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2018 Trial Examination

	STUDENT NUMBER								Letter
Figures									
Words									

CHEMISTRY

Units 3&4 - Written examination

Reading time: 15 minutes
Writing time: 2 hour 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	10	10	100
			Total 130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, VCAA approved data book and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 22 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 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
Which of the following could represent the composition of a sample of biogas?
A. 92% methane, 6% ethane, 2% propane
B. 68% methane, 32% ethane
C. 68% methane, 32% nitrogen
D. 68% methane, 28% carbon dioxide, 3% nitrogen, 1% hydrogen

Use the following information to answer Questions 2 and 3
The complete combustion of 0.50 mole of a hydrocarbon fuel produces 2.0 mole of carbon dioxide gas. The carbon dioxide is stored at 35 ^{0}C and 100 kPa.

Question 2
The fuel could be
A. methane
B. ethane
C. butane
D. octane

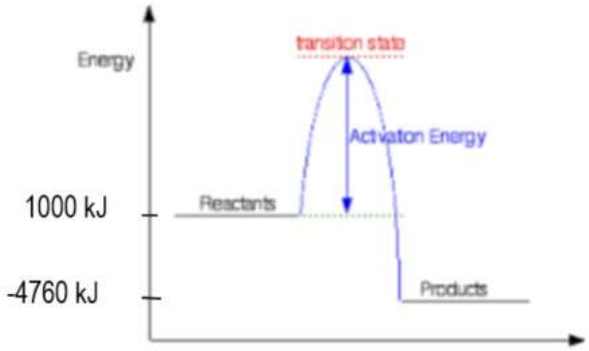
Question 3
The volume of the CO_2 gas will be, in L,
A. 4.3
B. 17
C. 51
D. 67

Question 4
Which of the following fuel samples can release the most energy?
A. 10 g of octane
B. 9 g of butane
C. 8 g of methane
D. 0.2 mole of ethanol

Question 5
A piece of zinc is dropped into a solution of hydrochloric acid. As the reaction proceeds,
A. the pH of the solution will increase but will not rise above 7.
B. the pH of the solution will decrease as the acid is being used up.
C. the frequency of collisions will increase as more product molecules are formed.
D. the rate of reaction will increase as the activation energy for the reaction drops.

SECTION A – continued

Question 6
The energy profile diagram of a thermochemical equation for the combustion of a common fuel is shown below



The fuel is likely to be
A. methane
B. butane
C. octane
D. ethanol

Question 7
The decomposition of nitrogen dioxide is an endothermic, reversible reaction.

$2NO_2(g) \rightleftarrows 2NO(g) + O_2(g) \qquad \Delta H = +ve$

A mixture of the above gases is at equilibrium.
Which option lists only changes that will increase the concentration of NO?
A. addition of a catalyst, increase in volume and addition of oxygen
B. decrease in temperature, decrease in volume and removal of some oxygen
C. increase in temperature, increase in volume and removal of some oxygen
D. increase in temperature, decrease in volume and removal of some oxygen gas

Question 8
The equation for the reaction between hydrogen and iodine gases is

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

The value of K for this reaction at 800 ^{0}C is 2.4×10^3.

In an equilibrium mixture of these gases,
A. there will always be equal concentrations of hydrogen and iodine gases.
B. the concentration of HI will be much greater than the concentration of the reactants.
C. the concentration of HI will always be twice that of H_2.
D. the amounts of each species will be equal.

SECTION A – continued
TURN OVER

Question 9

The expression for K for a reaction is $K = \dfrac{[SO_2]^2[O_2]}{[SO_3]^2}$

The reverse reaction of the reaction shown in the equilibrium expression is

A. $2SO_3(g) \rightleftarrows 2SO_2(g) + O_2(g)$

B. $2SO_2(g) + O_2(g) \rightleftarrows 2SO_3(g)$

C. $SO_2(g) + O_2(g) \rightleftarrows SO_3(g)$

D. $2SO_3(g) + O_2(g) \rightleftarrows 2SO_2(g)$

Question 10

The overall equation for the reaction in a lithium/iron cell is

$FeS + 2Li \rightarrow Fe + Li_2S$

In this cell

A. the sulfur ions are reduced and the lithium ions oxidised.
B. the sulfur ions are oxidised and the iron ions reduced.
C. the iron ions are the oxidant while lithium metal is oxidised.
D. both sulfur ions and iron ions are reduced.

