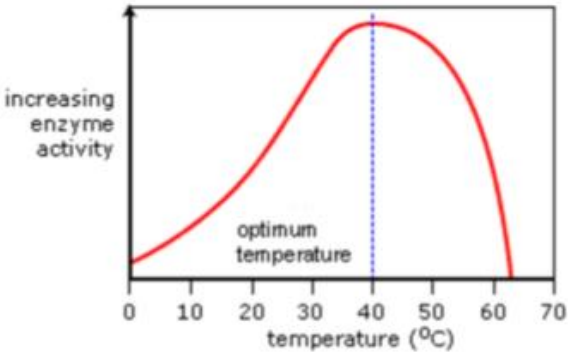
$$N_2H_4\ (l) + O2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (l) \quad \Delta H = -622\ kJ$$
$$H_2\ (g) + O_2\ (g) \rightarrow H_2O_2\ (l) \quad \Delta H = -188\ kJ$$
$$H_2\ (g) + \tfrac{1}{2}O_2\ (g) \rightarrow H_2O\ (l) \quad \Delta H = -286\ kJ$$

A. -720
B. -1096
C. -818
D. -622

SECTION A – continued
TURN OVER

Question 20

Invertase is an enzyme that can catalyse the breakdown of sucrose to its monosaccharide components. The graph below shows the reaction rate of sucrose and invertase at different temperatures.



This graph provides evidence that

A. the rate of a reaction has a linear relationship with temperature

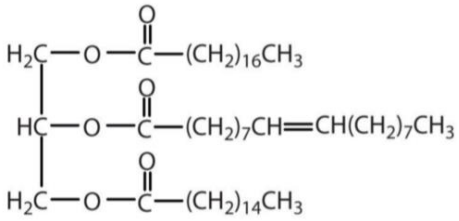
B. invertase will denature at temperatures over 40 ^{0}C

C. the number of collisions will decrease above 40 ^{0}C

D. the activation energy of the reaction increases if the temperature is above 40 ^{0}C

Question 21

The structure below is a triglyceride.



The fatty acids used to make this triglyceride are

A. arachidic acid, oleic acid and palmitoleic acid

B. arachidic acid, linoleic acid and palmitic acid

C. stearic acid, linoleic acid and palmitoleic acid

D. stearic acid, oleic acid and palmitic acid

SECTION A – continued

Question 22

The production of hydrogen iodide is a reversible reaction;

$H_2(g) + I_2(g) \rightleftarrows 2HI(g) \qquad \Delta H = -ve$

Which of the following changes will lead to an improved yield of hydrogen iodide?

A. Decrease in temperature

B. Increase in temperature

C. Increase in pressure

D. Addition of a catalyst

Question 23

Which energy conversion is not likely to occur in the generation of electricity in a coal-fired power station?

A. thermal energy to mechanical energy

B. mechanical energy to electrical energy

C. mechanical energy to kinetic energy

D. chemical potential energy to thermal energy

Question 24

What mass of carbon must undergo complete combustion to produce 1.00 MJ of energy?

A. 2.54 g

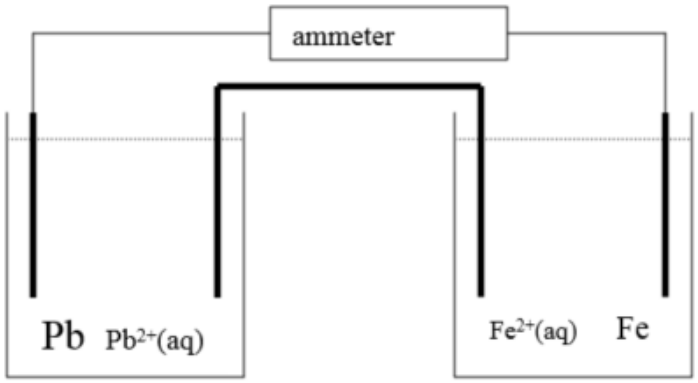
B. 24 g

C. 30.5 g

D. 3.05×10^4 g

Use the following information to answer Questions 25 and 26

A galvanic cell is assembled from a lead half-cell and an iron half-cell.



Question 25

When this cell is operating

A. lead metal is reduced and iron metal oxidised

B. lead ions are reduced at the anode

C. lead ions will be the oxidant and iron metal the reductant

D. lead metal will be the oxidant and iron metal the reductant

Question 26

The salt bridge contains saturated potassium nitrate solution. When the cell is operating

A. the ions in the salt bridge allow electrons to travel from one half-cell to the other

B. nitrate ions will flow into the lead half cell

C. potassium ions will flow into the iron half-cell

D. potassium ions will flow into the lead half-cell

Question 27

The anode half-equation that will occur in an ethanol fuel cell operating in acidic conditions will be

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

B. $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

C. $CH_3CH_2OH(l) + 3H_2O(l) \rightarrow 2CO_2(g) + 12H^+(aq) + 12e^-$

D. $CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$

Question 28

Which statement is true for both a galvanic cell and an electrolytic cell?

