

STUDENT NAME:

## VCE CHEMISTRY

### Unit 3 & 4 Trial Examination 2023

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	11	11	90
			<b>Total 120</b>

- Students are permitted to bring into the exam room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the exam room: blank sheets of paper and/or white out liquid/tape.
- Students are not permitted to bring into the exam a mobile phone, electronic devices or wear a smart watch.

#### Materials supplied

- Question and answer booklet of 29 pages
- A VCAA data booklet (at very least a Periodic table and electrochemical series)
- Answer sheet for multiple-choice questions.
- 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.
- Write your **student name** on your answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are **NOT** drawn to scale.
- All written responses must be in English.

**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**

Which of the following amino acids has a six-carbon ring in the R component?

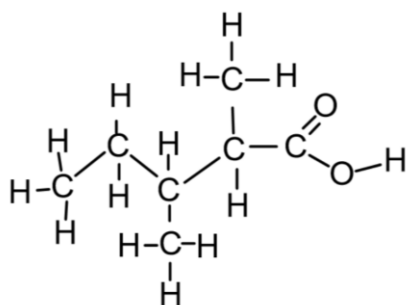
- A. His
- B. Phe
- C. Pro
- D. Val

**Question 2**

Which of following statements about HPLC is **not** true?

- A. It can be used to determine what chemicals are present in a sample
- B. It is unable to determine how much of each chemical is present
- C. Small particles in the solid phase create resistance to flow of the mobile phase
- D. The read out gives a graph of Absorbance versus time

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



### Question 3

The IUPAC name of the compound is:

- A. 2,3-dimethyl pentanoic acid
- B. 3,4-dimethyl pentanoic acid
- C. heptanoic acid
- D. 3-ethyl-2-methyl butanoic acid

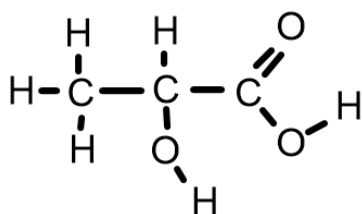
### Question 4

When this molecule reacts with propanol, how many different molecular products will form

- A. 0
- B. 1
- C. 2
- D. 3

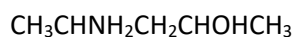
### Question 5

Lactic acid is a common name for the following molecule



The  $^{13}\text{C}$  NMR read out has 4 peaks. The peak that corresponds to the primary carbon will have a chemical shift (ppm) of:

- A. 0.00
- B. 22.8
- C. 71.2
- D. 185

**Question 6**

The name of this molecule is:

- A. 2-aminopentan-4-ol
- B. 4-aminopentan-2-ol
- C. 2-hydroxypentan-4-amine
- D. 4-hydroxypentan-2-amine

**Question 7**

Which of the following could be considered a biofuel?

- A. Methanol produced from fractional distillation
- B. Ethanol produced from ethene and water
- C. Methane produced from farm waste
- D. Methane from fracking

**Question 8**

Which of the lists has the carbohydrates listed from lowest glycaemic index value to highest glycaemic index value?

- A. Amylose, Amylopectin, Cellulose
- B. Amylopectin, Cellulose, Amylose,
- C. Cellulose, Amylose, Amylopectin,
- D. Amylopectin, Amylose, Cellulose

*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 eating two servings of tacos?

- A. 52.4
- B. 535
- C. 1115.5
- D. 2231

### Question 10

Which of the following statements is true when referring to the energy content due to protein:

- A. A serving of fried rice provides more than three times the energy compared to tacos
- 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 40 kJ

### Question 11

The molecule  $C_5H_{10}O_2$  has a number of isomers; including organic acids, esters, hydroxyketones and hydroxyaldehydes

Which of the following is not an isomer of  $C_5H_{10}O_2$ ?

- A. 2,2-dimethylpropanoic acid
- B. Butyl methanoate
- C. Ethyl ethanoate
- D. Pentanoic acid

**Question 12**

Which of the following is an omega-6 fatty acid?

