Neap

VCE Chemistry Units 3&4

Question and Answer Booklet

2024 Trial Examination

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

Student's Name: _____

Teacher's Name: _____

Materials supplied

- Question and Answer Booklet of 32 pages
- Data Booklet
- Multiple-Choice Answer Sheet

Instructions

- Write **your name** and your **teacher's name** in the spaces above on this page.
- Follow the instructions on your Multiple-Choice Answer Sheet.
- At the end of the examination, place your Multiple-Choice Answer Sheet inside the front cover of this booklet.

Students are **not** permitted to bring mobile phones and/or any unauthorised electronic devices into the examination room.

Contents pages

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2024 VCE Chemistry Units 3&4 Examination.

Section A – Multiple-choice questions

Instructions

- Answer **all** questions in pencil on the Multiple-Choice Answer Sheet.
- Choose the response that is **correct** or that **best answers** the question.
- A correct answer scores 1; an incorrect answer scores 0.
- Marks will **not** be deducted for incorrect answers.
- No marks will be given if more than one answer is completed for any question.
- Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1

Denaturation of a protein can result from

A. increased temperature only.

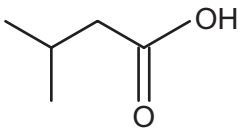
B. changes in pH only.

C. decreased temperature only.

D. increased temperature or changes in pH.

Question 2

The skeletal structure of a compound is shown below.



What is the relative molecular mass of the compound?

A. 60

B. 92

C. 102

D. 106

Use the following information to answer Questions 3 and 4.

The equation for a reaction is as follows.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

At 1000°C, the equilibrium constant, *K*, for the reaction is 1.75 M^{-1}.

Question 3

What is the equilibrium constant at 1000°C for the reaction $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$?

A. 0.756

B. 0.875

C. 1.32

D. 1.75

Question 4

At 900°C, the equilibrium constant for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is greater than 1.75 M^{-1}.

It can be concluded that this reaction is

A. endothermic and so the enthalpy change is positive.

B. endothermic and so the enthalpy change is negative.

C. exothermic and so the enthalpy change is positive.

D. exothermic and so the enthalpy change is negative.

Question 5

Which of the following levels of enzyme structure can be altered during an enzyme-catalysed reaction?

A. primary and secondary structures only

B. secondary structure only

C. tertiary structure only

D. primary, secondary and tertiary structures

Question 6

Which one of the following **cannot** be predicted for an equilibrium reaction using Le Chatelier's principle?

A. the change in the rate of reaction when a catalyst is added to an equilibrium mixture

B. the effect on the concentration of products when a component of the reaction is added

C. the movement in the position of equilibrium when an exothermic reaction is heated

D. the effect that an increase in pressure will have on a gaseous equilibrium reaction

Question 7

A student conducted an experiment using ethanol in a 20 mL test tube. The results are shown in the table below.

Condition	Observation
The ethanol was gently heated.	The ethanol vaporised.
The ethanol was ignited.	A combustion reaction occurred.

The student wished to repeat the experiment to increase the rate of the combustion reaction. They proposed that any one of the following changes would increase the reaction rate.

I using a 50 mL beaker instead of the 20 mL test tube

II halving the volume of ethanol in the 20 mL test tube

III adding water to the 20 mL test tube in order to double the volume of ethanol

IV heating the ethanol to a higher temperature before ignition

Which of these changes would result in an increase in the rate of the combustion reaction?

A. I, II and III only

B. I and IV only

C. II and IV only

D. II, III and IV only

Question 8

A student electroplated a house key with chromium using an electrolytic cell with an aqueous electrolyte.

During the electrolysis,

A. the house key would have been the positive electrode and the site of reduction.

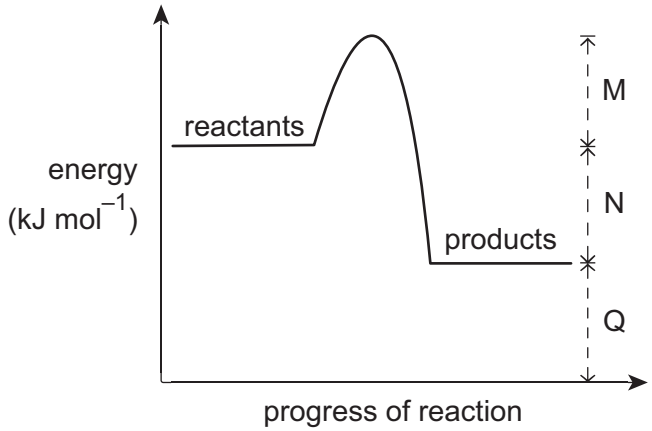
B. hydrogen gas would have been produced at the anode during oxidation.

C. a chromium block would have been used as the electrode where oxidation occurred.

D. chromium ions would have been the reducing agents and water molecules would have been the oxidising agents.

Use the following information to answer Questions 9 and 10.

The energy profile diagram for a reaction is shown below. The letters M, N and Q represent certain amounts of energy.



For the forward reaction, the enthalpy of the products is 50 kJ mol^{-1}, the activation energy, E_a, is 30 kJ mol^{-1}, and the enthalpy change, ΔH, is –60 kJ mol^{-1}.

Question 9

Which one of the following equations is correct?