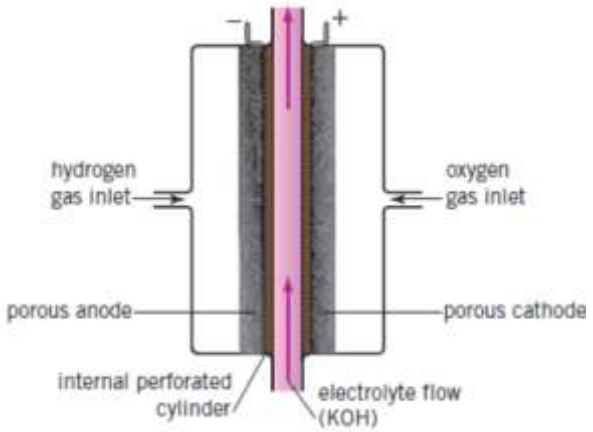
Question 11

Metal A will react when added to a solution of $AgNO_3$
Metal A will react when added to a solution of $Pb(NO_3)_2$
Metal A will not react when added to a solution of $Al(NO_3)_3$
Metal A will react when added to a solution of $NiSO_4$
Metal A could be

A. gold
B. tin
C. manganese
D. sodium

Use the following information to answer Questions 12 and 13

The sketch below is of a galvanic cell.



SECTION A – continued

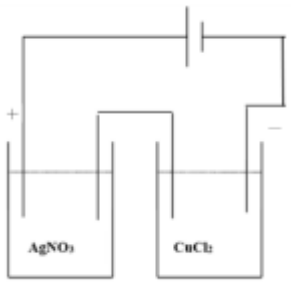
Question 12
In this cell
A. hydrogen will be oxidised releasing electrons to reduce oxygen gas.
B. hydrogen ions will be reduced by electrons released by the oxygen gas.
C. oxygen ions will be oxidised and hydrogen ions reduced.
D. oxygen gas is oxidised releasing electrons to reduce hydrogen gas.

Question 13
The half-equation for the reaction occurring at the anode will be
A. $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e$
B. $2H^+(aq) + 2e \rightarrow H_2(g)$
C. $O_2(g) + 2H_2O(l) + 4e \rightarrow 4OH^-(aq)$
D. $O_2(g) + 4H^+(aq) + 4e \rightarrow 2H_2O(l)$

Question 14
Electrolysis of an aqueous ionic solution produces a clear gas at the anode and a deposit on the cathode. The solution is likely to be
A. 4.0 M NaCl(aq)
B. dilute $CuBr_2(aq)$
C. dilute $MgBr_2(aq)$
D. dilute $CuCl_2(aq)$

Use the following information to answer Questions 15 and 16

Dilute solutions of silver nitrate and copper chloride are connected through electrical leads and inert electrodes. A power supply is included in the circuit.

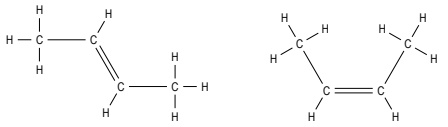
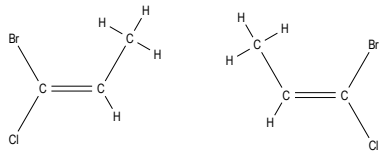
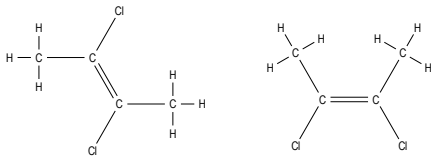
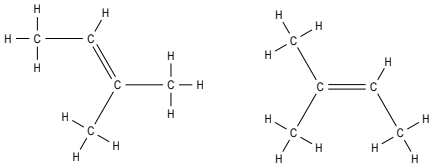


Question 15
A current is passed through the circuit that deposits 3.17 g of copper metal on the negative electrode. The mass of silver that would be deposited in the same time would be, in g,
A. 3.17
B. 5.4
C. 10.8
D. 21.6

SECTION A – continued
TURN OVER

Question 16
The total number of mole of gas evolved from this set-up will be
A. 0.025
B. 0.050
C. 0.10
D. 0.20

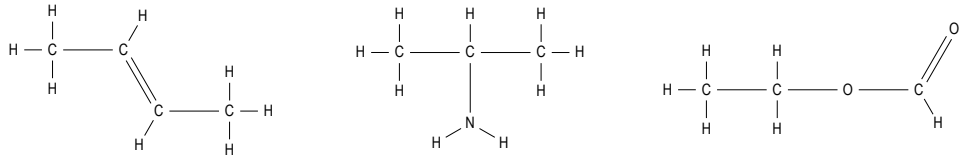
Question 17
MnO_4^- solution can be used to oxidise Fe^{2+} ions to Fe^{3+}. The MnO_4^- ions are reduced to Mn^{2+} ions in this reaction. The number of mole of Fe^{2+} reacting will equal
A. $5 \times n(MnO_4^-)$
B. $2 \times n(MnO_4^-)$
C. $n(MnO_4^-)$
D. $0.2 \times n(MnO_4^-)$

Question 18
Which alternative does NOT represent geometric isomers?
A. 
B. 
C. 
D. 

