



STUDENT NAME:

VCE CHEMISTRY

Unit 3 & 4 Trial Examination 2022

Reading time: 15 minutes

Writing Time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	30	30	30
B	10	10	90
			Total 120

- 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 correction fluid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer booklet of 29 pages
- Additional space is available at the end of the booklet if you need extra paper to complete an answer.

Instructions

- Write your **student name** in the space provided above on this page.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the data book.

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

Disclaimer: This practice examination has been written for students of VCE Chemistry. This does not imply that it has been endorsed by the Victorian Curriculum and Assessment Authority (VCAA). Teachers are advised to preview and evaluate this resource before using or distributing it to students.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** and **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 book are **not** drawn to scale.

Question 1

What catalyst would be used in a substitution reaction to form a haloalkane from an alkane?

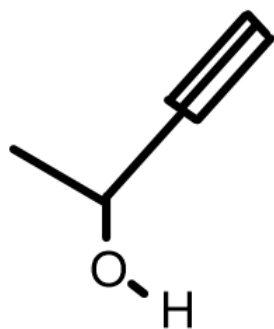
- A. $\text{Cr}_2\text{O}_7^{2-}$
- B. H^+
- C. MnO_4^-
- D. UV

Question 2

In an addition reaction between an alkene and a hydrogen chloride. The atom economy of this reaction is closest to?

- A. 22%
- B. 78%
- C. 100%
- D. There is not enough information to determine

The following information is to be used to answer questions 3 & 4



Question 3

The IUPAC name of the compound is:

- A. 2-hydroxybutyne
- B. 3-hydroxybutyne
- C. but-1-yn-3-ol
- D. but-3-yn-2-ol

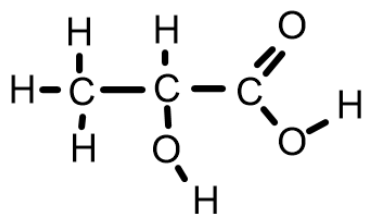
Question 4

The molar mass of the compound is

- A. 68
- B. 70
- C. 72
- D. 74

Question 5

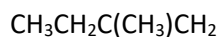
Lactic acid is a common name for the following molecule



Which of the following statements is **not** true?

- A. The IUPAC name ends in acid.
- B. The molecule contains 1 chiral centre.
- C. The empirical formula is CH_2O .
- D. It is a diprotic acid

Question 6



The name of this molecule is:

- A. 3-methyl butane
- B. 3-methyl but-3-ene
- C. Trans methyl butene
- D. 2-methyl but-1-ene

Question 7

Which of the following is **not** considered a biofuel?

- A. Ethanol produced from cellulose
- B. Ethanol produced from ethene and water
- C. Methane produced from farm waste
- D. Diesel produced from used cooking oil

Question 8

Primary cells and fuel cells have several features in common. Which of the following is **not** common to both cells?

- A. Chemical energy is converted into electrical energy
- B. Oxidation occurs at the anode
- C. Porous electrodes
- D. Reductant and oxidant must be separated

The information below is to be used for Questions 9 and 10

Year 11 Outdoor Ed students are preparing for a 3-day hike by comparing several dehydrated meals for total energy content. The figures below include the recommended additions as per the instructions (e.g. meat for tacos, butter for pasta etc.)

	Serving size	Average Fat per 100g	Average Protein per 100g	Average Carbohydrates per 100g
Meal A (fried rice)	115g	1.3g	3.6g	25.5g
Meal B (pasta)	85g	2.6g	5.8g	21.0g
Meal C (tacos)	24g	13.0g	4.1g	35.3g

Question 9

What is the total amount of energy, in kilojoules, a student would obtain from fat if they ate all three meals?

- A. 6.83
- B. 16.9
- C. 253
- D. 625

Question 10

Which of the following statements is **not** true when referring to the energy content due to fat:

- A. A serving of tacos provides more than twice the energy compared to fried rice
- B. A serving of fried rice provides the smallest amount of energy
- C. A serving of Pasta provides twice the energy of fried rice
- D. All three meals provide less than 4 kJ

Question 11

The molecule $C_4H_8O_2$ has a number of isomers.

Which of the following isomers of $C_4H_8O_2$ will have the highest boiling point?

- A. Butanoic acid
- B. Ethyl ethanoate
- C. Methyl propanoate
- D. Boiling point will be the same for all three as the molecular mass is the same

Question 12

Which fatty acid is likely to have the lowest melting point?

- A. linoleic acid
- B. oleic acid
- C. palmitic acid
- D. stearic acid

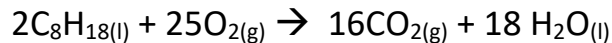
Question 13

When 3.2g of pentan-1-ol is completely combusted, the volume of CO₂ released at 120°C and 150kpa is closest to:

- A. 0.25L
- B. 0.81L
- C. 21.3L
- D. 69.7L

Question 14

An equation for the complete combustion of octane is



ΔH for this equation would be

- A. +5460 kJ mol⁻¹
- B. -5460 kJ mol⁻¹
- C. +10920 kJ mol⁻¹
- D. -10920 kJ mol⁻¹

Question 15

Which of the following is a correct pairing of amino acids and the types of bonding they might be involved in with in the tertiary structure of a protein?