A. N + Q = –30 kJ mol^{-1}

B. M + N = 80 kJ mol^{-1}

C. M + N + Q = 20 kJ mol^{-1}

D. M + N + Q = 140 kJ mol^{-1}

Question 10

Which one of the following correctly states the enthalpy change, ΔH, and activation energy, E_a, for the reverse reaction?

	ΔH (kJ mol^{-1})	E_a (kJ mol^{-1})
A.	+60	–30
B.	+60	+90
C.	+80	+90
D.	+80	+140

Question 11

The following statements relate to electrochemical cells.

I Electrons are released during oxidation at the positive electrode.

II The electrodes are never consumed in the cell reaction.

III The reactants are positioned outside the cell.

IV The stored energy of the products is less than the stored energy of the reactants.

V Both the oxidising agent and the reducing agent are in contact with the electrodes.

Which of these statements are true for fuel cells but not for galvanic cells?

A. I and II only

B. II and III only

C. IV and V only

D. II, III and V only

Use the following information to answer Questions 12 and 13.

The compound with the molecular formula C_4H_9Cl has several isomers.

Question 12

How many isomers does this compound have?

A. 2

B. 3

C. 4

D. 5

Question 13

Only one of the compound's isomers has a chiral centre.

What would be the peak area ratio on the ^1H NMR spectrum for this isomer?

A. 3 : 2 : 1 : 3

B. 3 : 2 : 2 : 3

C. 3 : 2 : 1 : 2

D. 3 : 2 : 2 : 2

Question 14

Systematic errors in an experiment

A. can be minimised by repeating the same experiment numerous times.

B. are not consistent, repeatable errors but are usually due to environmental fluctuations.

C. can be associated with flaws in experimental method or design.

D. can be eliminated by taking an average of all experimental readings and data.

Use the following information to answer Questions 15 and 16.

Under standard laboratory conditions (SLC), an electrolytic cell was set up using two inert metal electrodes and 500 mL of electroplating solution as the aqueous electrolyte. Various 1 M solutions underwent electrolysis separately for 90 minutes each at 2.5 A.

Question 15

Which one of the following electrolytes would deposit the smallest mass of metal onto one of the inert electrodes?

A. $AgNO_3(aq)$

B. $Fe(NO_3)_2(aq)$

C. $Pb(NO_3)_2(aq)$

D. $Zn(NO_3)_2(aq)$

Question 16

The experiment was repeated using 1 M $Al(NO_3)_3(aq)$ as the electrolyte. All other conditions were kept the same.

Which one of the following statements is correct?

A. 1.4 g of aluminium metal would have been deposited on one of the inert electrodes.

B. 4.1 g of aluminium metal would have been deposited on one of the inert electrodes.

C. No aluminium metal would have been deposited as aluminium is a weaker reducing agent than water.

D. No aluminium metal would have been deposited as the aluminium ion, $Al^{3+}(aq)$, is a weaker oxidising agent than water.

Question 17

How many peaks would be observed in the ^{13}C NMR spectrum of 2-methylbutan-1-ol?

A. 2

B. 3

C. 4

D. 5

Question 18

When 16.21 C of charge was passed through a molten manganese chloride sample, 0.462 g of manganese was formed.

What was the charge of the manganese ions in the manganese chloride sample?