Question 19
Which of the following alcohols will not react with acidified $K_2Cr_2O_7$?
A. $(CH_3)_3COH$
B. $CH_3CH_2CH_2OH$
C. $CH_3CHOHCH_2CH_3$
D. $CH_2OHCH_2CH_2OH$

SECTION A – continued

Question 20

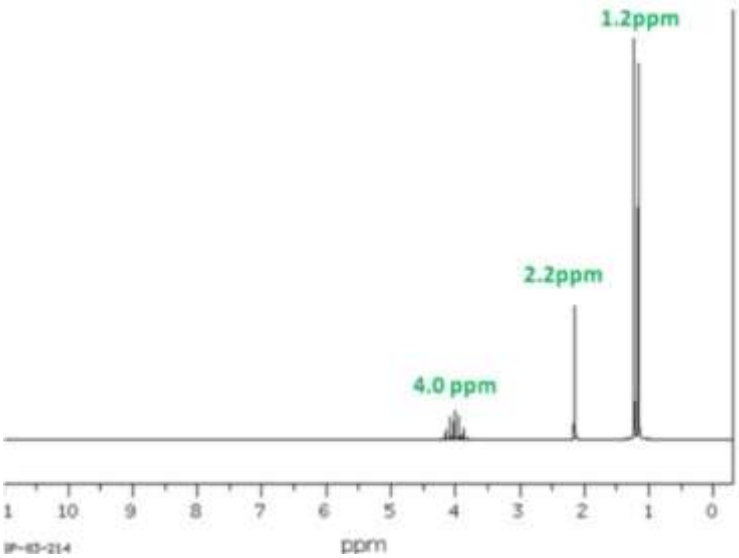


The systematic names for the three molecules above are, respectively,

A. but-1-ene, propan-2-amine and methylethanoate
B. but-2-ene, propan-2-amine and ethylmethanoate
C. but-2-ene, propan-2-amine and methylethanoate
D. but-2-ene, propan-1-amine and propanoic acid

Question 21

The spectrum below is a high resolution proton-NMR spectrum for an organic molecule.

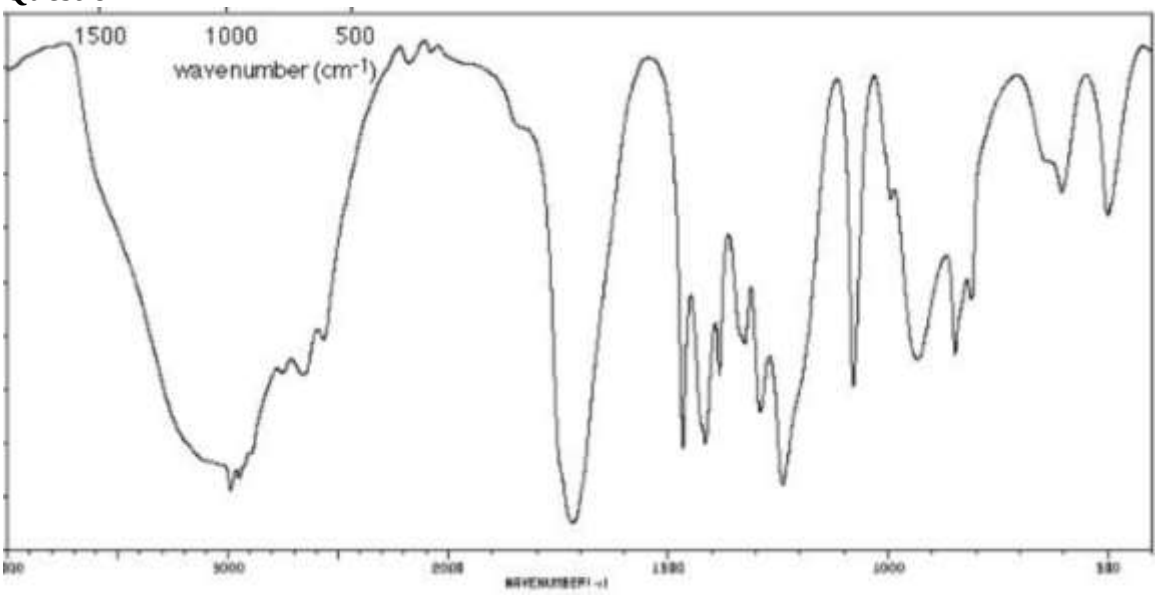


The spectrum shown is most likely to be that of

A. propan-1-ol
B. propan-2-ol
C. propanoic acid
D. methyl ethanoate

SECTION A – continued
TURN OVER

Question 22

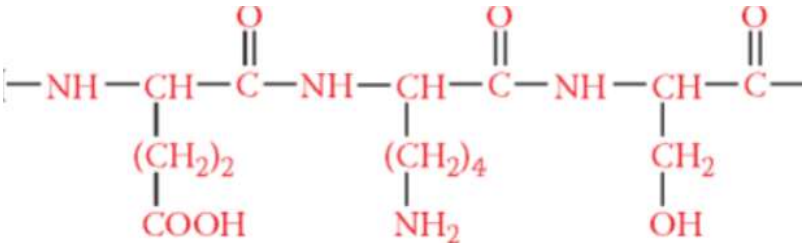


The infrared spectrum shown could belong to

A. propan-1-ol
B. propanal
C. methyl ethanoate
D. propanoic acid

Question 23

A segment of a protein chain is shown below.