- A. Linoleic acid
- B. Linolenic acid
- C. Oleic acid
- D. Palmitoleic acid

**Question 13**

When 3.2g of butan-1-ol is completely combusted, the volume of CO<sub>2</sub> released at 130°C and 120kpa is closest to:

- A. 0.389L
- B. 1.21L
- C. 1.56L
- D. 4.83L

**Question 14**

An equation for the complete combustion of butane is



ΔH for this equation would be

- A. +49.7 kJ g<sup>-1</sup>
- B. -49.7 kJ g<sup>-1</sup>
- C. +5760 kJ mol<sup>-1</sup>
- D. -5760 kJ mol<sup>-1</sup>

**Question 15**

The bonding involved in the secondary structure of a protein is

- A. Dispersion forces
- B. Ether link
- C. Hydrogen bonding
- D. Peptide link

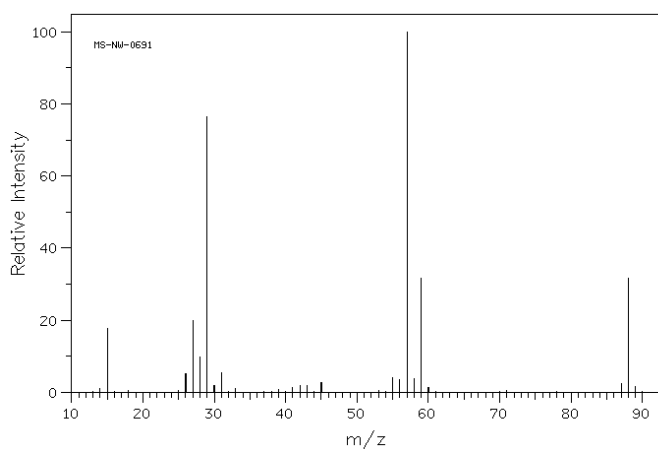
**Question 16**

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

- A. All titrations need an indicator
- B. The aliquot is delivered by a pipette
- C. The equivalence point for a weak base and a strong acid is less than pH 7
- D. The end 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 peak at 29 could be caused by:

- A.  $\text{CH}_3\text{CH}_2^+$
- B.  $\text{CHO}^+$
- C.  $\text{CHNH}_2^+$
- D. All of the above

**Question 18**

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

- A. All fragments are positively charged
- B. Fragmentation is caused by electrons being added onto the sample molecules
- C. The base peak always has a relative intensity of 100
- D. This graph could come from a sample of  $\text{C}_5\text{H}_{12}\text{O}$

**Question 19**

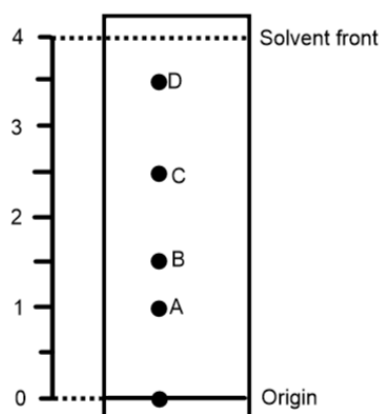
The dependent variable is

- A. Controlled by the researcher
- B. Graphed on the horizontal axis
- C. Kept constant during the investigation
- D. The variable that changes in response to the independent variable

**Question 20**

Scientists have been asked to determine the structure of an unknown substance. Which of the following statements is a correct step in the process to determine the structure.

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

**Question 21**

Which of the following statements is correct?

- A. Component A is the least strongly adsorbed to the stationary phase
- B. Component B has an R<sub>f</sub> value of 0.375
- C. Component C has an R<sub>f</sub> value of 0.25
- D. Component D is the most strongly adsorbed to the stationary phase



**Question 22**

Which of the following are comparisons is not correct?