A. +1

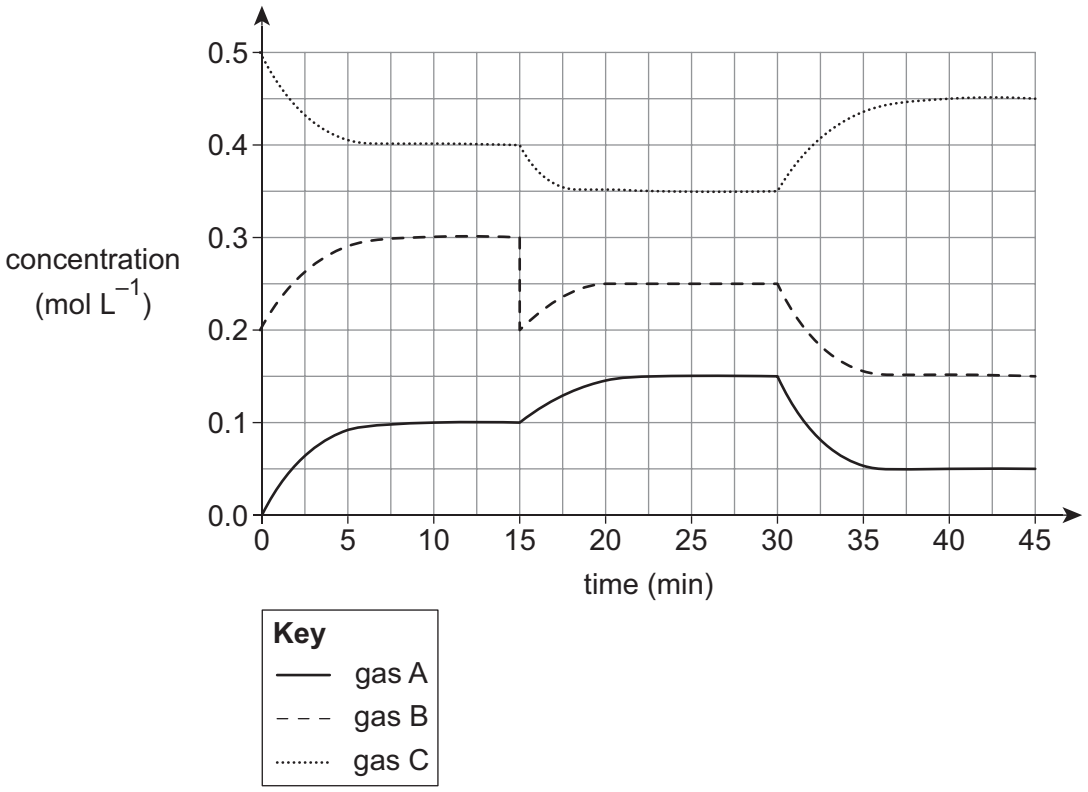
B. +2

C. +3

D. +4

Use the following information to answer Questions 19–21.

An experiment was conducted using gases A, B and C in a sealed container. The graph below shows the results.



Question 19

What is the equilibrium constant, *K*, for the reaction at 25 minutes?

A. 0.11 M

B. 0.34 M

C. 3.4 M

D. 9.0 M

Question 20

Which one of the following correctly identifies the changes made to the equilibrium mixture at 15 minutes and 30 minutes?

	Change made at 15 minutes	Change made at 30 minutes
A.	The volume of the container was reduced.	A catalyst was introduced.
B.	Some of gas B was removed.	The temperature was changed.
C.	The temperature was increased.	More of gas C was injected into the container.
D.	A catalyst was introduced.	The equilibrium mixture was compressed.

Question 21

A student made the following statements about the experiment.

I Based on the graph, only one equilibrium constant value can be determined.

II Between 10 and 15 minutes, no new product molecules are formed.

III The results of the experiment indicate that the reaction is endothermic.

It can be concluded that

A. only statements I and II are correct.

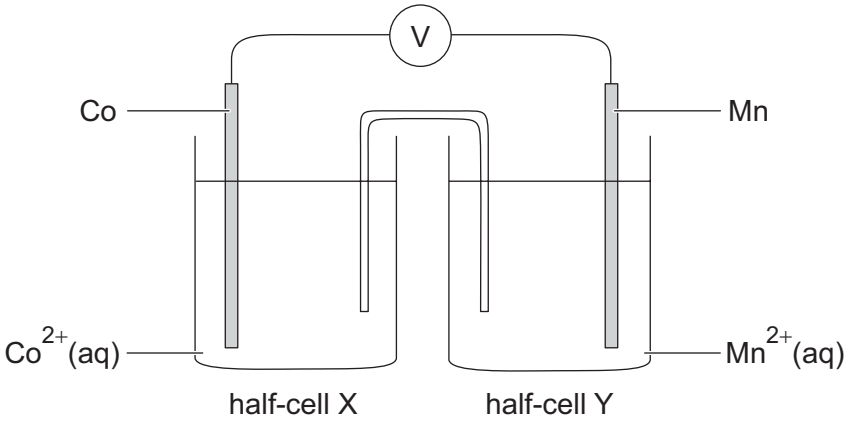
B. only statements II and III are correct.

C. all of the student's conclusions are correct.

D. none of the student's conclusions are correct.

Use the following information to answer Questions 22 and 23.

Consider the following galvanic cell.



Half-cell Y is to be replaced with a half-cell of another metal and its conjugate ion. The possible metals are copper, zinc, lead and aluminium.

Question 22

Which of the following metals could be used in the new galvanic cell so that the cobalt (Co) electrode is the cathode?

A. copper or zinc

B. zinc or aluminium

C. copper, lead or aluminium

D. lead or aluminium

Question 23

Which metal would produce the highest cell voltage in the new galvanic cell under standard laboratory conditions (SLC)?

A. copper

B. zinc

C. lead

D. aluminium

Question 24

An equimolar molten mixture of magnesium chloride, $MgCl_2$, and calcium fluoride, CaF_2, underwent electrolysis.

Which one of the following shows the most likely product formed at each electrode?

	Product at cathode	Product at anode
A.	magnesium metal	chlorine gas
B.	chlorine gas	magnesium metal
C.	calcium metal	fluorine gas
D.	fluorine gas	calcium metal

Use the following information to answer Questions 25 and 26.

The following equation shows the reaction that was used in a redox titration to determine the mass of vitamin C, $C_6H_8O_6$, in a sports drink.

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

The following data was obtained.

Mass of sports drink used in the titration	3.87 g
Concentration of iodine solution, I_2(aq), in the burette	3.47×10^{-4} M
Titre volume	17.8 mL
Molar mass of vitamin C	176 g mol^{-1}

Question 25

What mass of vitamin C was in 3.87 g of the sports drink?

A. 6.18×10^{-6} g

B. 1.09×10^{-3} g

C. 6.18×10^{-3} g

D. 0.109 g

Question 26

Which one of the following statements is correct?

A. Repeating the experiment several times and using the average titre in calculations would reduce the precision of the experiment's results.

B. Rinsing any burettes and pipettes with water only would improve the accuracy of the experiment's results.

C. Ensuring that the experimenter's eye is level with the meniscus when reading volumes in the burette would reduce the precision of the experiment's results.