A. Oxidation occurs at the negative electrode

B. The anode is negatively charged

C. The strongest oxidant will react with the weakest reductant.

D. Electrons flow from the anode to the cathode

Question 29

Aluminium can be produced from the electrolysis of molten aluminium oxide, Al_2O_3. In this electrolysis,

A. 1 mole of aluminium is produced for every mole of oxygen gas

B. 4 mole of aluminium is produced for every 3 mole of oxygen gas

C. 4 mole of aluminium is produced for every 3 mole of oxygen atoms

D. 2 mole of aluminium is produced for every 3 mole of oxygen gas

Question 30

Brine is a concentrated solution of sodium chloride. The electrolysis of brine is a common industry due to the useful products it yields. The products are

A. hydrogen gas, chlorine gas and sodium hydroxide

B. hydrogen gas and oxygen gas

C. sodium metal and oxygen gas

D. sodium metal and chlorine gas

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 (11 marks)

A student calibrated a calorimeter by applying a specific voltage and current for a certain time and measuring the rise in temperature of the water in the calorimeter. The only problem with this process was that they forgot to record the actual voltage, current and time. The only recorded values were the following:

Volume of water in calorimeter (mL) = 100 mL

Initial temperature of water (°C) = 16.5

Final temperature of water (°C) = 23.1

Remembering their lessons on the specific heat capacity of water, the student decided to use this calculation to work out the calibration factor of the calorimeter.

a. Calculate the energy involved in this calibration process.

_____

_____

1 mark

b. Calculate the calibration factor for the calorimeter suing this value.

_____

_____

2 marks

SECTION B – Question 1 - continued

The calorimeter was then emptied and used to calculate the ΔH of the reaction between nitric acid and sodium carbonate. 100 mL of 0.0750 M nitric acid was placed in the calorimeter and 1.32 g of sodium carbonate was added. The temperature of the calorimeter rose from 17.4 to 21.2 °C.

c. Write a balanced chemical equation (including states for this reaction.

_____

2 marks

d. Calculate the ΔH for this reaction.

_____

_____

_____

3 marks

e. The result from this experiment is inaccurate due to the calculation of the calibration factor. If this step was performed accurately, how does would this change the final result of the experiment? Explain your answer.

_____

_____

_____

3 marks

SECTION B – continued

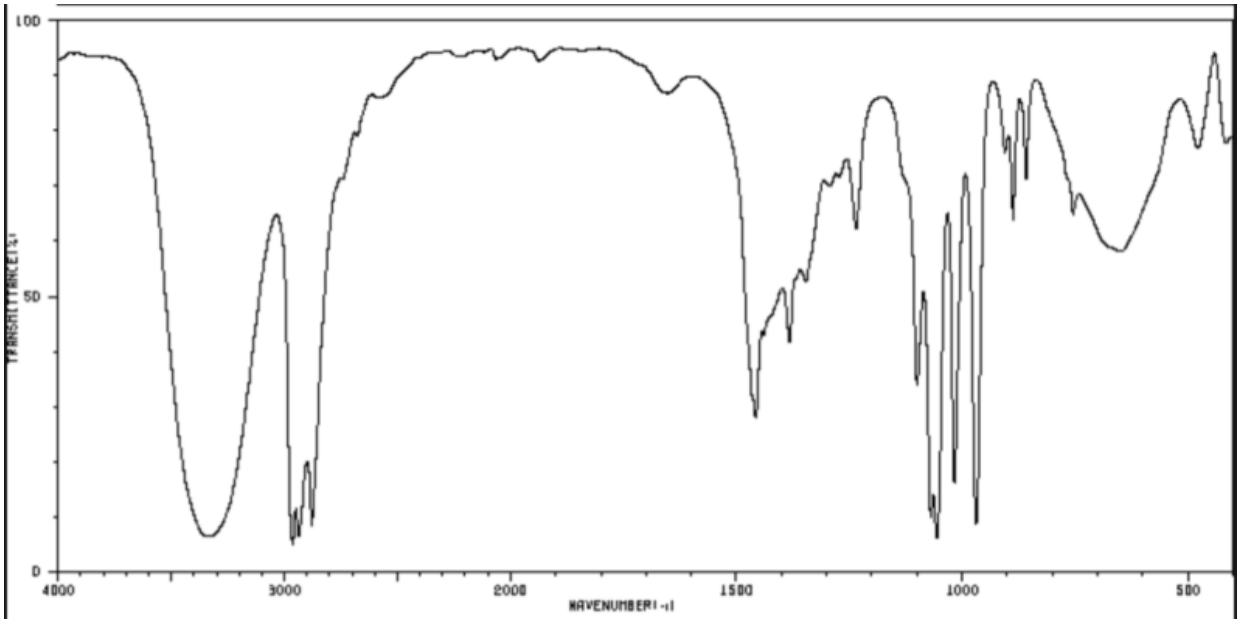
TURN OVER

Question 2 (11 marks)

A molecule is found to contain 26.6% oxygen and 13.3% hydrogen by mass. The remainder is carbon.