	Ionic	Hydrogen bonding
A.	Arg	Lys
B.	Asp	Ser
C.	Gln	Lys
D.	Pro	Trp

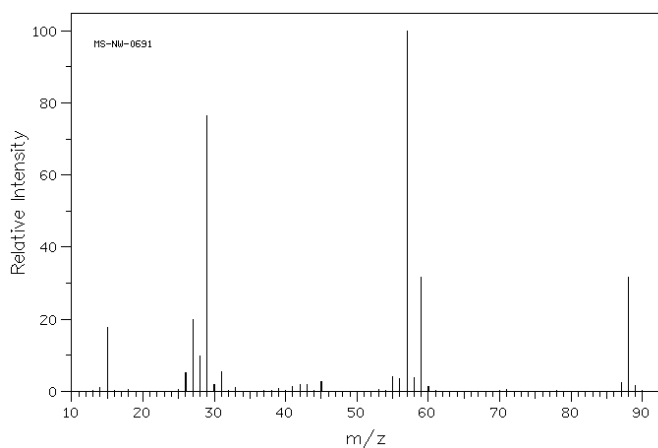
Question 16

Which of the following statements about titration is true?

- A. All titrations need an indicator
- B. The aliquot comes from the burette
- C. The equivalence point for a weak base and a strong acid is less than pH 7
- D. The equivalence point is when the colour has permanently changed

The following information is to be used for questions 17 and 18

An unknown sample was run through a mass spectrometer. The output is below.



Data: SDBS web <http://sdb.sdb.aist.go.jp>

National Institute of Advanced Industrial Science and Technology

Question 17

The m/z value of the base peak is:

- A. 15
- B. 57
- C. 88
- D. 100

Question 18

The molecular mass of the unknown substance is most likely

- A. 15
- B. 57
- C. 88
- D. 100

Question 19

A year 12 student wrote the following Hypothesis for a practical investigation

“If the distance between a heat source and a fixed volume of water increases, then the efficiency of the energy transfer from the heat source to the water will decrease because more of the energy will be lost to the surroundings.”

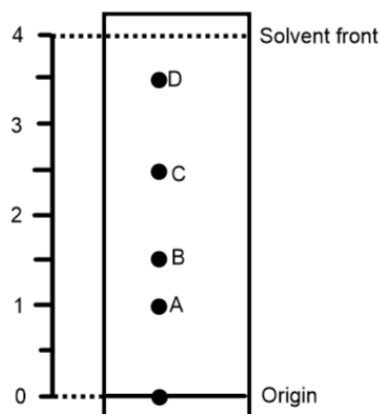
The dependent variable in this investigation is

- A. distance
- B. energy transfer
- C. water volume
- D. unable to be determined

Question 20

Scientists have been asked to determine the structure of an unknown substance. Which of the following statements is **not** a correct step in the process to determine the structure

- A. Use mass spectroscopy to determine the molecular mass
- B. Use proton NMR to determine the hydrogen environments
- C. Use IR spectroscopy to determine the functional groups
- D. Use magnetic resonance to determine the empirical formula

Question 21

Which of the following statements is **not** correct?

- A. Component A is the least strongly adsorbed to the stationary phase
- B. Component B has an R_f value of 0.375
- C. Component C will have a larger R_f value than component B
- D. Component D is the least strongly adsorbed to the stationary phase

Question 22

Which of the following are examples of omega 3 and omega 6 fatty acids respectively?

- A. arachidonic and palmitoleic
- B. linoleic and oleic
- C. linolenic and arachidonic
- D. propanoic and hexanoic

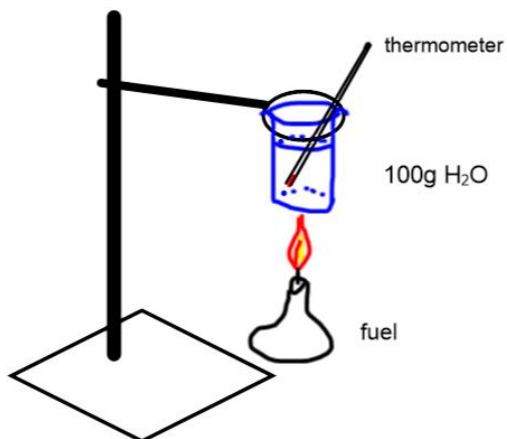
Question 23

An unknown organic molecule is known to have one oxygen in its molecular formula. From carbon NMR data, the Chemical shift value of 75, suggests it might be

- A. an aldehyde
- B. an ester
- C. a carboxylic acid
- D. a primary alkanol

Question 24

1.1g of ethanol is placed in a spirit burner and ignited below a can containing 100 g of water



If the initial temperature of the water was 20.0 °C, and assuming 50% of the heat is lost to the environment, what will be the final temperature of the water when all the ethanol is used up?