D. Using an iodine solution that is twice as concentrated as the original iodine solution would reduce the accuracy of the experiment's results.

Question 27

A particular solution calorimeter has a calibration factor of 600 J °C^{-1} for the calorimeter and 100 mL of water. When 50.0 mL of 1.00 M hydrochloric acid solution, HCl(aq), and 50.0 mL of 1.00 M sodium hydroxide solution, NaOH(aq), were mixed into the solution calorimeter, a reaction occurred according to the following equation.

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l) \qquad \Delta H = -57.25 \text{ kJ}$$

If the temperature of the reactants was 18°C before mixing, what was the highest temperature reached by the mixture?

A. 19°C

B. 23°C

C. 28°C

D. 35°C

Question 28

Linolenic acid, oleic acid, linoleic acid and stearic acid are all fatty acids that have 17 carbon atoms per molecule.

Which one of these acids has the lowest melting point?

A. linolenic

B. oleic

C. linoleic

D. stearic

Question 29

A group of students are conducting an experiment to investigate the amount of alcohol produced by the fermentation of yeast when supplied with different amounts of glucose. They are planning to record their results in a graph.

The horizontal axis of the graph should show the amount of

A. alcohol produced because it is the independent variable.

B. alcohol produced because it is the dependent variable.

C. glucose supplied because it is the independent variable.

D. glucose supplied because it is the dependent variable.

Question 30

A particular medicine is an organic compound that functions as a competitive enzyme inhibitor.

This means that

A. a molecule of the medicine combines with a specific normal substrate compound to prevent the substrate from binding to the complementary active site of an enzyme.

B. the active site of a specific enzyme is permanently destroyed after colliding with a molecule of the medicine.

C. the active site of a specific enzyme bonds with a molecule of the medicine, which prevents a specific substrate from interacting normally with the enzyme.

D. the molecules of the medicine are enzymes that hydrolyse a specific substrate compound, preventing the substrate from participating in a chemical reaction.

End of Section A

Section B

Instructions

- Answer **all** questions in the spaces provided.
- Write your responses in English.
- Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.
- Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.
- Ensure 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, the diagrams in this booklet are **not** drawn to scale.

Question 1 (7 marks)

An experiment was conducted to investigate the equilibrium reaction represented by the following equation.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H \text{ is positive.}$$

The experiment used a 2.00 L vessel and was conducted at 25°C. At equilibrium, the vessel contained 0.200 mol of $CH_4(g)$; 0.400 mol of $H_2O(g)$; 0.600 mol of $H_2(g)$; and CO(g).

At 25°C, the equilibrium constant, K, for the reaction is 0.256 M^2.

a. Calculate the amount of CO(g) in the equilibrium mixture. 3 marks

b. In the table below, identify whether each statement is correct or incorrect and justify your answers. 4 marks

Statement	Correct or incorrect	Justification
At equilibrium, the rates of the forward and reverse reactions are zero.		
Increasing the pressure by introducing an inert gas into the equilibrium mixture will move the position of equilibrium towards the reactants.		

Question 2 (15 marks)

The combustion of octane and the combustion of ethanol each release about the same amount of energy per mole of carbon dioxide produced. Octane is a major component of petrol, which is not a sustainable transport fuel. Ethanol is a sustainable biofuel.

a. Explain why petrol is not a sustainable transport fuel. 2 marks

b. Glucose is a product of photosynthesis. The industrial production of bioethanol requires the fermentation of glucose.

i. Write a balanced equation for the chemical reaction involved in photosynthesis. 2 marks

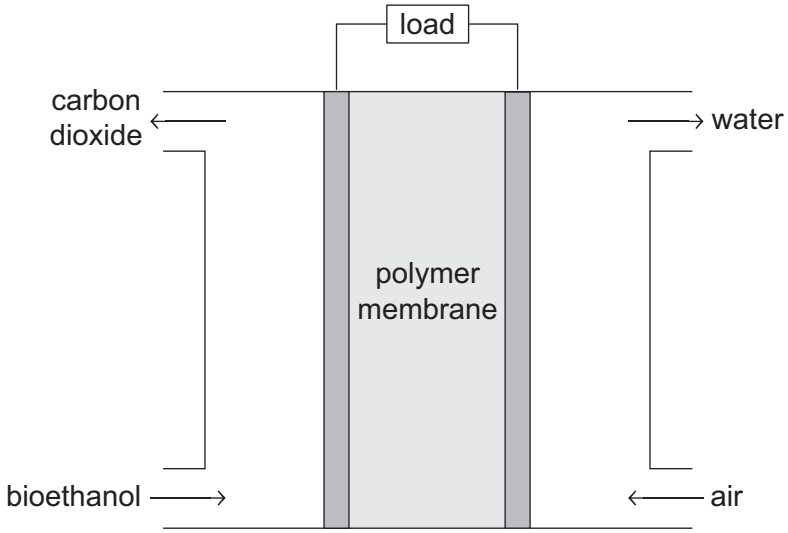
ii. Bioethanol is one of the products formed by the fermentation of glucose.
Outline why the products of this fermentation reaction must be distilled. 2 marks

iii. Write a thermochemical equation for the complete combustion of liquid bioethanol. 2 marks

iv. Bioethanol can be mixed with petrol to make a blended fuel that is suitable for use in cars.

