



The Victorian
Institute of
Learning

VCE Unit 3 & 4 Chemistry

Trial Examination 2019

Question and Answer Booklet

Student Name: _____

Teacher Name: _____

Reading time: 15 minutes

Writing time: 2 hour 30 minutes

Section	Number of Questions	Number of Marks
A	30	/30
B	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.

Instructions

Write your name and your teacher's name in the space provided above on this page.

Unless otherwise indicated, the diagrams in this booklet are not drawn to scale.

All written responses must be in English.

You may keep the data booklet.

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

Students are reminded that this is a trial examination only and can not guarantee the content or format of the 2018 VCAA Examination

Section A – Multiple Choice

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

Which of the following best describes a renewable resource?

- a) A resource that is formed by natural biological processes
- b) A resource that is replenished as quickly as it is consumed
- c) A resource that produces no carbon emissions
- d) A resource that takes less than a year to replenish itself

Question 2

In which of the following molecules would you find an amide link?

- a) A triglyceride made from three oleic acids
- b) A disaccharide consisting of glucose and maltose
- c) A tripeptide made of alanine, cysteine and glycine
- d) An essential vitamin

Question 3

In an electrolytic cell the charge on the anode and the flow of electrons can be described as...

- a) Positive and from anode to cathode
- b) Negative and from anode to cathode
- c) Positive and from cathode to anode
- d) Negative and from cathode to anode

Question 4

Which of the following methods of generating energy is considered the most efficient?

- a) Burning coal in a coal fired power station
- b) Burning propane gas
- c) A hydrogen oxygen fuel cell
- d) A Daniel cell

Question 5

The enzyme amylase operates best at a temperature of approximately 37 degrees C, which of the following best explain why the rate of reaction of the enzyme would decrease at a temperature of 5 degrees C.

- a) The rate of reaction slows as the substrate and enzyme particles collide less frequently with less energy
- b) None of the substrate particles have enough energy to overcome the activation energy
- c) The enzyme denatures and can no longer function
- d) The enzyme coagulates and can no longer function

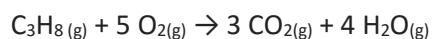
Question 6

Which of the following would be considered a disaccharide?

- a) Glucose
- b) Cellulose
- c) Fructose
- d) Lactose

Question 7

The combustion of propane is described in the equation below.

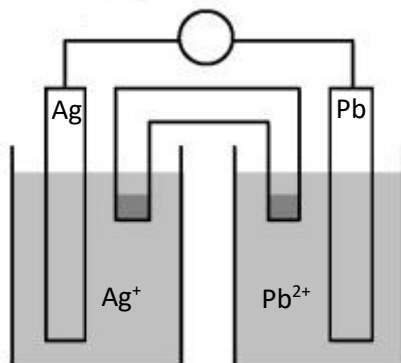


The mass of greenhouse gas produce by the burning of 12.8 grams of propane in excess oxygen

- a) 59.4 grams
- b) 36.6 grams
- c) 38.3 grams
- d) 20.9 grams

Use the following information to answer questions 8 and 9

A galvanic cell is set up as shown in the diagram below



Question 8

Which of the following would you observe during the operation of the cell above?

- a) Silver atoms will deposit on the silver electrode
- b) Lead atoms will deposit in the silver electrode
- c) Silver atoms will deposit on the lead electrode
- d) The colour of the lead solution will darken

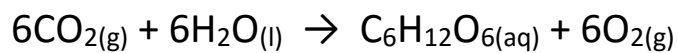
Question 9

Calculate the potential cell voltage that this electrochemical cell would produce.

- a) +0.67
- b) -0.93
- c) +0.93
- d) +0.80

Question 10

Photosynthesis occurs via the reaction shown below



Calculate the volume of carbon dioxide needed to produce 115.0 g of glucose at SLC.

- a) 87.01 L
- b) 95.07 L
- c) 14.50 L
- d) 15.84 L

Question 11

The basic hydrogen oxygen fuel cell can exist as either an acidic or alkaline fuel cell. Which of the following is correct about these two cells?