	Fuel	Advantages	Disadvantages
A.	Natural gas	Easy to transport through pipes	Non-renewable
B.	Biogas	Made from waste	Low energy content
C.	LPG	Low cost	Non-renewable
D.	Bioethanol	High level of particulates	Limited supply of raw material

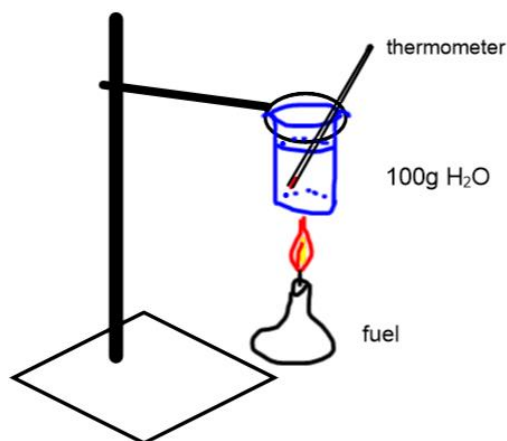
**Question 23**

An unknown organic molecule is known to have one oxygen in its molecular formula. From carbon NMR data, the Chemical shift value of 205, suggests it might be

- A. A ketone
- B. An ester
- C. A secondary alcohol
- D. A primary alkanol

**Question 24**

2-methylpropan-1-ol has a heat of combustion of 36.1 kJ/g. 1.1g of 2-methylpropan-1-ol is burned in a spirit burner below a can containing 100 g of water



If the final temperature of the water is 70.5 °C, and assuming 60% of the heat is lost to the environment, what was the initial temperature of the water?

- A. 13.5 °C
- B. 32.5 °C
- C. 38.0 °C
- D. 57.0 °C

**Question 25**

Which of the following reactions is a condensation reaction?

- A. Oxidation of hydrogen sulphide to sulphur
- B. Production of carboxylic acids from alcohols
- C. Production of triglycerides from fatty acids
- D. Reduction of  $\text{MnO}_2$  to  $\text{Mn}^{2+}$

**Question 26**

The role of Vitamin C in slowing the rate of deterioration of food is to:

- A. Act as an emulsifier
- B. Be preferentially oxidised
- C. Dehydrate the food
- D. Stop free radicals

*The following information is to be used to answers 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
- $\text{AgNO}_3$  (1M)
- $\text{CuSO}_4$  (1M)
- $\text{FeSO}_4$  (1M)
- $\text{ZnNO}_3$  (1M)
- $\text{KNO}_3$  (1M)

**Question 27**

A cell is to be made using  $\text{AgNO}_3$  and a silver electrode on one side and  $\text{FeSO}_4$  and the nail on the other. What the expected Voltage of the cell?

- A. 0.36
- B. 0.44
- C. 0.80
- D. 1.24

**Question 28**

A different student is given the same materials, but puts the carbon rod in the copper solution and the nail in the  $\text{FeSO}_4$  solution. The voltmeter shows 0. What is the most likely cause?

- A. A direct reaction is happening between the nail and iron 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 a disulphide bridge?

- 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 the cell runs for 3.00 hours, how much copper will be deposited on the cast, if it operates at 8.00 Amp current?

- A. 0.474g
- B. 0.948g
- C. 28.4g
- D. 56.9g

**END OF SECTION A**

**Section B – Short Answer Questions****Instructions for Section B**

Answer **all** questions in the spaces provided but if more space is needed, use the additional working space at the end and clearly label your answer.

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** (9 marks)

- a) Using structural formulae for all reactants and products, write a balanced equation for the formation of ethanamide from ethanoic acid. (States are not required.) [3 marks]

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The amide group is also produced when amino acids combine.

- b) i. Draw the two possible isomers when alanine and serine form a dipeptide. [2 marks]

- ii. How many chiral centres are found in either of the isomers? [1 mark]

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- c) i. Draw a Zwitterion of alanine in an intermediate pH environment. [1 mark]

- ii. Draw the structure of aspartic acid in a high pH environment. [2 marks]

**Question 2** (5 marks)

Propane is used in domestic gas bottles commonly found attached to a backyard BBQ. An environmentally conscious family want to calculate how much CO<sub>2</sub> they are producing each time they cook a meal on their BBQ. They weigh a gas bottle before they start cooking and it is 3.27kg. After the cooking is finished, they reweigh the bottle and find that it now weighs 3.04kg.