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

Some conclusions can be drawn about the molecule from the infrared spectrum shown below.

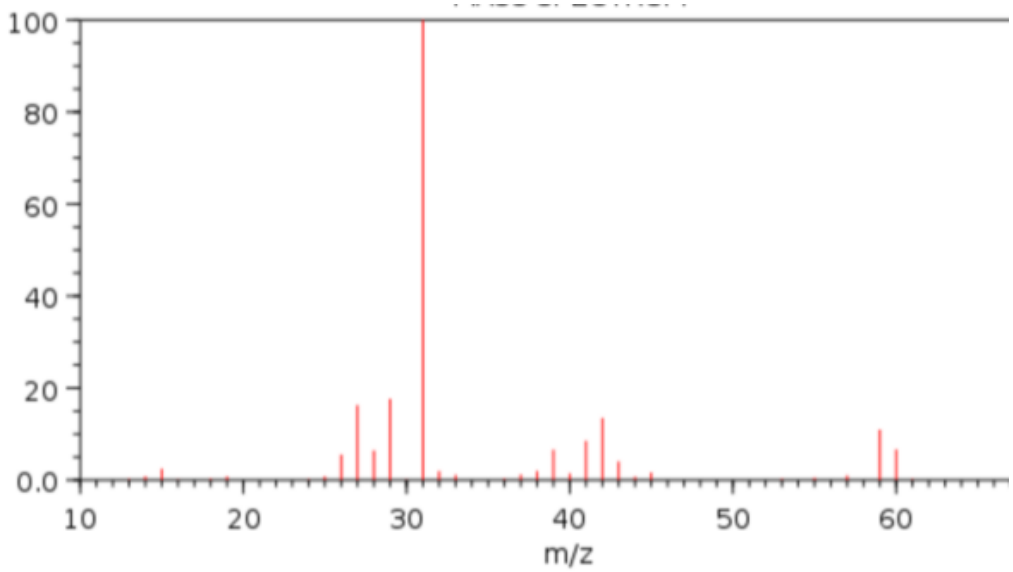


b. i. How does the infrared spectrum show the molecule is not an ester? 1 mark

ii. How does the infrared spectrum show the molecule is not a carboxylic acid? 1 mark

SECTION B - Question 2- continued

The mass spectrum of the molecule is shown below.



c. **i**. What is the molecular formula of the molecule? 1 mark

_____

ii. Suggest a possible structure for the fragment that has caused the base peak on this spectrum. 1 mark