- a) $\text{KOH}_{(\text{aq})}$ is an appropriate electrolyte for both cells
- b) Hydrogen is the reductant in the acidic cell and the oxidant in the alkaline cell
- c) In the acidic cell the electrolyte is high in H^+ ion concentration and the alkaline cell is high in OH^- concentration
- d) The potential difference will be greater in the alkaline cell

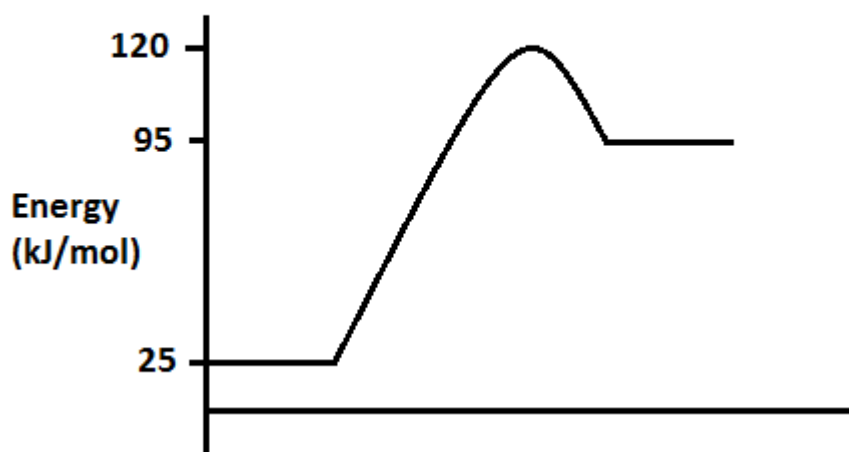
Question 12

Which of the following metals can't be produced via the electrolysis of an aqueous solution?

- a) Tin
- b) Lead
- c) Iron
- d) Manganese

Question 13

Below is the energy profile of a chemical reaction

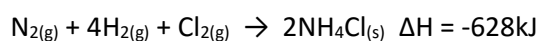
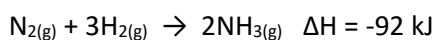
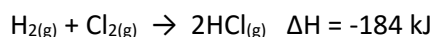


When an inorganic catalyst is added it reduces the activation energy of the reaction by 12 kJ/mol. The activation energy of the catalysed reverse reaction of the reaction shown in the profile would be...

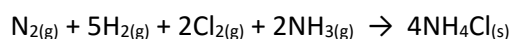
- a) 13 kJ/mol
- b) 83 kJ/mol
- c) 25 kJ/mol
- d) 95 kJ/mol

Question 14

Consider the thermochemical equations below



Determine the ΔH value for the equation below



- a) -1164 kJ
- b) -1348 kJ
- c) -536 kJ
- d) -720 kJ

Question 15

The percentage composition of four fruits is shown in the table below

Fruit	% Carbohydrates	% Fats and oils	% Protein
Apple	53	8	4
Avocado	6	2	17
Banana	23	1	1
Tomato	4	1	1

Which fruit has the lowest percentage of water?

- a) Apple
- b) Avocado
- c) Banana
- d) Tomato

Question 16

Which one of the following molecules doesn't contain a chiral carbon?

- a) $\text{CH}_3\text{CHOHCH}_2\text{CH}_3$
- b) $\text{CH}_2\text{BrCH}_2\text{Cl}$
- c) CH_3CHClOH
- d) $\text{CHClOHCH}_2\text{CH}_3$

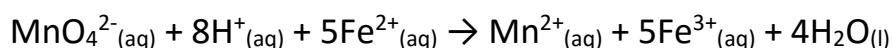
Question 17

Which of the following is essential for the operation of a rechargeable battery?

- a) High temperatures
- b) Volatile reactants and products
- c) Products to remain in contact with the electrodes
- d) The system must be insulated against the input of electricity

Use the following information to answer questions 18 -20

Kale is now commonly recognised as a superfood, meaning that it contains high levels of nutrients which are desirable to be consumed as part of our diet. Kale is supposed to have very high iron levels even compared to other leafy greens. The amount of iron present in kale was determined using redox titration with potassium permanganate solution. Iron reacts with permanganate as shown in the equation



A 50.00 g sample of kale was heated in a crucible until only ash remained, 5.00 g of the ash was dissolved using 10.00 ml of 0.5M HCl and transferred into a 200.00 ml volumetric flask and made up to the mark. A 20.00 ml aliquot of the iron solution was then titrated with 0.01M KMnO₄ solution. The average titre was found to be 4.32 ml.

Question 18

Calculate the concentration of iron in the stock solution

- a) 1.08×10^{-2} M
- b) 1.08×10^{-5} M
- c) 2.16×10^{-3} M
- d) 2.16×10^{-6} M

Question 19

Which of the following pieces of glassware should not be rinsed with the solution to be used?