Calculate the total energy produced by the complete combustion of 100.0 g of fuel that contains 90.0 g of octane and 10.0 g of bioethanol. 3 marks

c. Research is being conducted to investigate the viability of a fuel cell that uses gaseous bioethanol with an alkaline electrolyte for use in transport vehicles. The design of the fuel cell is shown in the diagram below.



i. The half-equation for the reaction that occurs at one electrode is as follows.

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

Write the half-equation for the reaction that occurs at the other electrode. 2 marks

ii. State **one** property of the electrodes that enables the fuel cell to function efficiently. 1 mark

iii. State why the polymer membrane enables the fuel cell to function efficiently. 1 mark

Question 3 (11 marks)
In the laboratory, iodine can be used to distinguish between the gases ethane and ethene.

a. **i.** Explain what would be observed when a coloured iodine solution is shaken with separate samples of ethane gas and ethene gas. 2 marks

ii. In the space below, draw the structural formula of the compound that forms when iodine reacts with ethene gas and give the IUPAC name of the compound. 2 marks

IUPAC name _____

b. Iodine can also be used to measure the degree of unsaturation of compounds.

In an experiment, 1.109 g of an edible unsaturated oil ($M = 900.0$ g mol^{-1}) was reacted completely with an average titre of 19.50 mL of 0.382 M iodine, I_2, solution in ethanol.

i. Why was the iodine solution in ethanol rather than water? 1 mark

ii. Use the results of the experiment to determine the number of carbon-to-carbon double bonds in one molecule of the oil. 3 marks

c. When an unsaturated oil is reacted with hydrogen gas, it changes to a solid.
In terms of structure and bonding, explain why this change in state occurs. 3 marks

Question 4 (9 marks)

The following information is known about a particular organic compound.

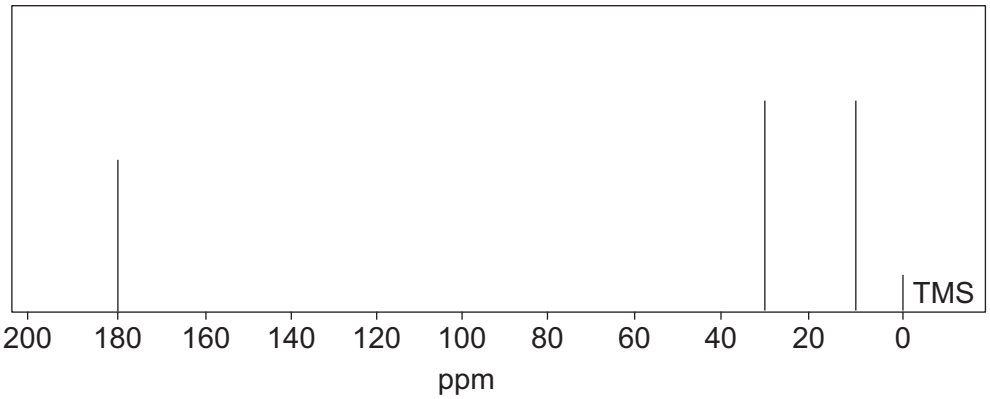
- The compound contains carbon, hydrogen and oxygen atoms only.
- There are no carbon-to-carbon double bonds in the compound's molecule.
- The molar mass of the compound is 74 g mol^{-1}.

a. The molar mass of the compound was determined from its mass spectrum.

i. Which part of the mass spectrum would have enabled the molar mass of the compound to be determined? 1 mark

ii. Some of the carbon atoms in the compound are ^{13}C atoms.
How would this be evident in the mass spectrum? 1 mark

b. The ^{13}C NMR spectrum of the compound is shown below.



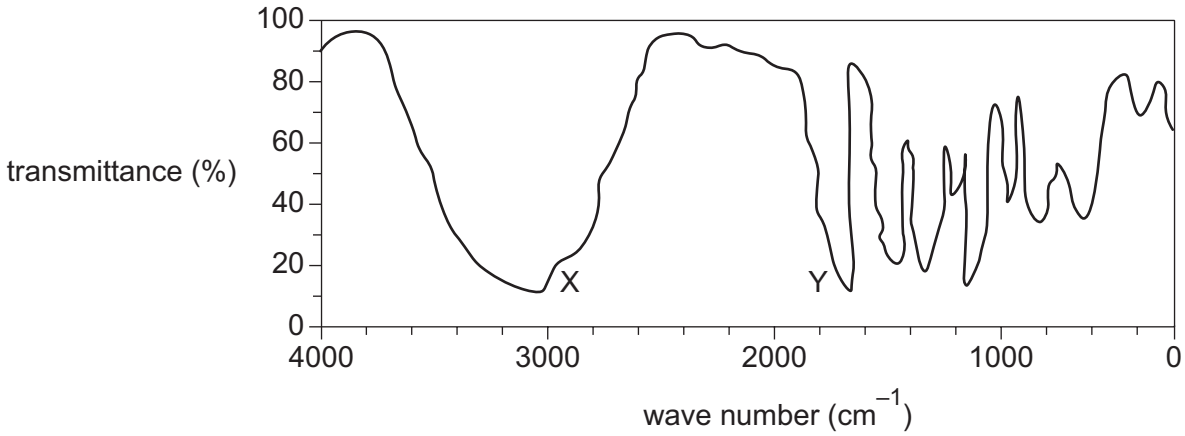
Identify one feature of the compound's molecular structure that can be derived from the mass spectrum. 1 mark

c. The following data was obtained from the ^{1}H NMR spectrum of the compound.