- A. 38.9 °C
- B. 59.9 °C
- C. 77.8 °C
- D. 77.9 °C

Question 25

Which of the following reactions is **not** a condensation reaction?

- A. Production of disaccharides from monosaccharides
- B. Production of carboxylic acids from alcohols
- C. Production of protein from amino acids
- D. Production of triglycerides from fatty acids

Question 26

Which of the following is not required as part of a healthy diet because the human body is able to synthesise it?

- A. Arachidonic acid
- B. Folic acid
- C. Phenylalanine
- D. Vitamin D

The following information is to be used to answer questions 27 and 28

A teacher has given a student the following starting materials to produce a galvanic cell:

- A carbon rod
- An iron nail
- A piece of zinc
- A strip of copper
- AgNO_3 (1M)
- CuSO_4 (1M)
- FeSO_4 (1M)
- ZnNO_3 (1M)
- KNO_3 (1M)

Question 27

A cell is to be made using CuSO_4 and the strip of copper on one side and FeSO_4 and the nail on the other. What the expected Voltage of the cell?

- A. 0.10
- B. 0.34
- C. 0.44
- D. 0.78

Question 28

A different student, given the same materials, puts the nail in the copper solution and the copper strip in the FeSO_4 solution. The voltmeter shows 0. What is the most likely cause?

- A. A direct reaction is happening between the nail and copper solution bypassing the voltmeter
- B. An electrolysis reaction is taking place, which the voltmeter cannot detect
- C. No reaction is occurring
- D. The student forgot to connect the voltmeter

Question 29

Which of the following pairs of amino acids might be connected in the tertiary structure of a protein via dispersion forces alone?

- A. arginine and lysine
- B. aspartic acid and glutamine
- C. cysteine and methionine
- D. isoleucine and phenylalanine

Question 30

The impression of a child's hand is to be copper plated as a present for the child's grandparent. A special conducting material is used to make a cast of the hand. The cast is used as the cathode of an electrolysis cell and is dipped into a solution of copper(II)sulphate. If 10.0g of copper is to be deposited on the cast, for how many minutes does the 10.0 Amp current need to operate?

- A. 25.3
- B. 50.7
- C. 1520
- D. 3040

SECTION B**Instructions for Section B**

Answer **all** questions in the spaces provided. Write using blue or black pen. No white out

To obtain full marks 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 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
- make sure chemical equations are balanced and that the formulas for individual substances include indication of state; for example; e.g. $\text{H}_2(\text{g})$, $\text{NaCl}(\text{s})$
- unless otherwise indicated, the diagrams in this exam are not drawn to scale.

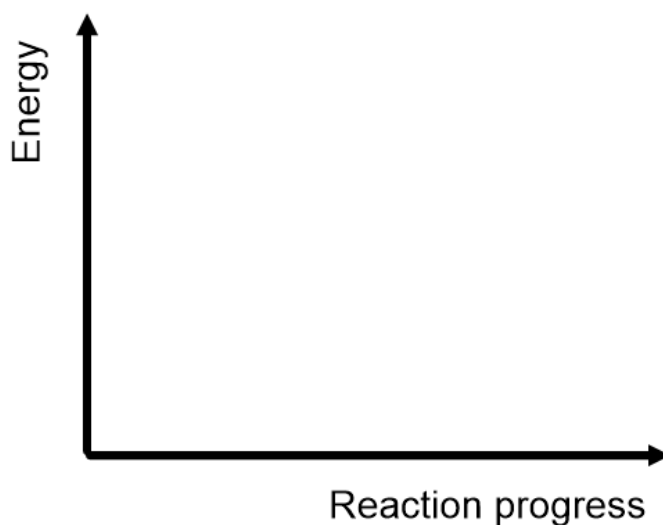
Question 1 (7 marks)

Chemical reactions are occurring around us all the time. Some are reasonably slow, like metal rusting, and some are extremely fast, like the deployment of an airbag in a car crash. Chemists use catalysts to speed up the rate of reaction.

- a. Name two other factors that a chemist could change to increase the rate of a chemical reaction

2 marks

- b. On the graph below, draw two energy profile diagrams for an exothermic reaction; one with a catalyst, one without a catalyst.



2 marks

- c. Using the language of collision theory, explain how a catalyst increases the reaction rate. In your answer refer to reaction pathways and activation energy

3 marks

Question 2 (9 marks)

Energy consumption continues to grow on a global scale. The introduction of alternative energy sources is a major component of research worldwide. However, until infrastructure catches up for alternative fuels, petrol will be part of the fuel puzzle for a few more years.