- i. Burette
- ii. Pipette
- iii. Volumetric flask
- iv. Conical flask

- a) i, ii, iii and iv
- b) i and ii
- c) iii and iv
- d) None of them

Question 20

Which of the following actions if taken during the titration will increase the reliability of the analysis?

- a) Rinsing all of the glassware with the appropriate solutions
- b) Using an electronic balance which reads to 5 decimal places
- c) Using a greater number of concordant titres to calculate the average titre
- d) Using an electronic drop counter to measure each titres

Question 21

Which of the following is true of biodiesel but not bioethanol?

- a) They are produced from excess plant and animal waste
- b) They are non-renewable fuels
- c) They can be mixed with regular petrochemical fuels to create a greener alternative
- d) They are formed from triglycerides and small chain alcohols

Question 22

Generally, when the temperature of a reaction is increased the rate of the reaction will increase, this is best explained by which of the following statements?

- a) The particles have more energy to collide with each other thus they react at a higher rate
- b) The particles have more energy and collide more often resulting in a higher frequency of successful collisions
- c) The particles collide more often in the correct orientation resulting in a higher rate of reaction
- d) The particles have more energy and thus more particles are able to overcome the activation energy for the reaction resulting in a higher rate of reaction

Question 23

The molar heat of combustion of cyclohexane is 3920 kJ/mol. Calculate the mass of cyclohexane, in kg, required to produce 15 MJ of energy.

- a) 32.1 kg
- b) 3.21 kg
- c) 0.321 kg
- d) 0.0321 kg

Question 24

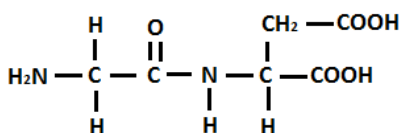
Given that an unknown chemical's empirical formula is C_2H_4N which of the following would you expect to appear on the unknown chemical's IR spectrum

- a) A strong peak at approximately 3400 cm^{-1} due to an O-H bond
- b) A strong peak at approximately 3400 cm^{-1} due to an N-H bond
- c) A strong peak at approximately 1750 cm^{-1} due to a C=O bond
- d) A strong peak at approximately 1750 cm^{-1} due to a C=C bond

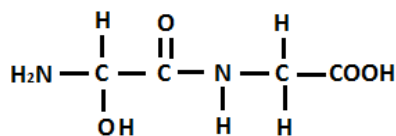
Question 25

Which of the following dipeptides contains only non-polar Z groups?

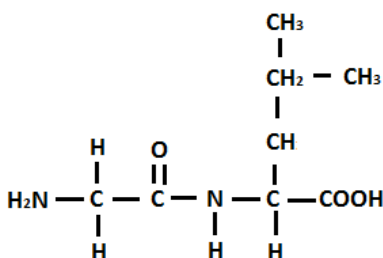
a)



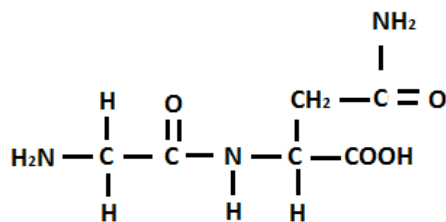
b)



c)



d)



Question 26

Consider the three reactions shown below

- i. $\text{P}_4(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons \text{P}_4\text{O}_{10}(\text{s}) \quad \Delta H = -3643\text{ kJ/mol}$
- ii. $\text{OH}^-(\text{aq}) + \text{H}^+(\text{aq}) \rightleftharpoons \text{H}_2\text{O}(\text{l}) \quad \Delta H = -57\text{ kJ/mol}$
- iii. $2\text{H}_2\text{O}(\text{g}) \rightleftharpoons 2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \quad \Delta H = +484\text{ kJ/mol}$

Which of the reactions would show an increase in yield of the forward reaction if the temperature is increased and the pressure is decreased?

- a) i and ii
- b) i, ii and iii
- c) ii only
- d) iii only

Question 27

Calculate the molecular mass of a piece of cellulose that consists of 453 glucose monomer units.

- a) 73404 g/mol
- b) 81540 g/mol
- c) 8154 g/mol
- d) 73386 g/mol

Question 28

Vitamin C is an antioxidant and can be used to preserve food, food containing triglycerides composed of which of the following fatty acids would require the greatest amount of vitamin C to preserve it?

- a) Myristic acid
- b) Arachidic acid
- c) Linoleic acid
- d) Linolenic acid

Question 29

Most food molecules including vitamins, fatty acids and amino acids can be classified as either essential or non-essential, Essential food molecules are those that...