Chemical shift (ppm)	Relative peak area	Peak splitting
1.2	3	triplet
2.4	2	quartet
11.8	1	singlet

Identify **three** features of the compound's molecular structure that can be derived from this data. 3 marks

d. The infrared (IR) spectrum of the compound is shown below. Two peaks are labelled X and Y.

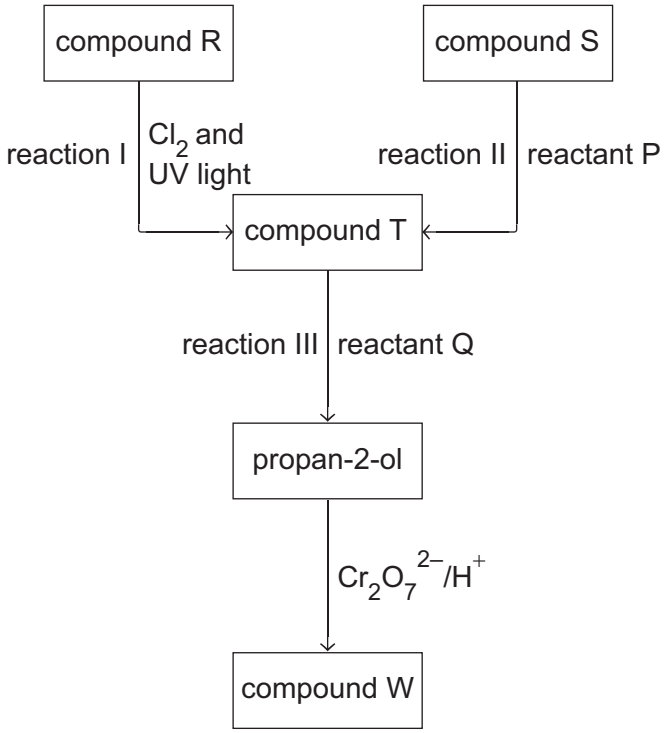


i. Identify the functional group that is responsible for peak X. 1 mark

ii. Identify the functional group that is responsible for peak Y. 1 mark

e. In the space below, draw the structural formula of the compound. 1 mark

Question 5 (8 marks)
The following diagram shows the reaction pathways for the formation of compound W.



a. What type of reaction is reaction I? 1 mark

b. State the molecular formula of reactant P. 1 mark

c. **i.** In the space below, draw the skeletal structure of compound R. 1 mark

ii. State the semi-structural (condensed) formula of compound S. 1 mark

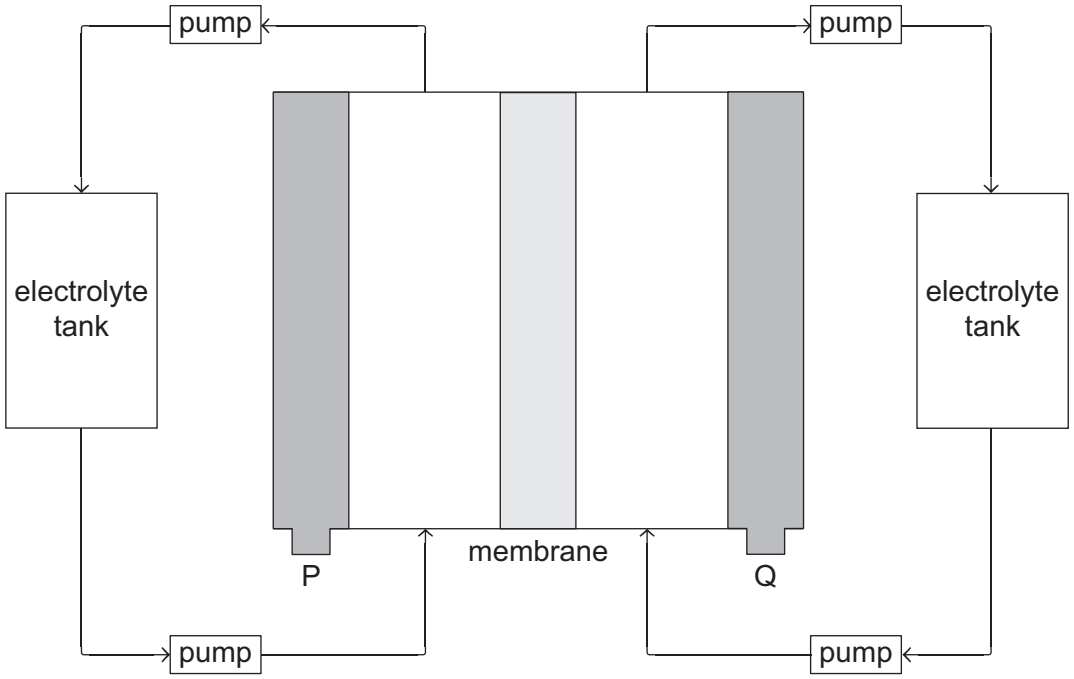
iii. Give the IUPAC name of compound T. 1 mark

iv. In the space below, draw the structural formula of compound W. 1 mark

d. Identify **one** reaction (I, II or III) that has an atom economy that is less than 100% and explain why its atom economy is less than 100%. 2 marks

Question 6 (12 marks)

The design of a vanadium redox battery is illustrated in the diagram below.