- a. The main component of petrol is octane.

Write a balanced thermochemical equation for the combustion of octane.

2 marks

The 60L fuel tank of a popular Australian made family car holds 42.2 kg of octane.

- b. i. If a petrol engine has a maximum fuel efficiency of 25%, what is the maximum amount of useful energy that can be obtained from one tank of fuel. Assume the tank is completely emptied.

2 marks

- b. ii. What volume of carbon dioxide gas would one tank of fuel produce if it were measured at 85.0 °C and 235 kPa?

2 marks

Ethanol can be used as a substitute for petrol, or it can be blended with petrol. Ethanol provides about 62% of the energy content of petrol based on weight, but has the advantage that it can be produced from renewable sources as bioethanol. Currently there are a number of blended fuels sold to the public; E10 is a petrol blend that is 10% ethanol.

- c. If the car's 60L fuel tank was filled with E40, what would be the total amount of energy available from the E40 fuel? (assume percentage by mass to calculate this question) Give your answer in GJ.

2 marks

- d. The benefits of bioethanol as a transport fuel include lower carbon emissions and less particulate pollutions.

What is one disadvantage of bioethanol as transport fuel in cars?

1 mark

Question 3 (7 marks)

The production of glucose, the primary source of energy in all plants and animals, is through a process called cellular respiration. Through a series of steps glucose is oxidised by oxygen. In this process one mole of glucose produces 2860 kJ of energy. If there is a lack of oxygen when exercising, muscles can extract energy directly from glucose. This process, called anaerobic respiration, leads to the production of the lactate ion and one mole of glucose produces 120 kJ.

- a. Write a balanced thermochemical equation to represent the overall redox process of cellular respiration.

2 marks

In yeast, anaerobic respiration leads to the production of ethanol and carbon dioxide.

- b. i. Write a balanced chemical equation for anaerobic respiration in yeast.

2 marks

- ii. If 500.0g of glucose is consumed by the yeast, what volume of carbon dioxide gas will be produced if the reaction takes place at SLC?

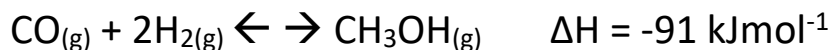
2 marks

- iii. Explain why the CO₂ produced is considered to have negligible environmental impact.

1 mark

Question 4 (6 marks)

Methanol is used as a car racing fuel. One method of production is by reacting carbon monoxide and hydrogen according to the following reaction. One such system has the following equilibrium equation:



- a. Write an expression for the equilibrium constant K_c .

1 mark

- b. One way to increase the yield is to add more carbon monoxide. Use Le Châtelier's principle to explain why this is.

2 marks

- c. What effect would increasing the temperature have on this system. In your answer refer to yield of methanol and rate of reaction.

2 marks

A different process to make methanol is to react carbon dioxide and hydrogen to produce methanol and water.

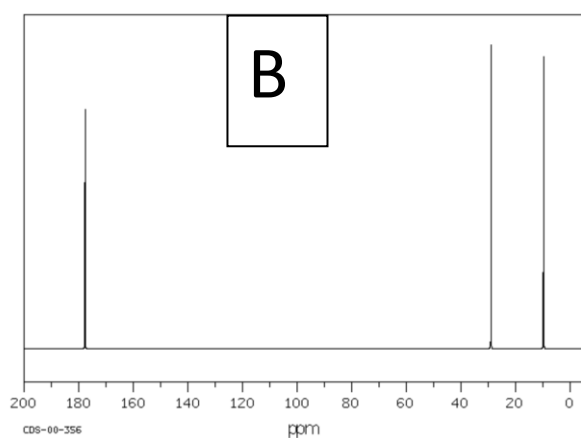
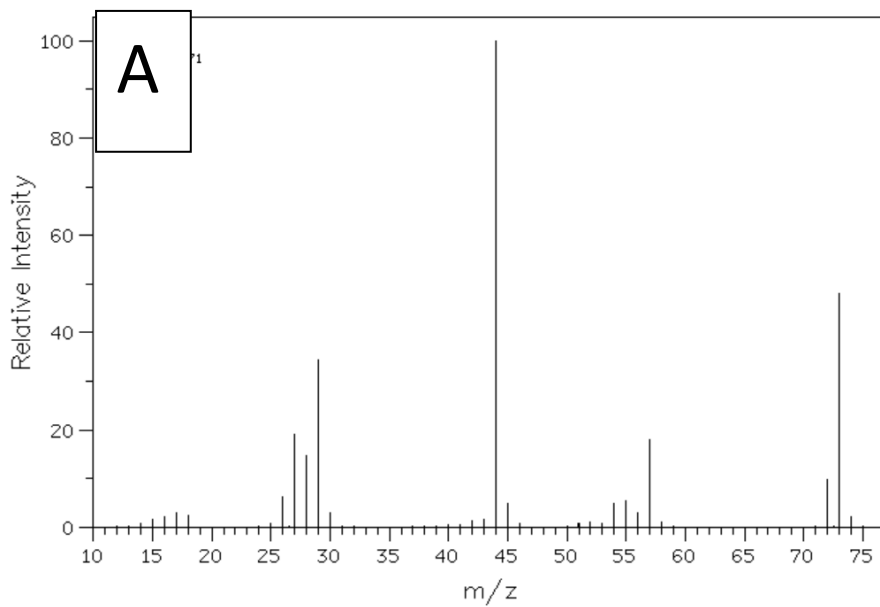