- a) Can't be synthesised by the body so must be consumed as part of the diet
- b) Are essential to all bodily functions
- c) Are only found in leafy greens
- d) Require greater amounts of energy to be synthesised in the human body

Question 30

Which of the following is incorrect about protein structure?

- a) Primary structure is the only level that remains intact after a protein denatures
- b) Secondary structure is held together by hydrogen bonds between amide links
- c) Tertiary structure is held together by hydrogen bonds between side groups of amino acids
- d) Quaternary structure involved more than one peptide chain

Section B – Short Answer

Answer all questions in the spaces provided. Write using black or blue pen.

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, $\text{H}_2(\text{g})$, $\text{NaCl}(\text{s})$.

Unless otherwise indicated, the diagrams in this booklet are not drawn to scale.

Question 1 (10 marks)

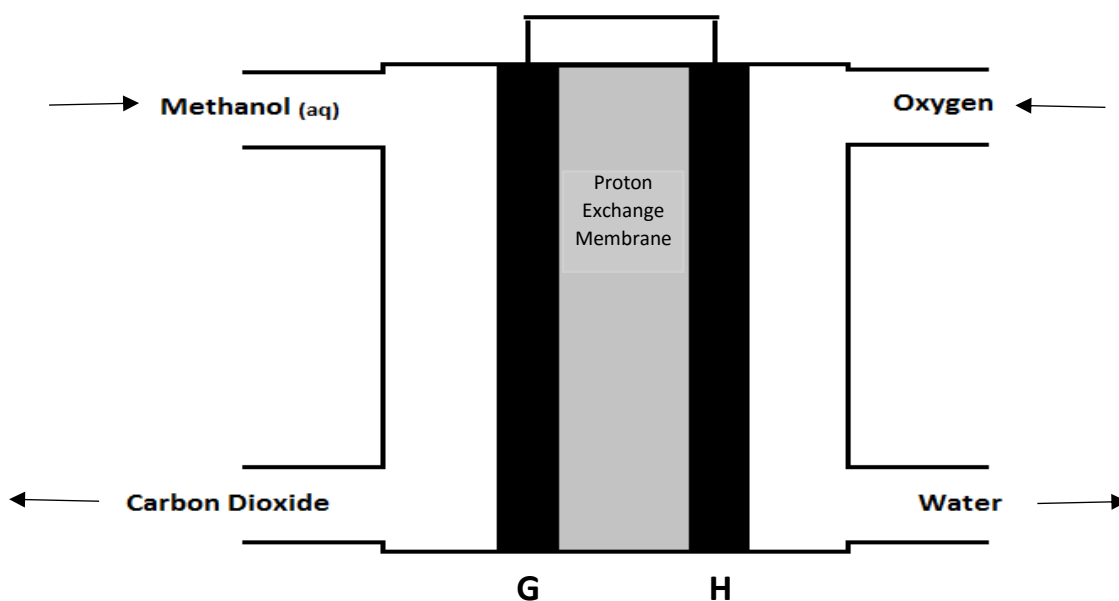
Living in isolated areas such as rural Australia require residents to have an emergency source of power to use in times of need as help and relief is often 100's of kilometres away. Most people that live in these types of communities have emergency power generators, in the past these have mostly been diesel powered generators but in recent times fuel cell generators are becoming more popular.

Two popular choices for people are the direct methanol fuel cell generator or the standard diesel generator.

- a) Suggest 1 reason why a consumer would choose a fuel cell generator over a diesel generator

1 mark

A diagram of the methanol fuel cell is shown below



b) Given that methanol is oxidised to carbon dioxide, write the two half equations for the methanol fuel cell

Anode: _____

Cathode: _____

2 marks

c) On the diagram label

- i. The polarity of electrode G
- ii. The direction of electron flow

2 marks

d) Diesel is composed of a mixture of hydrocarbons with one of the main components being $C_{12}H_{26}$. Write an equation for the complete combustion of this hydrocarbon

2 marks

e) Given that a diesel generator has a 450 L fuel tank and diesel has a density of 0.832 g/ml calculate the energy in GJ that could be produced from a diesel generator with fuel tanks.

3 marks

Question 2 (10 marks)

Choosing appropriate fuels to power and propel our modern technology is a decision many scientists and engineers must make. Three possible fuels that could be used include petrol (octane), ethanol and hydrogen, each has a different energy output and advantages and disadvantages associated with it.