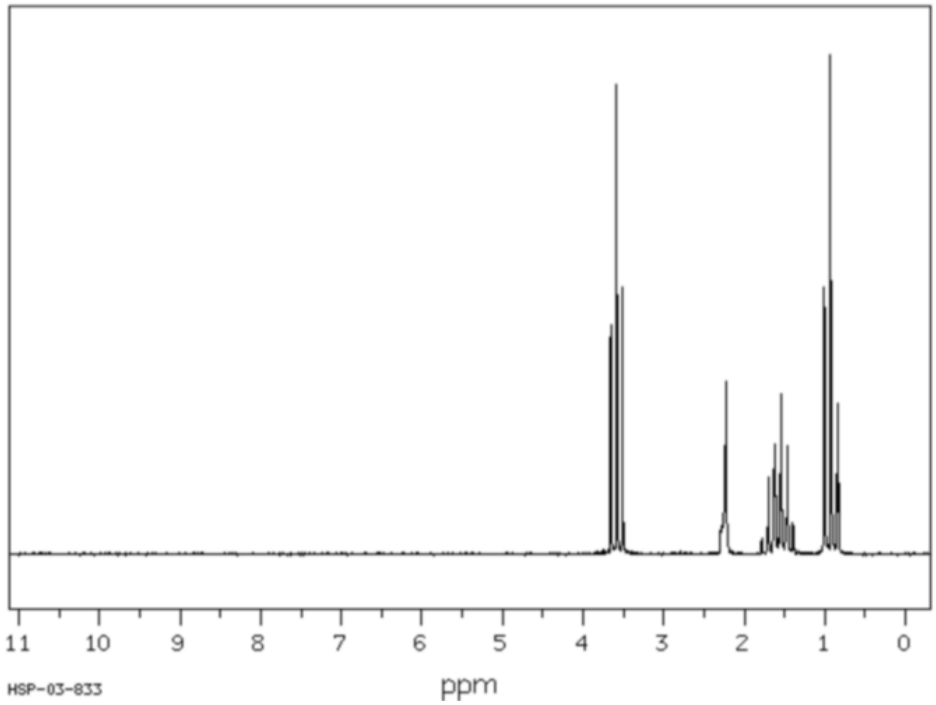
_____

d. Draw two possible structures for this molecule. 2 marks

e. The spectrum below is a proton NMR for the molecule. 2 marks

SECTION B – Question 2 - continued

TURN OVER



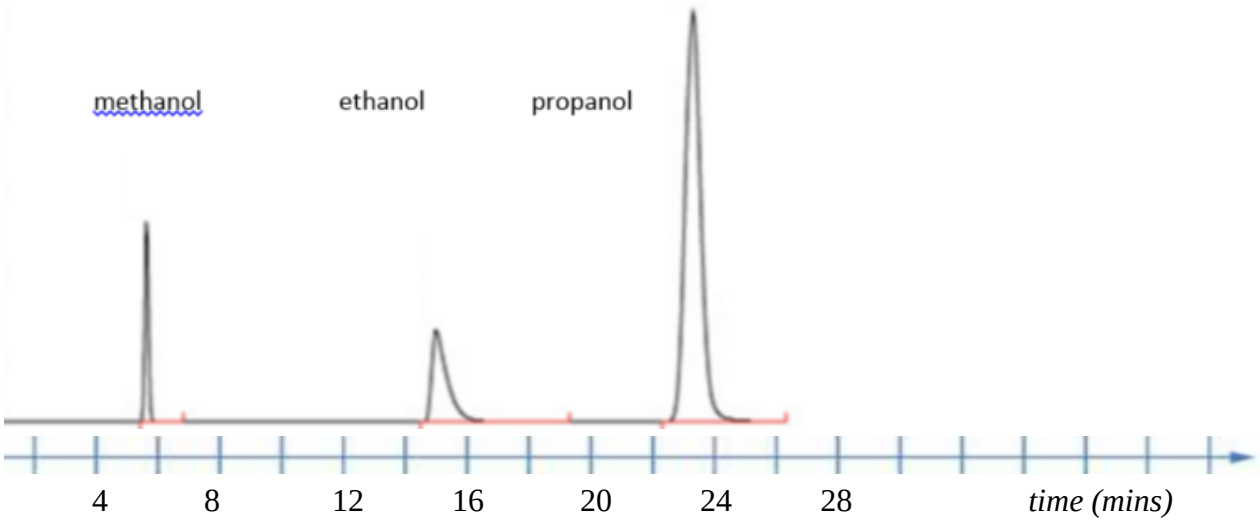
Use the NMR spectrum to confirm the identity of the molecule.

_____

_____

Question 3 (4 marks)

A cleaning fluid contains the three alcohols, methanol, ethanol and propanol. A sample injected into a HPLC produces the chromatogram below.



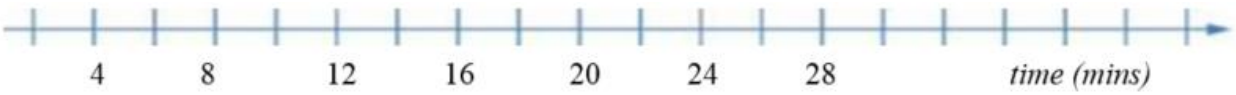
SECTION B – Question 3 - continued

Peak areas

methanol	4500
ethanol	4200
propanol	7920

a. A sample of another cleaning agent that contains no methanol but double the concentration of ethanol and half the concentration of propanol is next tested.