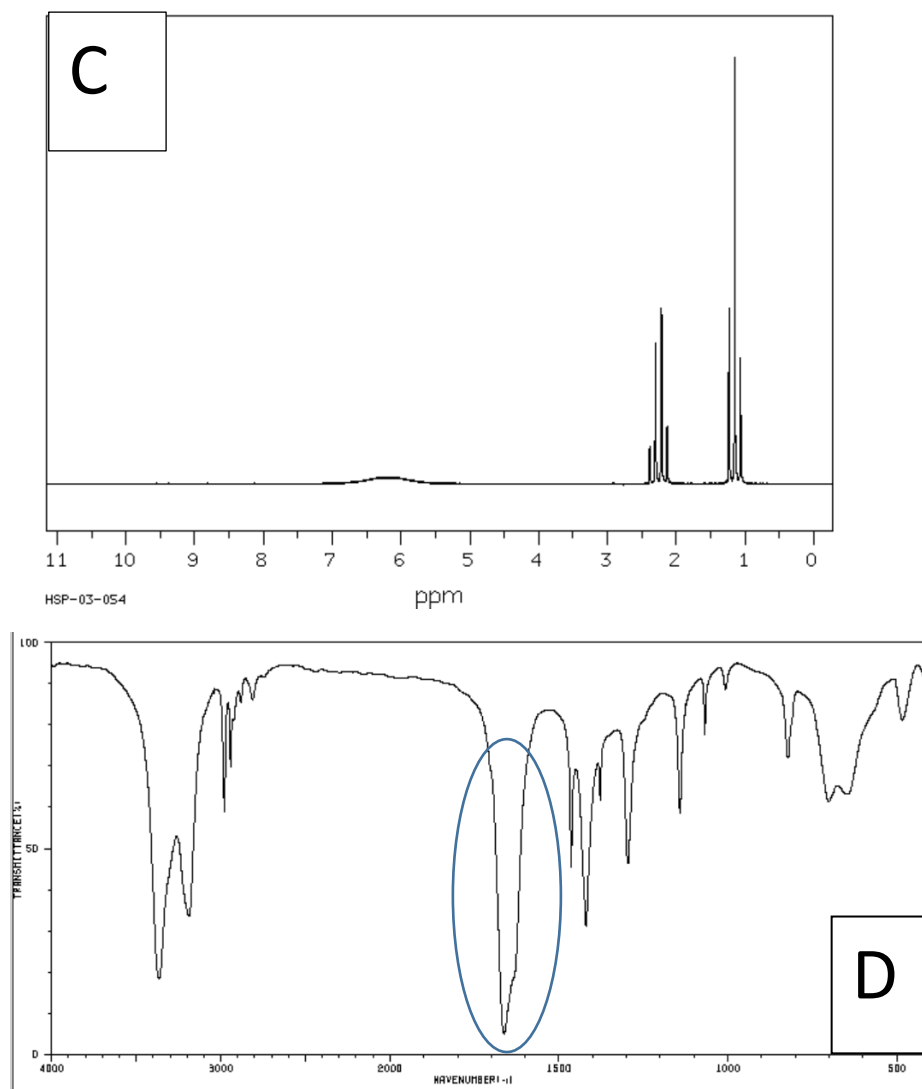
- d. Which process will have the higher atom economy

1 mark

Question 5 (10 marks)

Scientists are asked to determine the structure of an unknown pure organic substance. The molecule is known to contain only carbon, hydrogen, oxygen and nitrogen. A number of tests were conducted and the various spectra are shown before labelled A-D.





All Data: SDBS web <http://sdb.sdb.aist.go.jp>
National Institute of Advanced Industrial Science and Technology

- a. Spectra A is the readout from the Mass Spectroscopy. List the other spectra by letter in the following order: IR, ¹³C NMR, H NMR

1 mark

- b. i. Circle the base peak value on Spectrum A

1 mark

- ii. Draw a fragment that might account for the peak at 29 m/z value

1 mark

c. How many carbon environments are there in the unknown molecule?

1 mark

d. What type of bond does the circled peak on spectrum D indicate?

1 mark

e. What is the molecular mass of the unknown substance?