A student wanted to compare these fuels for two possible uses; propelling a rocket and powering a generator.

- a) Determine which fuel will produce the most energy from 15.0 kg of fuel.

4 marks

Explain why hydrogen would be considered the greenest fuel choice of the three options

2 Marks

b) Propose which fuel would be best suited to the two purposes the student was investigating, justify your selection for each purpose.

4 marks

Question 3 (7 marks)

Justine was designing an experiment to investigate how redox reactions can be used to generate electricity.

- a) Explain how the structure of a galvanic cell allows for chemical energy to be transformed into useable electrical energy

2 marks

Justine began by setting up 5 different half cells

1. $\text{Zn(s)} / \text{Zn(NO}_3)_2(\text{aq})$
2. $\text{Ag(s)} / \text{AgNO}_3(\text{aq})$
3. $\text{Cu(s)} / \text{Cu(NO}_3)_2(\text{aq})$
4. $\text{Fe}^{2+}(\text{aq}) / \text{Fe}^{3+}(\text{aq})$
5. $\text{Ni(s)} / \text{Ni(NO}_3)_2(\text{aq})$

- b) Identify which half cell wouldn't use a solid metal electrode and suggest a possible substitute.

2 marks

- c) Identify which pair of half cells would generate the highest voltage?

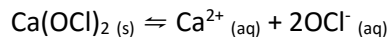
1 mark

- d) Describe two observations Justine would make about the electrodes in the galvanic cell composed of the Silver and Nickle half cells.

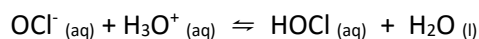
2 marks

Question 4 (6 marks)

Swimming pools are an excellent way to escape the heat in summer but they must be chlorinated to ensure that the water stays safe for swimming. The chemical used to chlorinate pools is called calcium hypochlorite ($\text{Ca}(\text{OCl})_2$). It dissolves the water according to the equation below



The hypochlorite then reacts with H_3O^+ in the water to form hypochlorous acid; an effective antibacterial agent and algaecide.



The H_3O^+ comes from the self-ionisation of water.

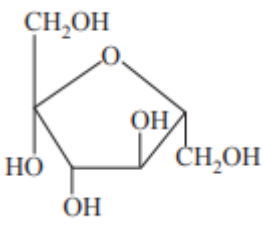
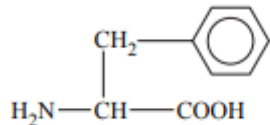
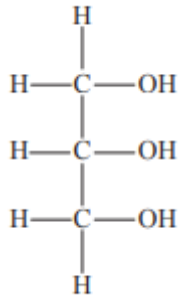
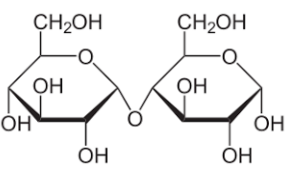
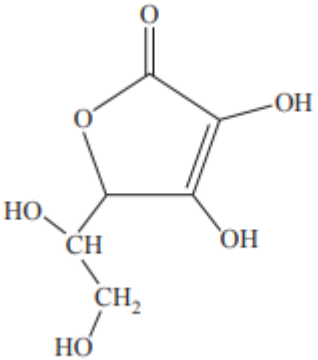
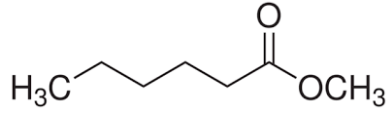
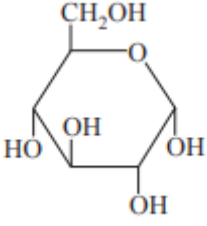
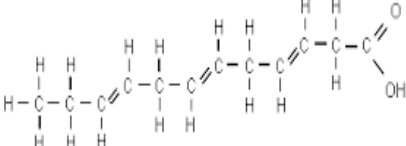
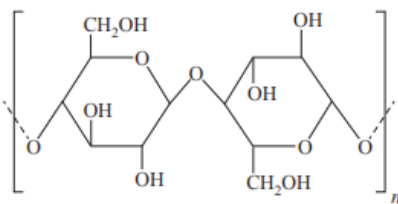
- a) Explain what would happen to the pH of the pool water if you added more calcium hypochlorite to the pool

3 marks

- b) The optimum pH range for a backyard swimming pool is between 7.2 and 7.8. Explain what you would have to do and why if the pH of your pool was 8.2.