i. Use the template below to draw the expected chromatogram. 2 marks



ii. What peak area might you expect for the propanol? 1 mark

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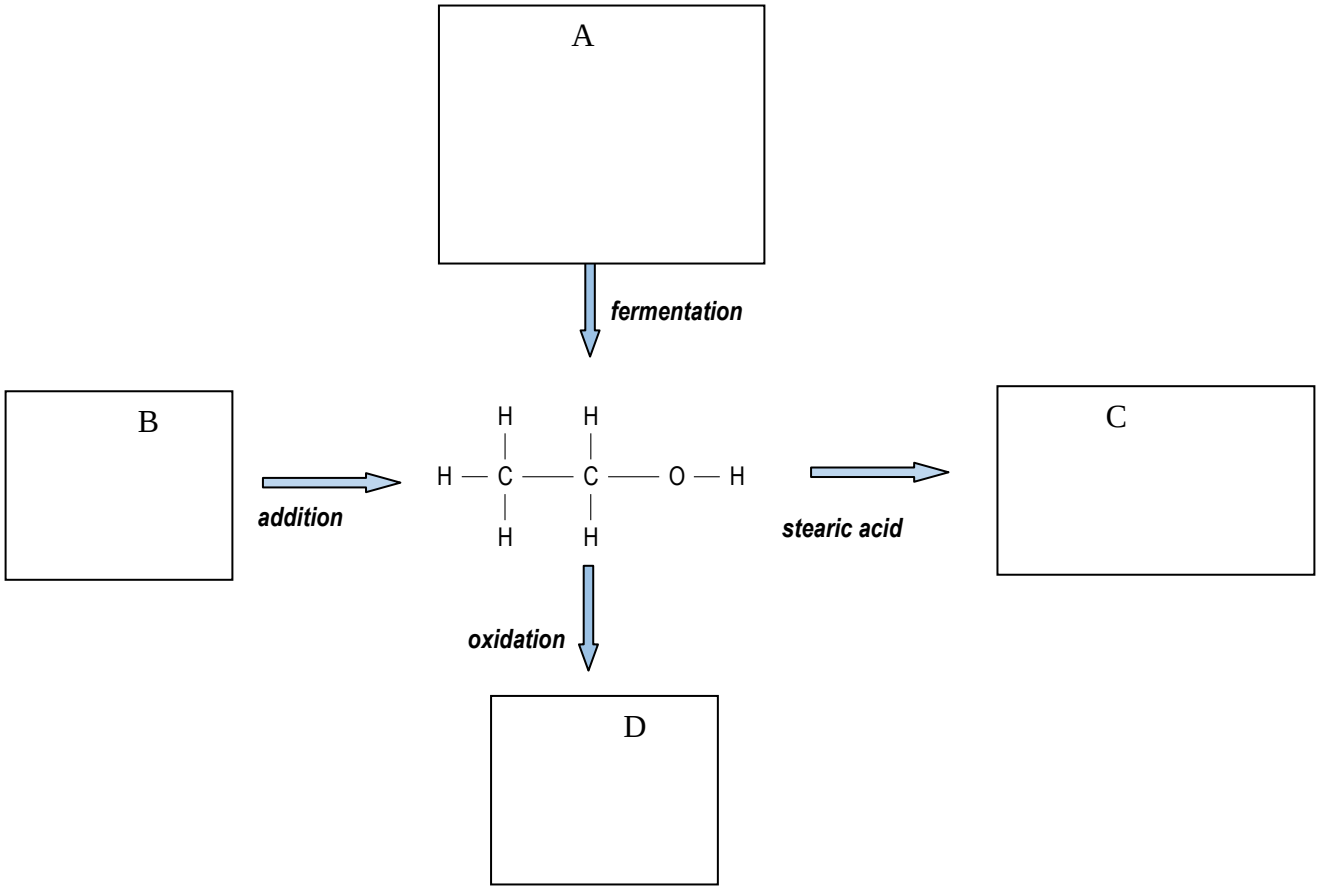
b. The first experiment is repeated with a faster flow rate of carrier gas used. Use the template below to draw the expected chromatogram. 1 mark

SECTION B – continued

TURN OVER

Question 4 (12 marks)

The flowchart is a reaction pathway revolving around the production and reactions of ethanol.



Reaction A

a. **i**. Use box A to draw the structure of the molecule undergoing fermentation. 1 mark

ii. Write a balanced equation for the fermentation reaction. 1 mark

_____

iii. Ethanol produced in this way is often considered to be a renewable fuel.
What is a renewable fuel? 1 mark

_____

SECTION B – Question 4- continued

Reaction B

Ethanol can also be produced in an addition reaction.

b. i. Use box B to draw the molecule used to form ethanol. 1 mark

ii. Write a balanced equation for the reaction occurring. 1 mark

_____

Reaction C

A biodiesel molecule can be formed from the reaction between ethanol and stearic acid

c. i. What is molecular formula of the biodiesel molecule? 1 mark

_____

ii. Write a balanced equation for the complete combustion of this biodiesel molecule. 2 marks