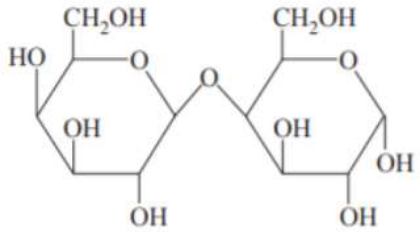


The amino acids in this segement are, respectively

A. aspartic acid, asparagine and lysine
B. glutamic acid, asparagine and lysine
C. glutamic acid, lysine and serine
D. aspartic acid, lysine and serine

SECTION A – continued

Question 24
The carbohydrate shown below is often part of our diets.



Select the correct statement about this molecule.
A. Lactase can hydrolyse this molecule to the monosaccharides glucose and galactose.
B. Lactose can hydrolyse this molecule to the disaccharides glucose and galactose.
C. Maltase can hydrolyse this molecule to two molecules of glucose.
D. Invertase can hydrolyse this molecule to glucose and fructose.

Question 25
Basmati rice has a lower GI value than other forms of rice. A possible explanation for this is that the
A. basmati has a higher cellulose percentage than most forms of rice.
B. human body does not have a suitable enzyme to hydrolyse basmati rice.
C. basmati has a higher percentage of amylose starch than most forms of rice.
D. basmati has a higher percentage of amylopectin starch than most forms of rice.

Question 26
Vitamin D is a molecule with a complex structure. It contains one –OH bond. Vitamin D
A. will be soluble in fat but needs to be consumed regularly to maintain levels.
B. will be soluble in fat and can be stored in the body for long periods.
C. will be soluble in water and can be stored in the body for long periods.
D. will be soluble in water but needs to be consumed regularly to maintain levels.

Question 27
The amino acid that will form an alkaline solution when added to deionised water will be
A. arginine
B. glycine
C. isoleucine
D. cysteine

Question 28
The molar mass of a fatty acid that contains 18 carbon atoms is 282 g mol^{-1}. The fatty acid is
A. stearic acid
B. oleic acid
C. linoleic acid
D. arachidic acid

SECTION A – continued
TURN OVER

Use the following information to answer Questions 29 and 30

0.015 mole of ethanol undergoes complete combustion in a bomb calorimeter. The temperature of the calorimeter increases from 23.8 ^{0}C to 36.2 ^{0}C. A 1.4 g sample of biscuit is then burnt in the calorimeter and the temperature change is a further 4.8 ^{0}C

Question 29
The calibration factor of the calorimeter is, in J $^0C^{-1}$,
A. 1.65
B. 420
C. 840
D. 1650

Question 30
The heat of combustion of the biscuit is, in J g^{-1},
A. 1500
B. 5620
C. 7820
D. 8560

END OF SECTION A

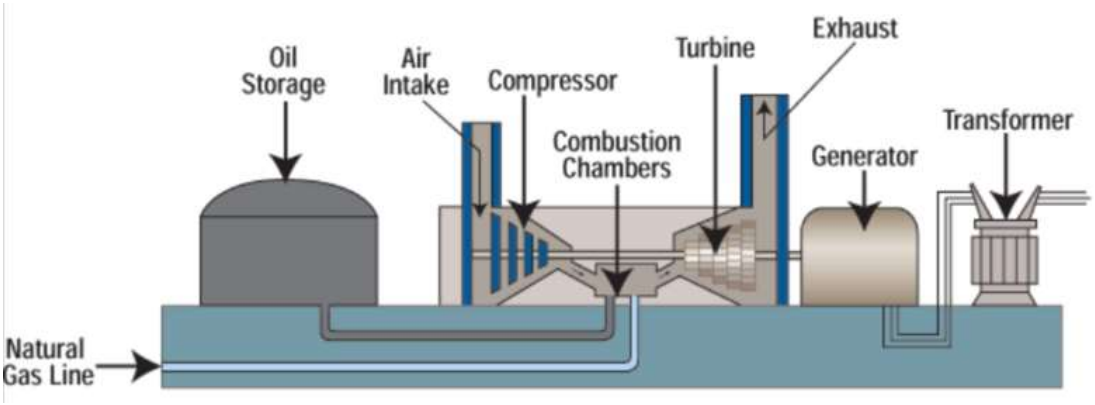
SECTION B – Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.
Write using blue or black pen.