- a) Write the balanced thermochemical equation for the complete combustion of propane. [2 marks]

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- b) What volume, in L, of CO<sub>2</sub> will be produced if the air temperature is 30 °C, and the air pressure is 101.7 kPa? [3 marks]

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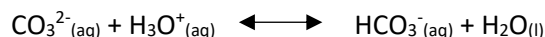
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**Question 3** (9 marks)

Climate change is affecting the balance of carbonate ions,  $\text{CO}_3^{2-}(\text{aq})$ , in the ocean. Shellfish and sea snails use the carbonate ions, in the form of calcium carbonate, to build their protective exoskeleton.

The process of making carbonate ions involves  $\text{CO}_2(\text{g})$  from the atmosphere dissolving in water, forming a hydrogen carbonate ion and then the carbonate ion; each step in the process is an equilibrium reaction.

The final step is written below:



- a) Write an expression for the equilibrium constant involving only the aqueous ions. [1 mark]

A group of scientists have decided to model this process to better understand how to protect marine invertebrates.

In the laboratory, under standard laboratory conditions (SLC), hydrogen carbonate ions, in the form of solid potassium hydrogen carbonate, were put in a fish tank containing 20L of deionised water. Initially 20.0g of  $\text{KHCO}_3$  was placed in the tank. The next day, the scientists measured the concentration of carbonate ions and found that it was 0.0034M. They decided not to start their calculations. The following day, the concentration of carbonate ions was retested, and again the concentration was 0.0034M.

- b) Why did the scientists measure the carbonate concentration two days in a row? [1 mark]

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- c) i. Calculate the value of  $K_c$  at 25°C. [3 marks]

ii. State the unit for the equilibrium constant.

[1 mark]

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d) What is the pH in the fish tank at equilibrium?

[1 mark]

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A literature research by the scientists has found that the pH of the ocean is 8.1. They decide that they want the equilibrium pH to also be 8.1. To increase the pH in the tank, it is decided to add sodium hydroxide (NaOH).

e) With reference to Le Châtelier's principle, describe what will happen to the carbonate ion concentration as a result of adding the sodium hydroxide. [2 marks]

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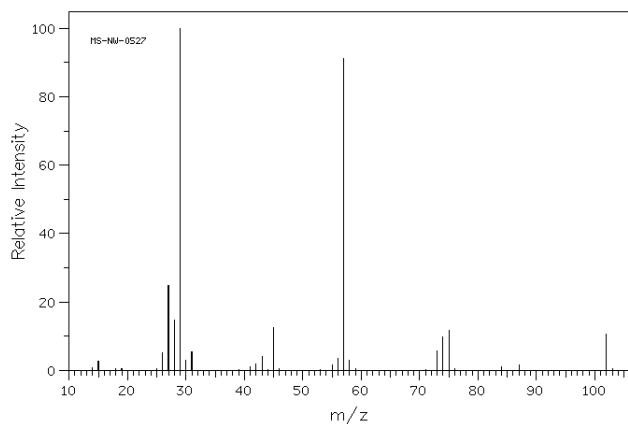
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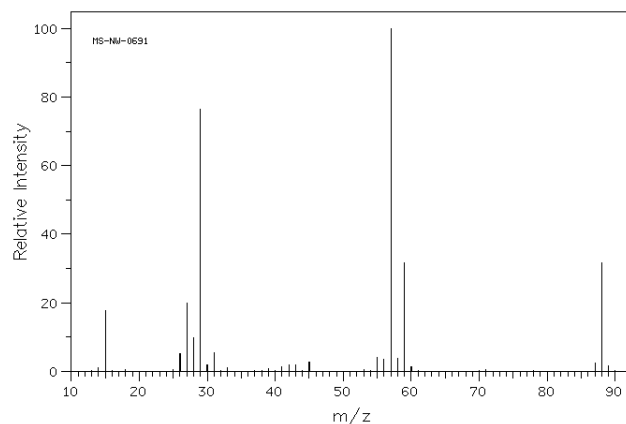
**Question 4** (6 marks)

The two mass spectra below represent two esters as labelled.