_____

Reaction D

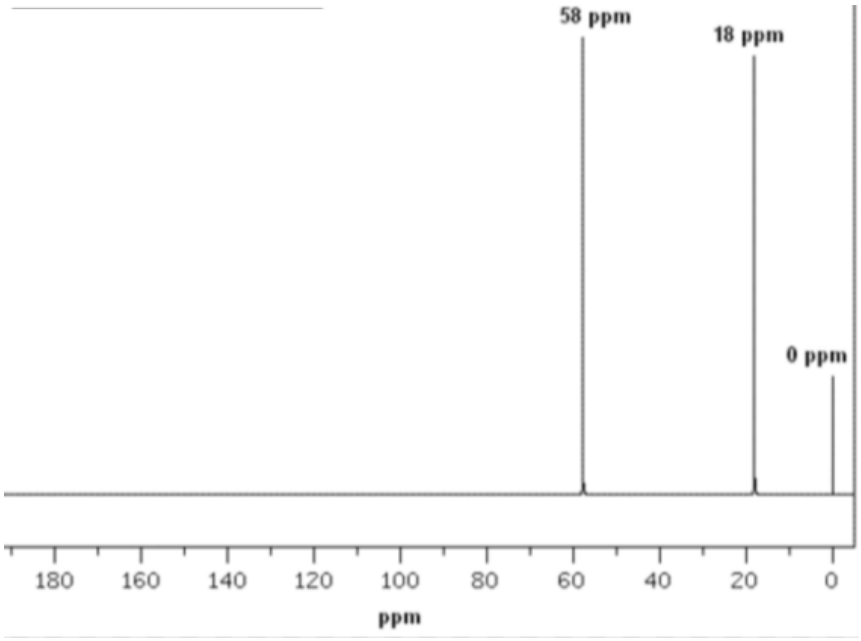
Ethanol can be oxidised in acid conditions.

d. i. Write the formula of a suitable oxidant for this reaction. _____ 1 mark

ii. Draw the molecule formed. 1 mark

The carbon NMR for ethanol is drawn below.

e.



Refer to your data book to explain clearly which part of the ethanol molecule has caused each peak on the NMR. 2 marks

_____

_____

Question 5 (5 marks)

a. But-1-ene can be used to form a polymer, polybut-1-ene.

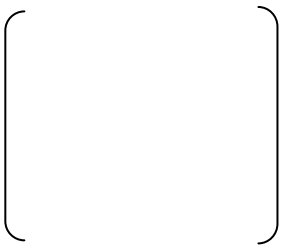
i. Use the space provided below to draw but-1-ene and the repeating unit in the polymer that can be formed from it. 2 marks

but-1-ene → [ ]n

ii. What type of polymerization is this? _____ 1 mark

SECTION B – Question 5 - continued

b. But-2-ene can also form a polymer, polybut-2-ene.
Use the space provided to draw but-2-ene and the repeating unit in the polymer that can be formed from it. 2 marks

but-2-ene   n

Question 6 (7 marks)

The table below contains the molecular formulas of six different organic molecules. Use these formulas to answer the questions below.

A	B	C	D	E	F
$C_4H_7O_4N$	$C_{19}H_{38}O_2$	$C_{12}H_{22}O_{11}$	C_6H_6	$C_3H_8O_3$	$C_{18}H_{32}O_2$

a. Which molecule is sucrose? _____ 1 mark

b. **i**. Which molecule is benzene? _____ 1 mark

ii. Write a balanced equation for the complete combustion of benzene. 1 mark

_____

c. Give the name of the amino acid included on this list. _____ 1 mark

d. Give the name of the molecule that can form ester links with three molecules of oleic acid. 1 mark

_____

e. One of the molecules is a biodiesel molecule.
Name the fatty acid used to produce this molecule. _____ 1 mark

f. One of the molecules is an unsaturated fatty acid. Name this acid. 1 mark

_____

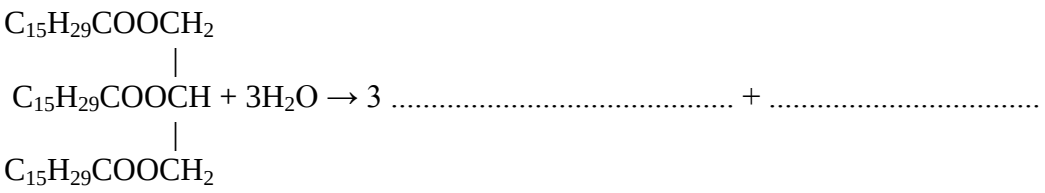
SECTION B – continued

TURN OVER

Question 7 (9 marks)

The slowing down of chemical processes is important in food storage. Over time, fats may become rancid. This involves the formation of compounds that have unpleasant odours and flavours within the food. Hydrolysis of fats is one way in which rancid flavours are formed. Fats break down to long-chain carboxylic (fatty) acids and glycerol.

a. Complete the right-hand side of the equation below to show how hydrolysis affects the molecule of fat shown.



2 marks

b. Other than by cooling, suggest one method that would decrease the rate of hydrolysis of fats.

1 mark

_____

_____

c. Food can also acquire unpleasant flavours when the fatty acids, produced by hydrolysis of fats, are oxidised by air. This oxidation occurs by a free-radical mechanism. Chemicals called anti-oxidants can be added to food to slow down the oxidation. Suggest why anti-oxidants are not regarded as catalysts.

2 marks

_____

_____

_____

d. A student investigated the extent of hydrolysis in an old sample of the fat in part (a). The carboxylic acid extracted from a 3.21 g sample of this fat reacted with 19.4 mL of a 0.130 mol/L solution of NaOH. Calculate the percentage of the fat that had hydrolysed. Show your working.