- 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)
- Unless otherwise indicated, diagrams are not drawn to scale.

Question 1 (9 marks)
The diagram below shows an outline of a gas-fired power plant



a. Natural gas can be sourced in different ways.

i. Outline one method of obtaining natural gas in Australia.

_____

ii. Write a balanced equation for the complete combustion of methane in air.

_____

iii. Calculate the amount of energy that could be released from the complete combustion of 120,000 tonne of methane.

_____

1 + 1 + 1 = 3 marks

b. **i**. Explain the role of the compressor in the gas-fired power station.

_____

SECTION B – Question 1 –continued
TURN OVER

ii. Give two examples of energy transformations taking place in the above process.

_____

_____

iii. Calculate the volume of CO_2 that is formed from each mole of methane that reacts. Assume the pressure is 100 kPa and the temperature at the top of the tower is 84 ^{0}C.

_____

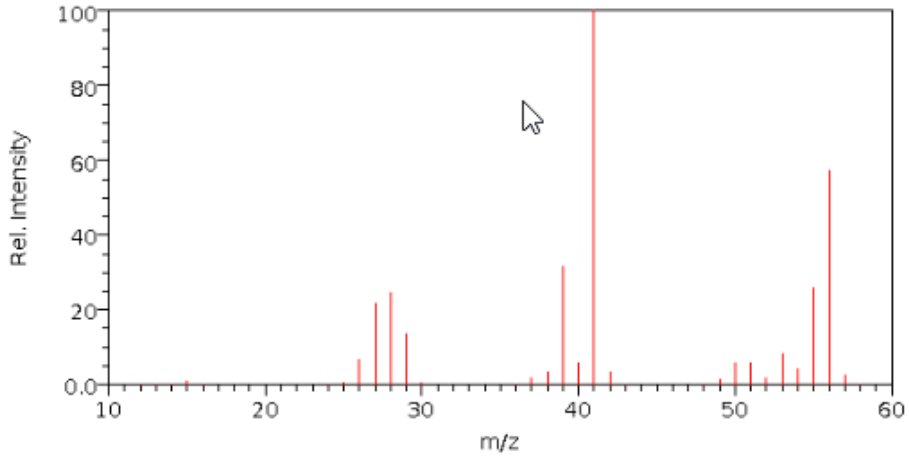
_____

1 + 2 + 3 = 6 marks

Question 2 (14 marks)

The empirical formula of a particular hydrocarbon is CH_2. The molecule is tested further to deduce its chemical structure.

a. The mass spectrum of the molecule is shown below.



i. What is the molar mass of the hydrocarbon? _____

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

iii. Suggest a fragment that is likely to have produced the base peak on this spectrum.

_____

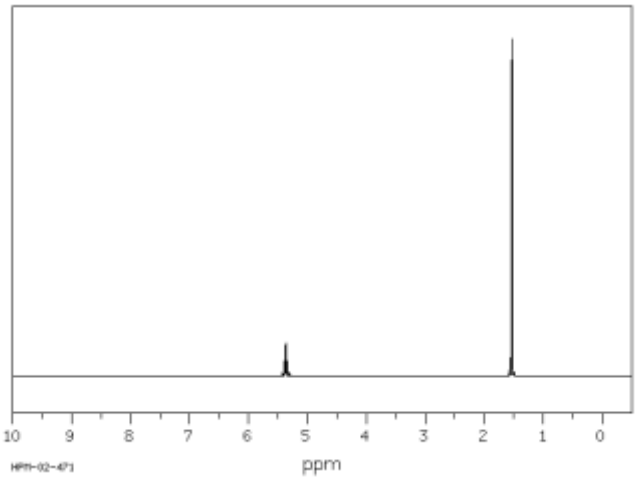
iv. Draw and name two possible structural isomers for this molecule.
(Assume the molecule is a straight chain hydrocarbon)

Structure 1: _____ Structure 2: _____

1 + 1 + 1 + 2 = 5 marks

SECTION B – Question 2 -continued

b. The proton-NMR of the molecule is shown below.



i. How many hydrogen environments does this molecule have? _____

ii. Name the molecule. Use the spectrum provided to justify your selection.

_____

_____

1 + 2 = 3 marks

c. This molecule can react with itself to form a polymer. Draw a section of the polymer that will form.

1 mark

d. This molecule has two geometric isomers.

i. What is a geometric isomer?

_____

ii. Draw and name the two possible geometric isomers.

Isomer 1: _____ Isomer 2: _____

1 + 2 = 3 marks

SECTION B – Question 2 –continued
TURN OVER

e. **i**. This molecule will show a positive result to a bromine test. Explain what a bromine test is.