3 marks

Question 5 (8 marks)

<p>A</p> 	<p>B</p> 	<p>C</p> 
<p>D</p> 	<p>E</p> 	<p>F</p> 
<p>G</p> 	<p>H</p> 	<p>I</p> 

a) Identify which of the biomolecule/s in the table apply to each statement

i. Can be metabolised by maltase

1 mark

ii. Undergo condensation reactions to form triglycerides

1 mark

iii. Can form peptide links

1 mark

iv. Are a major component of biofuels

1 mark

v. Is a water soluble vitamin

1 mark

vi. Is metabolised by breaking the glycosidic link via hydrolysis

1 mark

b) Draw the triglyceride that would be formed by the molecules identified in part a) ii)

2 marks

Question 6 (9 marks)

The vast number of organic molecules in existence are categorised and organised using a set of systematic nomenclature, the first level of organisation is into homologous series.

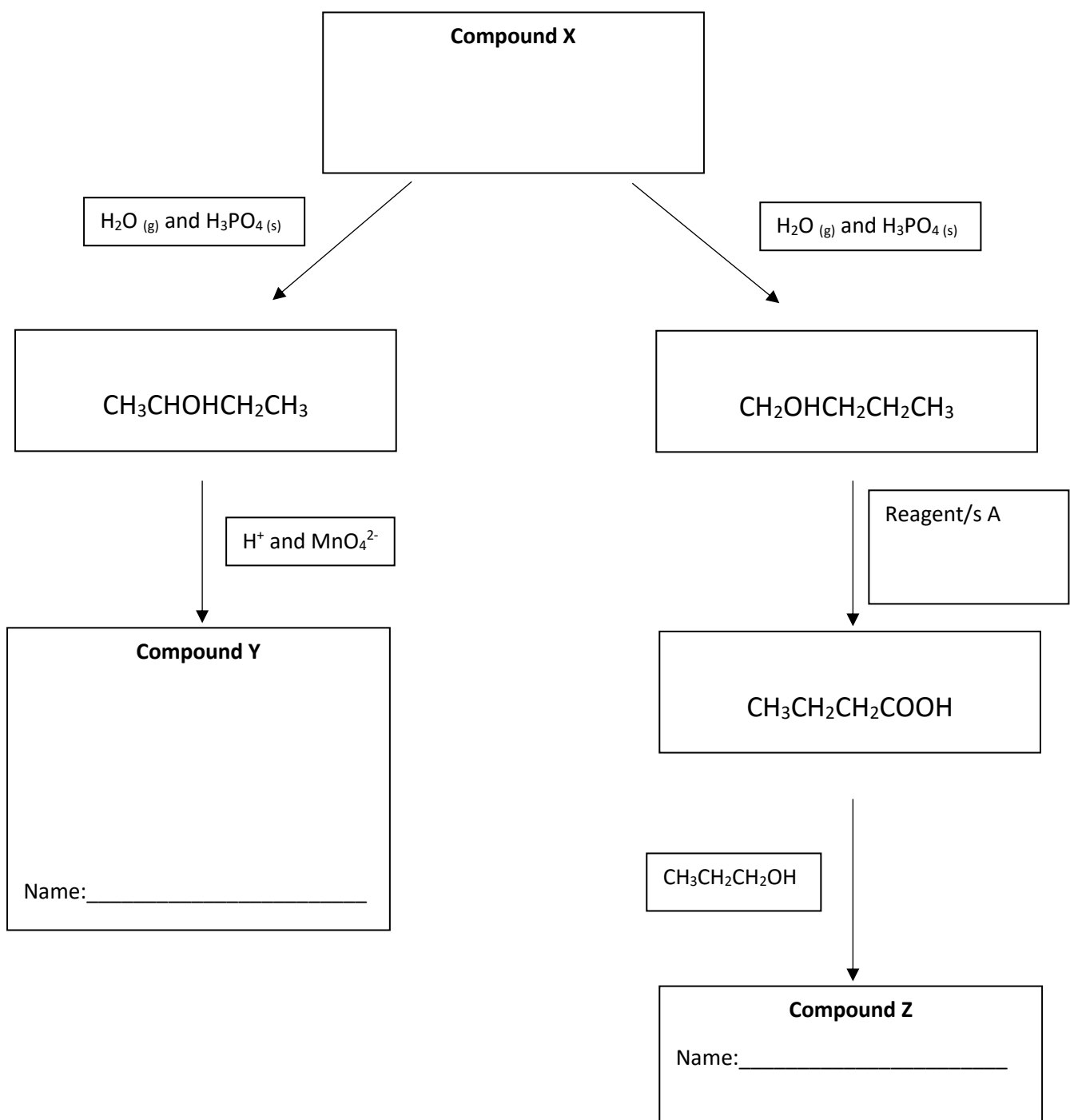
- a) Draw the structural formula for a molecule with 5 carbons that belongs to each of the following homologous series and provide its systematic name