Different vanadium-based chemicals are stored in each electrolyte tank and pumped into the cell to produce electrical energy via a chemical reaction that occurs according to the following equation.

$$VO_2^+(aq) + V^{2+}(aq) + 2H^+(aq) \rightarrow VO^{2+}(aq) + V^{3+}(aq) + H_2O(l)$$

Electrodes P and Q supply electricity to any electrical device that is attached to the battery. When the battery needs to be recharged, electrodes P and Q are attached to a source of renewable electrical energy, causing the chemical reaction shown above to reverse.

a. During discharge, when the battery is producing electricity, electrode P is the anode.

i. Write the half-equation for the reaction that occurs at electrode P during discharge. 1 mark

ii. Identify which electrode is positive during discharge. Justify your answer. 2 marks

iii. The standard electrode potentials, E^0, for the half-cell reactions are –0.255 V and +1.004 V.

Calculate the theoretical maximum cell voltage of the battery. 1 mark

iv. Explain why the cell may not produce the theoretical maximum cell voltage calculated in **part a.iii.**

2 marks

b. i. Name **one** source of renewable electrical energy that could be used to recharge the battery. 1 mark

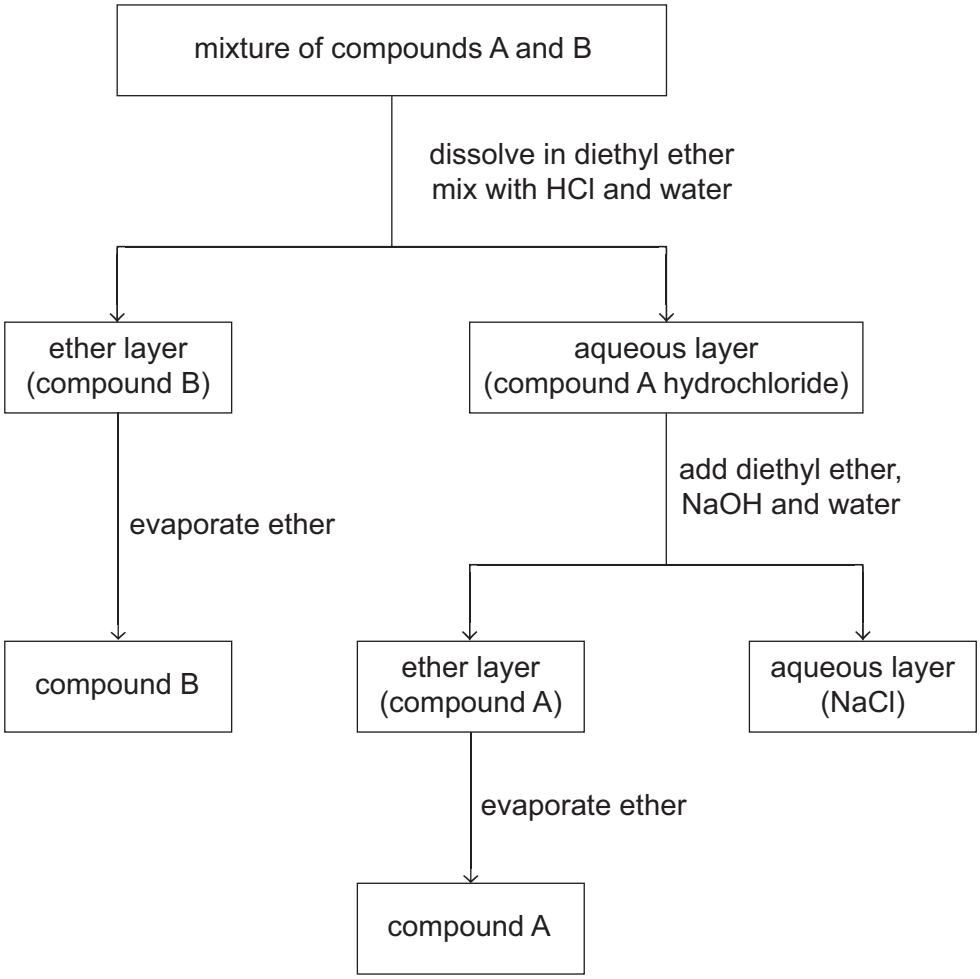
ii. Write the half-equation for the reaction that occurs at the anode during recharge. 1 mark

iii. Explain why a voltage that is **greater** than the maximum cell voltage must be used during recharge. 2 marks

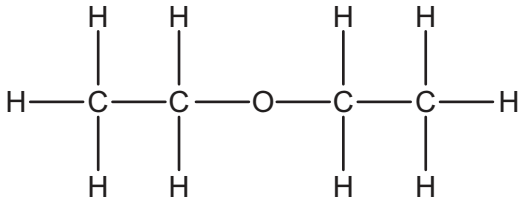
c. Explain why the vanadium redox battery can be described as a hybrid of a secondary cell and a fuel cell. 2 marks

Question 7 (8 marks)

A mixture of compounds A and B was extracted from natural plant material for use as possible active ingredients in medicines. Each compound contains a different non-polar cyclic hydrocarbon. Compound A has an amino functional group, whereas compound B has a hydroxyl functional group. Solvent extraction was used to separate the compounds, as shown in the diagram below.



a. The structural formula of diethyl ether is shown below.