_____

ii. Write a balanced equation using molecular formulea for the reaction of bromine with this molecule.

_____

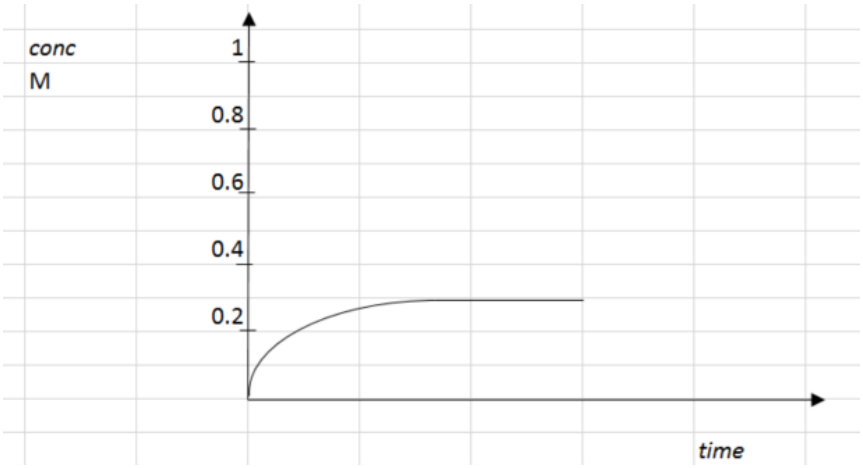
1 + 1 = 2 marks

Question 3 (11 marks)

Methanol has been produced for many years by a method referred to as the synthesis gas process. Carbon monoxide and hydrogen gas are the reactants.

$CO(g) + 2H_2(g) \rightleftarrows CH_3OH(g) \qquad \Delta H < 0$

A sample of carbon monoxide and hydrogen gases are added to an empty reactor at 450 ^{0}C and a reaction occurs. The concentration of the methanol formed is shown on the graph below.



a. The initial concentrations of both hydrogen and carbon monoxide are 0.80 M

i. Draw on the graph provided the concentration of both gases.

ii. Use the equilibrium concentrations from the graph to determine the value of *K* at 450 ^{0}C.

_____

_____

2 + 3 = 5 marks

b. At the three minute mark, the volume of the reactor is halved.
Add to the graph, the immediate change to the methanol concentration and the trend in how the concentration of methanol will change as the system re-establishes equilibrium.

1 + 1 = 2 marks

SECTION B – Question 3 –continued

c. The temperature of an equilibirum mixture of the above gases is increased. Explain the impact of this change on

i. the value of *K*.

_____

ii. the amount of methanol.

_____

1 + 1 = 2 marks

d. **i**. Write a balanced reaction for the complete combustion of methanol.

_____

ii. Calculate the energy released from the combustion of 1.0 tonne of methanol?

_____

1 + 1 = 2 marks

Question 4 (6 marks)

The use of lithium technology has revolutionised the use of batteries. An example is the lithium-thionyl chloride cell shown in the diagram that delivers a massive 3.6 Volts.

a. **i**. Give two reasons why lithium is popular in modern cells.

_____

_____

_____

ii. State one concern with the use of lithium cells.

_____

2 + 1 = 3 marks

b. The overall equation for the reaction occurring in the lithium-thionyl chloride cell is

$4Li + 2SOCl_2 \rightarrow 4LiCl + SO_2 + S$

i. Use the spaces provided to write the half-equations for the reactions occurring.

anode: _____

cathode: _____

SECTION B – Question 4 –continued
TURN OVER

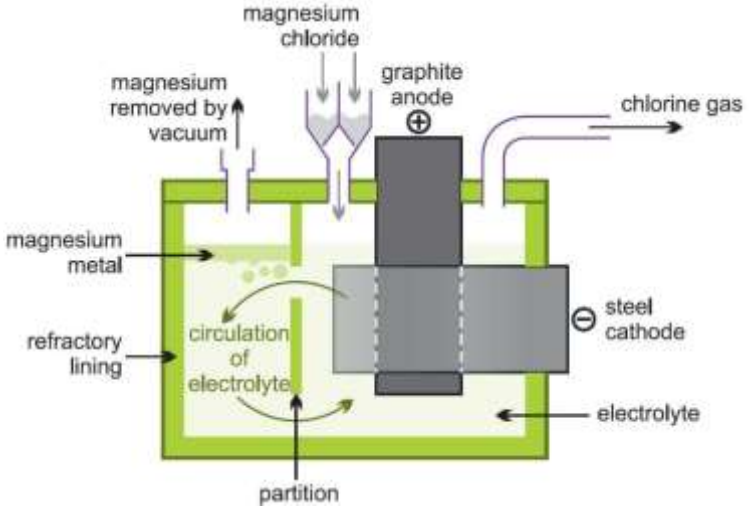
ii. What is the likely electrochemical potential of the thionyl chloride half-equation? _____

2 + 1 = 3 marks

Question 5 (11 marks)

The Dow process is a form of electrolysis used to manufacture reactive metals from molten ionic solutions. One of the metals this cell can be applied to is magnesium. The cell runs at 700 ^{0}C and uses an average current of 180 000 amps.