Haloalkane	
	Name: _____
Aldehyde	
	Name: _____

4 marks

- b) Consider the reaction pathway shown in the flow chart on the next page
- Draw the semi-structural formula for compound X in the space provided
 - Draw the structural formula of compound Y in the space provided
 - State the systematic names of compounds Y and Z in the spaces provided
 - State chemical formula of reagent/s A in the space provided

5 marks



Question 7 (8 Marks)

Methionine is a very important amino acid in maintaining normal cell function within the body and is used to synthesis cysteine another important amino acid.

- a) Name the type of tertiary bond that only methionine and cysteine can form

1 Mark

- b) Proteins with a large number of the bond mentioned in part a tend to have a larger pH and temperature tolerance range, suggest why this might be

2 Marks

- c) Draw methionine as a zwitterion

1 Mark

- d) Methionine can be absorbed by the body through the metabolism of protein in food. Name the type of reaction involved in the metabolism of proteins.

1 Mark

Methionine can be manufactured in the body with the aid of an enzyme called methionine synthase. This enzyme also requires a cobalt containing coenzyme called cobalamin.

e) Outline to role the coenzyme plays in this reaction

3 Marks

Question 8 (5 Marks)

Butan-2-one and butanal are very similar organic molecules with the same molecular formula and weight

- a) State the molecular formula for the two compounds

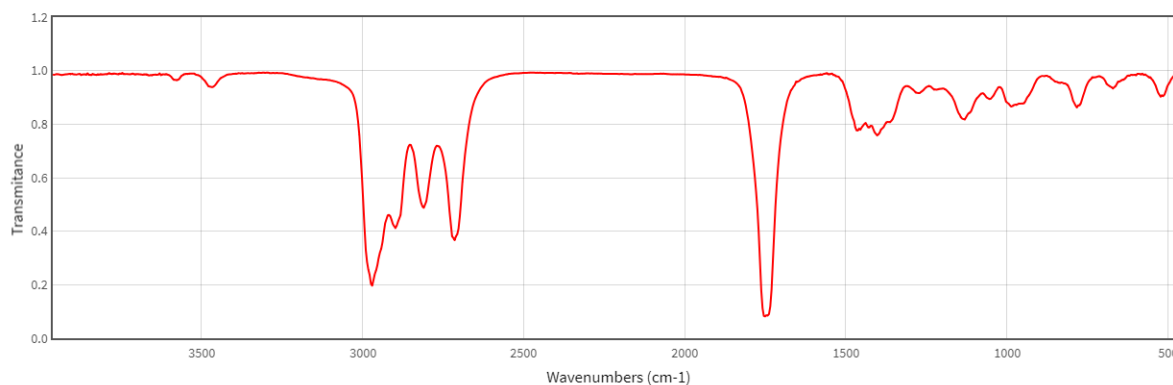
1 Mark

- b) Explain why butan-2-one and butanal are considered positional isomers and not chain isomers

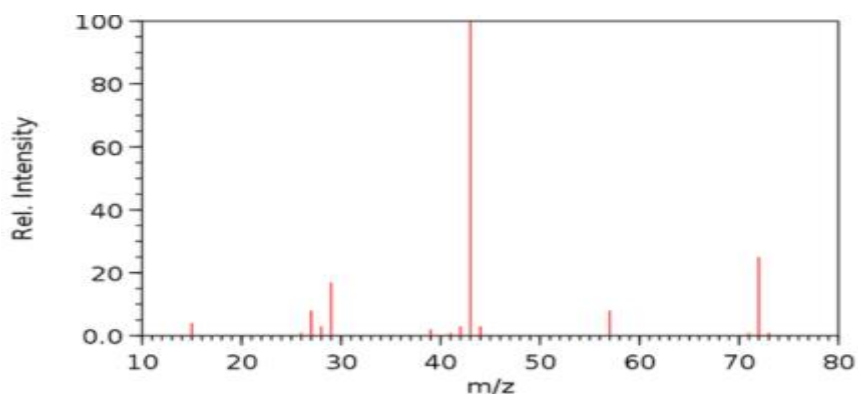
1 Mark

Both substances are colourless liquids at room temperature, 50.00 ml of each were measured into conical flasks and not labelled. Each sample was run through a mass spectrometer, infrared spectrometer and HNMR spectrometer. Some of the spectra are shown below