4 marks

_____

_____

_____

_____

_____

Question 8 (9 marks)

The addition of potassium thiocyanate, KSCN to iron(III) solutions leads to the formation of an intense red colour. The reaction producing this red colour is a reversible reaction between Fe^{3+} and SCN^-;

$$Fe^{3+}(aq) + SCN^-(aq) \rightleftarrows \underset{\text{red}}{FeSCN^{2-}(aq)} \qquad \Delta H = +122 \text{ J mol}^{-1}$$

For each of the following changes to a system at equilibrium, state the impact upon the intensity of red, the numerical value of K and the concentration of Fe^{3+}. (The concentration of $[Fe^{3+}]$ before the change is to be compared with the $[Fe^{3+}]$ after equilibrium is re-established.)

a. Increase in temperature 3 marks

Impact upon K	
Impact on red intensity	
Impact on $[Fe^{3+}]$	

b. Addition of a few drops of the highly soluble $Fe(NO_3)_3$. 3 marks

Impact upon K	
Impact on red intensity	
Impact on $[Fe^{3+}]$	

c. Addition of water to double the volume. 3 marks

Impact upon K	
Impact on red intensity	
Impact on $[Fe^{3+}]$	

SECTION B – continued

TURN OVER

Question 9 (7 marks)

A series of experiments are performed between calcium carbonate and hydrochloric acid. The data is shown in the table below.

Experiment	$CaCO_3$ mass (g)	HCl	Temperature (^oC)
1	1.00	20 mL of 1.0 M	25
2	1.00	20 mL of 2.0 M	25
3	1.00	20 mL of 2.0 M	50

a. For experiment 1, calculate the volume of carbon dioxide that will be released at SLC.

3 marks

_____

_____

_____

b. The production of carbon dioxide in experiment 1 is shown on the graph below.

i. Use collision theory to explain why the graph has this shape. 2 marks

_____

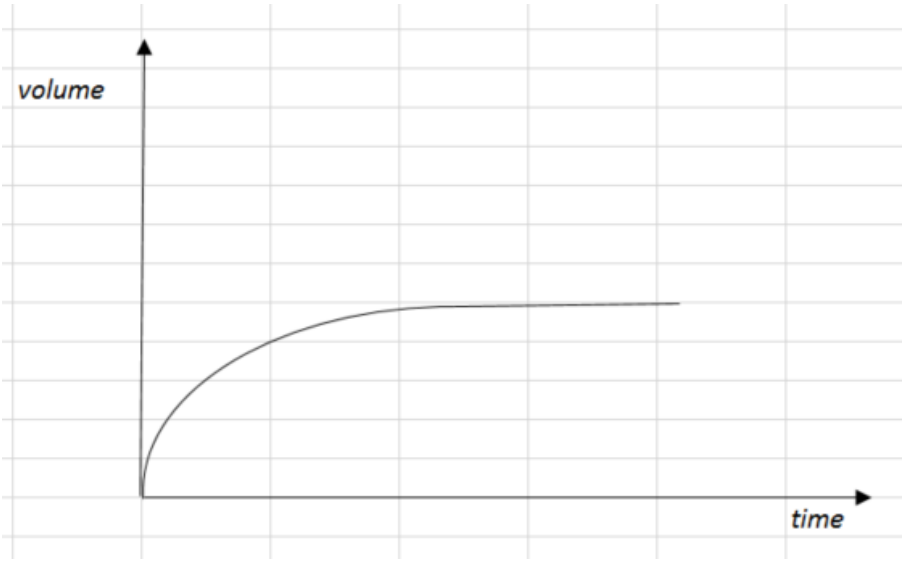
ii. Draw on the same graph, the rate of production of carbon dioxide in experiment 2.

1 mark

SECTION B – Question 9 - continued

c. Draw on the axes below the rate of production of carbon dioxide in experiment 3.

1 mark

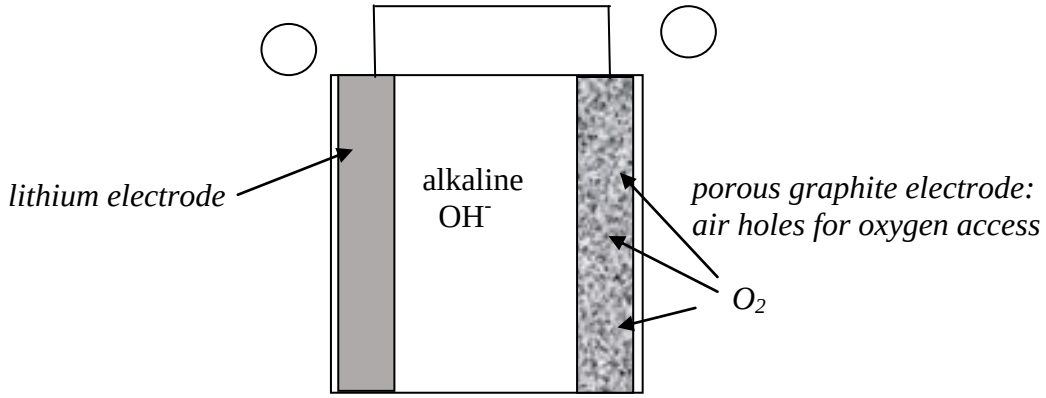


SECTION B – continued

TURN OVER

Question 10 (7 marks)