Diethyl ether has a boiling point of 34.6°C. An isomer of diethyl ether is butanol-1-ol, which has a boiling point of approximately 117°C.

i. In terms of structure and bonding, explain why diethyl ether has a much lower boiling point than butan-1-ol. 2 marks

ii. In terms of structure and bonding, explain why the ether layer floats on top of the aqueous layer. 2 marks

iii. Why is the low boiling point of diethyl ether advantageous in the solvent extraction shown on page 25? 1 mark

b. When compound A is reacted with HCl, it becomes more soluble in water.

Give a reason for this. 2 marks

c. Another laboratory technique that is used to extract and purify the components of a mixture is distillation.

Outline the principle on which distillation is based. 1 mark

Question 8 (13 marks)

A student conducted a series of experiments to investigate the energy content of two popular savoury biscuits: Best Biscuits and Biscuit Bytes.

a. The following is displayed on the nutrition information panel on the packet of Best Biscuits.

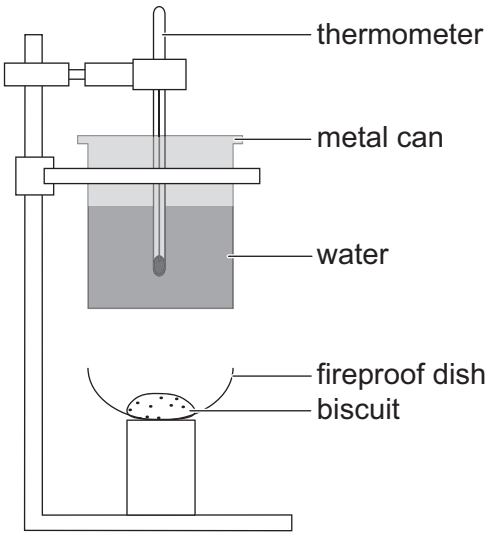
Quantity per 100 g			
Fat	**Carbohydrate**	**Protein**	**Dietary fibre**
9.4 g	74.1 g	8.9 g	4.0 g

i. Show that the energy available in a 100 g serving of Best Biscuits is 1685 kJ. 2 marks

ii. The nutrition information panel on the packet of Best Biscuits states that the total energy content per 100 g is 1790 kJ.

Explain why this value is different to the value stated in **part a.i.** 2 marks

The nutritional information for Biscuit Bytes was not available as the student misplaced the packaging. To determine the energy content of Biscuit Bytes, the student used the experimental set-up shown in the following diagram.



In the experiment, one biscuit was weighed, placed in the fireproof dish and ignited. After the biscuit finished burning, the remains were allowed to cool and were then reweighed. The temperature of the water in the metal can was recorded before the biscuit was ignited. The highest temperature that the water reached after heating was also recorded.

Mass of water in metal can	100 g
Mass of Biscuit Bytes biscuit before burning	3.48 g
Mass of burnt biscuit remains	1.29 g
Temperature of water before heating	18.3°C
Maximum temperature of water after heating	46.7°C

b. i. Calculate the amount of energy, in kilojoules, released by burning the biscuit. 2 marks

ii. The student visited the Biscuit Bytes website and found that the total energy content per 100 g of Biscuit Bytes is 1525 kJ.

Compare the results of the student's experiment with this published value and suggest an experimental error for any difference. Include a relevant calculation in your answer. 3 marks

c. **i.** Identify **two** variables that should have been controlled by the student. 2 marks

ii. One of the student's classmates suggested that the experiment could be improved by crushing the biscuit into a powder prior to weighing and igniting it.

Explain how this change may improve the experiment and whether it would affect the calculated amount of energy released. 2 marks

Question 9 (7 marks)
Consider the following extract.

Most ammonia, NH_3, is produced by the reaction between nitrogen gas, N_2, and hydrogen gas, H_2. The reaction is represented by the following equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

N_2 is sourced from the air and H_2 is mainly sourced from steam methane reforming. The reactor conditions are typically 450°C and 200 atm. NH_3 is removed from the product mixture by cooling, which liquifies the ammonia.
An iron/ruthenium-based catalyst is used in the reaction. A recent innovation involves the addition of lithium and barium to the catalyst. This improved catalyst allows the reaction to occur efficiently at temperatures lower than 300°C.
Nitrogen-fixing bacteria can also convert N_2 into NH_3. In nitrogen-fixing bacteria, the enzyme nitrogenase catalyses the reaction efficiently using a cluster of metal ions, including an unusual molybdenum ion.

a. In terms of the production of NH_3, identify **two** similarities and **two** differences between the inorganic iron/ruthenium-based catalyst and the biological catalyst nitrogenase. 4 marks

b. Using the lithium–barium enhanced inorganic catalyst may reduce the amount of energy that is required to produce NH_3 from N_2 and H_2, and therefore improve the sustainability of this production method.

Discuss **one** other change that could be made to this production method to improve its sustainability. 3 marks

End of examination questions