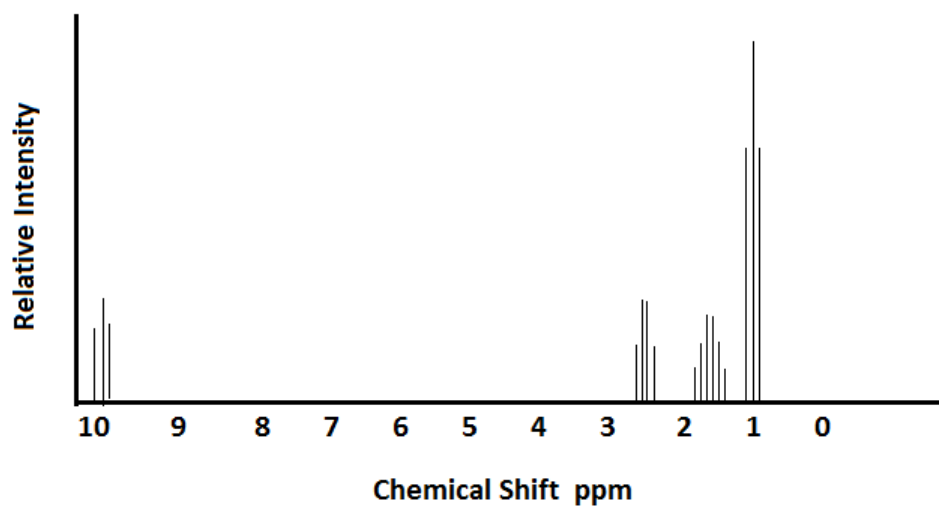
IR of Sample A



Mass Spectrum of Sample B



H NMR of Sample A



c) Using two pieces of evidence from the spectra provided determine the identity of Sample A

3 marks

Question 9 (9 Marks)

Tegan set up an electrolysis experiment in an effort to investigate the mass of metal that would be deposited on a stainless steel key when electroplated using each of the following solutions

1. Copper(I) Nitrate
2. Silver Nitrate
3. Tin(II) Nitrate
4. Chromium Nitrate

Tegan ran her experiment by electroplating a key with each solution, she ran each cell for 15 minutes at 25.0 A.

- a) Calculate the mass of tin that should deposit onto the key when she electrolyses the tin(II) nitrate solution

3 Marks

- b) Identify and explain which of the solutions would deposit the least number of mole of metal onto the key.

2 marks

Below are the results of Tegan's experiment

Metal Solution	Initial mass of key (g)	Final mass of key (g)
Copper(I) Nitrate	12.4	26.3
Silver Nitrate	11.9	32.4
Tin(II) Nitrate	12.7	23.6
Chromium(III) Nitrate	12.1	15.9

- c) Compare the theoretical amount calculated in part a and the amount recorded in Tegan's results and explain the difference.

2 Marks

- d) Explain why Tegan wouldn't be able to electroplate one of her keys with magnesium metal using this method

2 Marks

Question 11 (7 marks)

Many of the biological molecules within the human body, including enzymes, coenzymes, proteins and substrates are chiral.

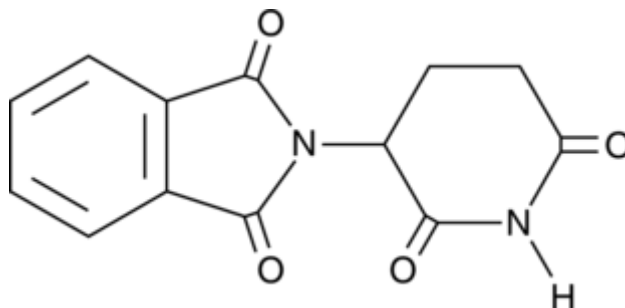
Explain what is meant by the term chiral

1 mark

Discuss how the functioning of an enzyme relies on the idea of chirality, explain with reference to molecular structure, why only one optical isomer of the substrate will enable the enzyme to function.

5 marks

Thalidomide was a famous occurrence in the evolution of drug design. It was a drug given to women in the 1960's for morning sickness. One enantiomer of the substance worked as intended but another optical isomer of the substance cause horrific birth defects. The structure of thalidomide is shown below



On the structure circle a chiral centre

1 mark