1 mark

f. On spectrum C, the peaks are split into 4 and 3, with respective areas of 2 and 3. Describe what causes the splitting and what specifically this information tells us

3 marks

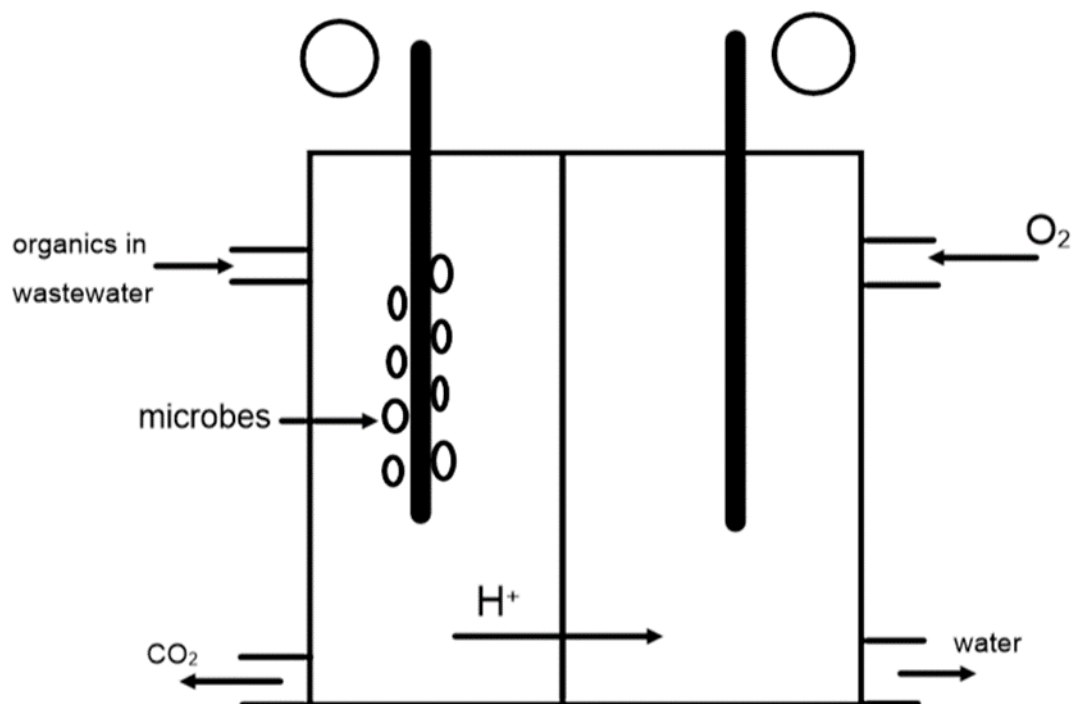
g. It is known that hydrogens on amide groups are hard to read on a proton NMR spectrum. With that knowledge, and all the other information given, draw the structure of the unknown substance.

1 mark

Question 6 (9 marks)

Research carried out at the University of Massachusetts into microbial fuel cells (MFC) found that the acetate that is produced from the decomposition of organic matter in lakes and other water bodies can be used to generate electricity and clean water. Whilst carbon dioxide is a by-product of this process, it is still considered a renewable system, as this would have been produced anyway as the plant naturally decomposed.

The acetate (wastewater) half equation is as follows:



- a. Label the polarity of the electrodes by adding + and – in the appropriate circles above.

1 mark

- b.i. Write the half equation that takes place at the cathode

1 mark

- ii. Write the overall reaction for this MFC.

2 marks

- c. Indicate the direction of the electron flow, from one terminal to the other, on the diagram above, with an arrow and label.

1 mark

One of the problems found in the research phase was that as the microbe colonies grew bigger, the amount of electricity generated reduced.

- d. Give an explanation, in terms of rate of reaction, as to why this might have occurred

2 marks

- e. One potential benefit of this MFC is that heavy metals found in the waste water may be reduced. If it were assumed that this MFC ran at standard conditions, use the electrochemical series to give an example of a heavy metal that might be recovered and state one advantage this would bring.

2 marks

Question 7 (11 marks)

Collagen is the most abundant structural protein in animals. It has a triple helix Quaternary structure. All proteins are made from amino acids.

- a. Name the link when 2 amino acids form a dipeptide.

1 mark

- b. Draw a diagram using proline and alanine to show that there are two ways that two amino acids can combine. Circle the link from part a.

3 marks

c. Describe, generally, how a quaternary structure is different to the tertiary structure?

3 marks

Collagen starts to denature at around 70 °C.

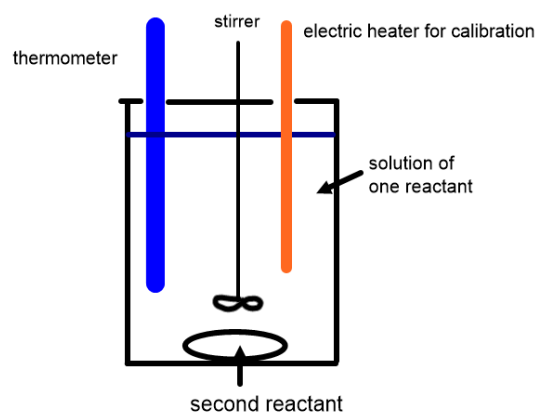
d. Describe the difference between denaturation and hydrolysis of proteins. In your answer ensure you reference the primary structure as well as the tertiary and/or quaternary structure.