The development of electric vehicles has sparked considerable interest in new battery technologies. One type of cell offering significant potential is the lithium-air cell. It offers the possibility of high energy density as the voltage produced is large and mass of the battery is low. An outline of the cell is shown below



a. The two reactants in this cell are lithium and oxygen. Use the electrochemical series to write half equations and an overall equation for the reactions occurring. 3 marks

Anode: _____

Cathode: _____

Overall: _____

b. **i**. Use the circles provided to indicate the polarity of the electrodes. 1 mark

ii. Use an arrow to indicate the direction of electron flow. 1 mark

c. This cell is rechargeable. 1 mark

i. Write an equation for the reaction occurring when the cell is recharging.

_____

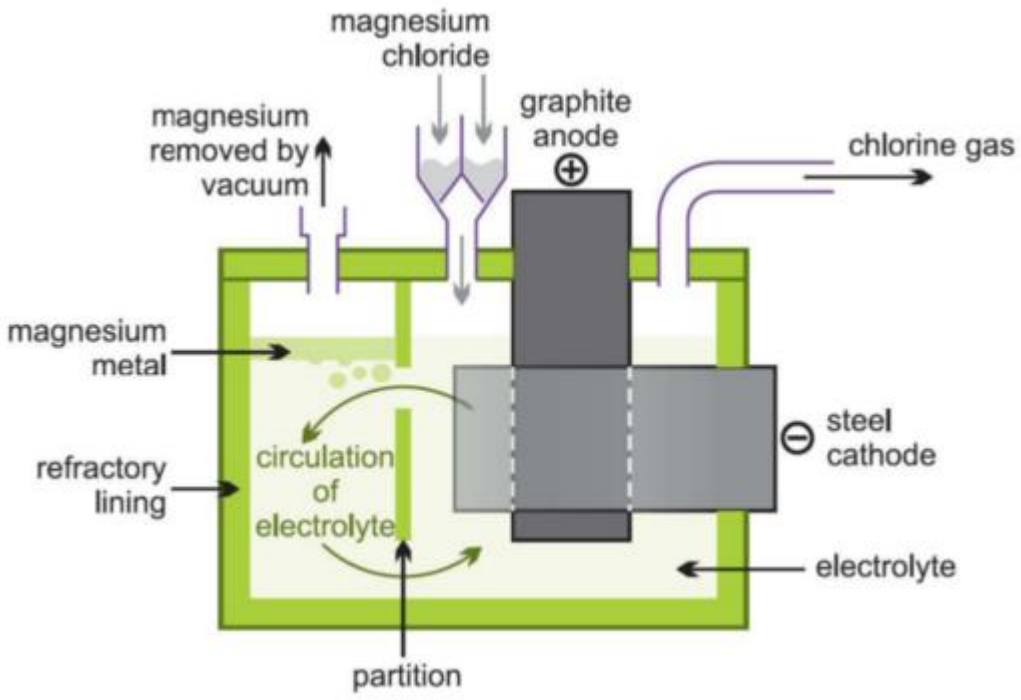
ii. Which electrode is the anode during the recharging process? 1 mark

_____

SECTION B – continued

Question 11 (10 marks)

Magnesium is produced on a large scale using electrolysis. The raw material added to the cell is molten magnesium chloride, $MgCl_2$. The steel cathode in the diagram is a cylindrical one, surrounding the graphite anode in the middle.



a. This cell uses a molten solution of $MgCl_2$.

i. Explain what a molten solution is? 1 mark

_____

_____

ii. What would the products be at each electrode if an aqueous solution of $MgCl_2$ was used? 2 marks

Anode: _____

Cathode: _____

iii. Give one reason why the use of a molten solution is more expensive than an aqueous solution. 1 mark

_____

SECTION B – Question 11 – continued

TURN OVER

b. Write half-equations for the reactions occurring in this cell.
Anode: _____ 2 marks

Cathode: _____

c. A current of 2500 amps is used in this cell. How long does it take for the manufacturer to produce 1.00 tonne of magnesium? 4 marks

_____

_____

_____

END OF QUESTION AND ANSWER BOOK