The feedstock used in this cell is 50% NaCl, 30% KCl and 20% $MgCl_2$. Graphite is used as an anode and it is consumed as part of the reactions occurring.



a. **i**. The electrolyte contains at least three different metals. Use data from the electrochemical series to explain why magnesium is formed at cathode rather than sodium or potassium.

_____

_____

ii. An aqueous solution of $MgCl_2$ cannot be used. Use half-equations to explain why not.

_____

_____

_____

2 + 2 = 4 marks

b. This is a dangerous chemical process. Give two reasons why it is dangerous.

_____

_____

2 marks

SECTION B – Question 5 –continued

c. Use the spaces provided to write the half-equations for this cell.

anode: _____ cathode: _____

2 marks

d. Calculate the mass of magnesium that can be produced in this cell each day.

_____

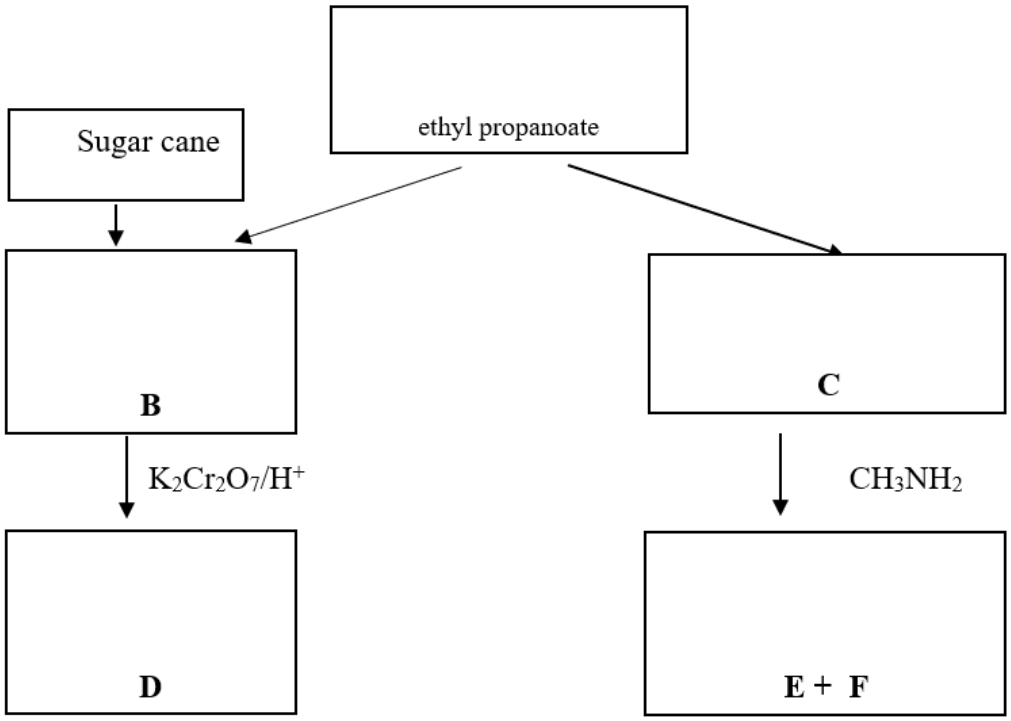
_____

_____

3 marks

Question 6 (10 marks)

Ethyl propanoate is an example of ester. The flowchart shown uses ethyl propanoate as a starting material. It is hydrolysed by gentle heating with KOH.



a. Use the box provided to draw the semi-structural formula for ethyl propanoate.

1 mark

SECTION B – Question 6 -continued
TURN OVER

b. **i**. Use the box provided to draw molecule B.

ii. Write a balanced equation for the formation of compound B from a component of sugar cane.

_____

iii. Use the box provided to draw molecule D.

1+ 1 + 1 = 3 marks

d. **i**. Use the box provided to draw molecule C.

ii. Use the box provided to draw molecules E and F

1 + 2 = 3 marks

e. A 5.0 mL sample of compound C reacts exactly with 25 mL of 0.50 M NaOH. Calculate the concentration of compound C.

_____

_____

3 marks

Question 7 (10 marks)

The formula of hydrogen peroxide is H_2O_2. It is not a highly stable molecule. Hydrogen peroxide is stored in a dark container and cool conditions to limit the rate at which it decomposes. Manganese dioxide, MnO_2 can be used as a catalyst to speed the decomposition up as can the enzyme catalase.

a. Use the electrochemical series to list the half-equations and overall equation occurring when H_2O_2 decomposes.