4 marks

Question 8 (8 marks)

A solution calorimeter is used to measure the energy change when two reactants mix in a solution. Before it can be used it must be calibrated.

When 5.0 volts was passed through the heater using a current of 4 amps for 2.0 minutes, the temperature rose 16.0 °C.



- a. Calculate the calibration factor for this calorimeter. Ensure you give the appropriate units.

2 marks

- b.i. When 2.04g of glucose is dissolved in the water of the calorimeter, the temperature dropped by 1.45 °C. Is the dissolution exothermic or endothermic?

1 mark

- ii. Calculate the enthalpy of solution, in kJmol^{-1} ,

2 marks

A bomb calorimeter can be used for combustion reactions. A particular bomb calorimeter has a calibration factor of 6.03 $\text{kJ/}^\circ\text{C}$. This calorimeter was used to burn a corn chip. The mass of the corn chip 2.75g initially. The temperature of the water rose 3.42 °C. There was 0.82g of corn chip residue and ash left over at the end.

- c. Determine the energy content of the corn chip. Give your answer in kJ/kg .

3 marks

Question 9 (11 marks)

Organic molecules are found in all aspects of 21st century life; from cosmetics and cleaning products to medicines and health food supplements. Many occur naturally in plants, others are manufactured using crude oil as the base material.

a.i. Name the following molecule $\text{CH}_3\text{CH}(\text{NH}_2)\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$

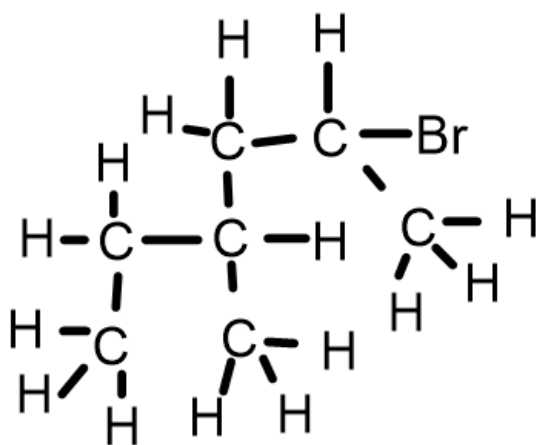
1 mark

ii. How many chiral centres does the molecule in **a.i.** have?

1 mark

iii. Write the semi-structural formula of 2, 4, 4, trifluorobutanoic acid

1 mark



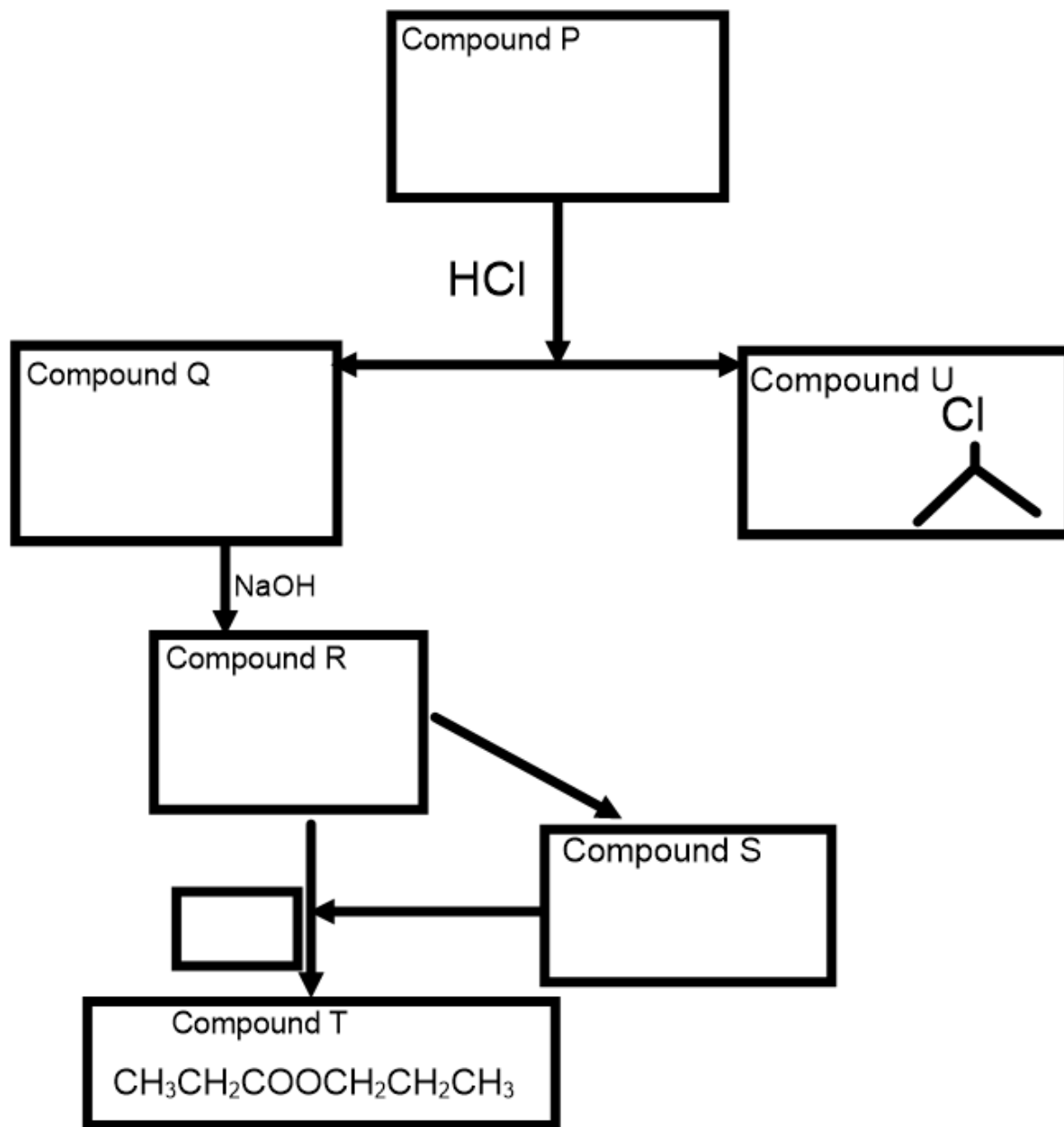
iv. Write the IUPAC name of the compound above

1 mark

v. How many chiral centres does the molecular in **a.iv.** have?

1 mark

- b. Starting with an alkene, the follow reaction pathway takes place. Compound P reacts with HCl to form an approximate 50:50 split of compound U and compound Q.



- b.i. Name compound U.

1 mark

- b.ii. Draw the stick diagram for compound P in the box

1 mark

- iii. Draw the structural formula of compound Q in the appropriate box.

1 mark

- iv. Compound Q is reacted with aqueous sodium hydroxide. Give the name of the homologous series that compound R belongs to.

1 mark

- v. Compound R is separated into two equal streams. One of those streams is reacted with an oxidising agent to form compound S, a carboxylic acid. State the conditions that ensure a carboxylic acid, and not an aldehyde, is produced.

1 mark

- vi. Compound S and the second stream of compound R are reacted to form compound T. What catalyst is used in this step to speed up the reaction? Write your answer in the appropriate box.

1 mark

Question 10 (12 marks)

A year 12 student wants to determine the ethanoic acid concentration of a supermarket generic vinegar. They plan to titrate a sample of the vinegar against sodium hydroxide. The concentration of the sodium hydroxide is determined by first titrating it against a standard solution.

- a. List two criteria that a primary standard must have:

2 marks

Sections from the procedure and results are shown in the boxes below.

Procedure

1. Dilute the vinegar by pipetting 25.00mL into a 250mL volumetric flask. Half fill the flask with de-ionised water and shake it. Add more de-ionised water until the bottom of the meniscus is sitting on the calibration line.
2. Fill a burette with standardised sodium hydroxide. Record the initial burette reading.
3. Take a 10.00 mL aliquot of the diluted vinegar and add it to a 100mL conical flask. Add 3 drops of phenolphthalein.
4. Place the flask under the burette on a white tile and titrate until the end point is reached.
5. Record the final burette reading.
6. Repeat steps 3-5 until 3 concordant titres have been obtained.

- b. The procedure makes no mention of rinsing the glassware before using it? List the five pieces of glassware and with what each one should be rinsed.

3 marks

- c. Write a balanced equation for the reaction between ethanoic acid and sodium hydroxide?

1 mark

Results

Sample	Initial Burette reading	Final burette reading
A	1.75	8.20
B	8.20	14.40
C	14.40	20.50
D	20.50	26.65

- d. Using the results table above, calculate the average titre of sodium hydroxide used during the titrations.

1 mark

- e. Given that the concentration of the standardised sodium hydroxide is 0.11 M, calculate the concentration ethanoic acid in the undiluted vinegar.

3 marks

- f. Having found that the concentration of ethanoic acid in the vinegar is below the value stated on the bottle, the student thinks about exposing the matter on their podcast "Affairs are current". The student seeks advice from the teacher before doing that. The wise teacher gives the student one piece of advice about the scientific method. Assume that the procedure was followed correctly, what advice is the teacher most likely to give to the student?

2 marks

END OF QUESTION AND ANSWER BOOKLET