Oxidation half-equation: _____

Reduction half-equation: _____

Overall equation: _____

What is the oxidation state change of oxygen atoms in this reaction? _____

1 + 1 + + 1 = 4 marks

b. Draw and label an energy profile diagram to explain the impact of the addition of MnO_2 to a solution of hydrogen peroxide.

2 marks

SECTION B – Question 7 -continued

c. **i**. Which catalyst is likely to be the more effective at a temperature of 75 ^{0}C. Explain your answer.

_____

_____

ii. List two similarities between the action of the two catalysts.

_____

_____

2+ 2 = 4 marks

Question 8 (13 marks)

The structure of a particular biodiesel molecule is shown below.

$CH_3(CH_2)_7CH=CH(CH_2)_7COOCH_2CH_3$

a. This molecule was formed from the reaction between a fatty acid and an alcohol.

i. Name the fatty acid used _____

ii. Name the alcohol used _____

1 + 1 = 2 marks

b. **i**. How will the melting point of this biodiesel molecule compare with that of petrodiesel?

_____

ii. How will the viscosity of this biodiesel molecule compare to that of one formed from arachidic acid and the same alcohol. Explain your answer.

_____

_____

1 + 2 = 3 marks

c. A sample of this biodiesel molecule is hydrolysed and the fatty acid isolated. The fatty acid component is reacted with glycerol to form a triglyceride.

i. What is the molecular formula of the triglyceride that will form?

_____

ii. A person consumes 0.34 g of a sample of this triglyceride. Calculate the amount of energy
available to the person from this sample?

_____

SECTION B - Question 8 - continued

TURN OVER

iii. If the same amount of energy was released under a 150 g sample of water at 21.6 ^{0}C, what would the final temperature of the water be?

_____

2 + 1 + 2 = 5 marks

d. This biodiesel molecule can go rancid if it is not stored appropriately.

i. Suggest a likely point of the biodiesel molecule that rancidity will occur at.

_____

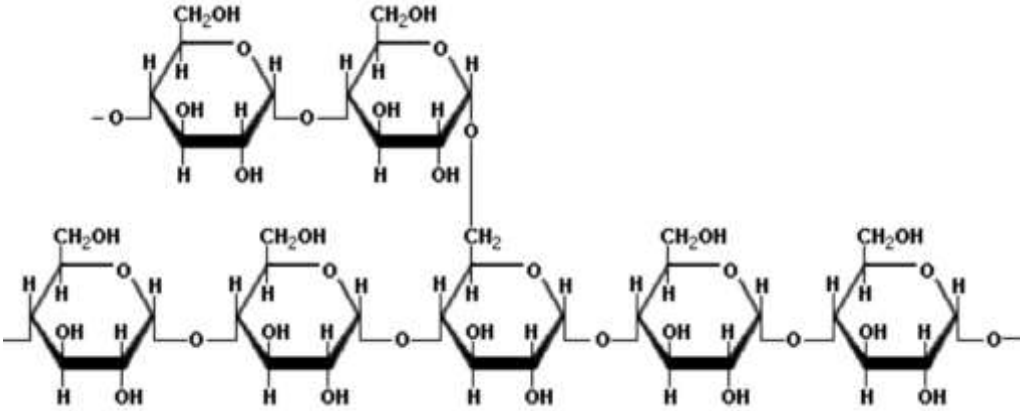
ii. List two storage factors that will help prevent the onset of rancidity.

_____

1 + 2 = 3 marks

Question 9 (7 marks)

A small section of a polysaccharide is shown below.



a. Describe the chemical features (building block, bonding present, relative solubility in water, ease of digestion in humans) of this substance.

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4 marks

b. Name two enzymes that play a role in the digestion of this substance in humans.

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2 marks

SECTION B – Question 9 - continued

c. This molecule is considered high GI. From a digestion point of view, what does this mean?

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1 mark

Question 10 (9 marks)

A student conducts an experiment to determine the ethanoic acid concentration in a commercial brand of vinegar. An outline of her procedure and her measurements are provided below.

230.0 mL deionised water added to a 250 mL volumetric flask
20.0 mL of vinegar added to the flask
20.00 mL aliquots added to flasks and titrated against 0.150 M NaOH.
Indicator used: methyl red
Titres obtained shown below

	Run 1	Run 2	Run 3	Run 4
Titre (mL)	23.9	22.1	22.0	21.9

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

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b. There are at least two significant issues with the procedure followed by the student. Identify two issues and explain, for each issue, why it is a problem. 4 marks

Issue	Why is it a problem?

c. Use concordant titres to determine the concentration of the ethanoic acid in the undiluted vinegar. 4 marks

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END OF QUESTION AND ANSWER BOOK