Ethyl propanoate



Methyl propanoate



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

National Institute of Advanced Industrial Science and Technology

- a) What is the base peak for ethyl propanoate? [1 mark]

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There are a number of similarities and differences between the two spectra.

- b) Explain why they both have strong peaks at 29 and 57. [2 marks]

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- c) What is the most likely fragment represented by the peak at 15? [1 mark]

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- d) Why is the peak at 15 for methyl propanoate much higher than the peak at 15 for ethyl propanoate? [2 marks]

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**Question 5** (12 marks)

People who suffer from Gastroesophageal reflux disease (GERD) are often placed on special diets to treat the condition.

The GERD diet suggests multigrain bread, which is low GI, instead of white bread, which is high GI.

- a) What does GI stand for? [1 mark]

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- b) During digestion, starch breaks down to what smaller molecules? [1 mark]

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Another part of the GERD diet is to reduce dairy intake. Lactose is a sugar found in milk.

- c) i. Lactose intolerance is caused by a lack of what protein? [1 mark]

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- ii. What could a lactose intolerant person do to help them digest lactose? [1 mark]

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Another part of the GERD diet is a low-fat intake.

- d) What is the basic difference between fats and oils? [2 marks]

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The World Health Organisation (WHO) states that “Industrial trans fats are not part of a healthy diet”. Trans-fat is often found in fast foods, snack foods and fried foods.

- e) Explain how the structure of a monounsaturated trans-fat potentially leads to more health issues compared to the naturally occurring cis fat isomer. [2 marks]

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The GERD diet does allow for fish to be eaten. It is known that fish has a high level of omega-3 and omega-6 fatty acids

- f) i. What is the difference between omega-3 and omega-6 fatty acids? [1 mark]

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- ii. What makes these fats, more easily digested than a saturated fat like stearic acid, found in beef? [3 marks]

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**Question 6** (8 marks)

Lentils are a source of protein.

Proteins are broken down into amino acids and then moved around the body in the bloodstream to the places that they are needed for growth and repair of tissue and other functions

- a) Describe the process of breaking down protein to form amino acids. In your response, start with the cooked lentil in the mouth and finish with the absorption of amino acids into the blood stream in the small intestine. [4 marks]

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- b) Enzymes form an essential part of the digestion of macromolecules in the body. Discuss the effects that lowering, and raising, the body's core temperature has on enzymes. In your response, refer to what happens to the enzymes once the body's temperature returns to normal. [4 marks]

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**Question 7** (11 marks)

Enzymes are biological catalysts speed up the rate of reaction. All amino acids, except glycine are chiral. When molecules and optical isomers react with assistance from an enzyme, only one enantiomer forms an enzyme-substrate complex in the active site. At the start of the twentieth century, scientists understood enzyme action via the “Lock and Key” model. At the start of the twenty first century, scientists understand enzyme action via the “Induced fit” model.

a) Define the following terms: [4 marks]

i. Chiral

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ii. Enantiomer

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iii. Enzyme-substrate complex

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iv. Active site

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- b) What are the similarities and differences between the “Lock and key” model and the “Induced fit” model. [4 marks]

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One of the many uses of Vitamin C in the human body is as a coenzyme.

- c) Describe the role of coenzymes in activating a previously inactive enzyme. A diagram may be helpful, but is not necessary to gain full marks. [3 marks]

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**Question 8** (7 marks)

As a way to help tackle climate change, researchers have been investigating using ascorbic acid (AA), commonly known as vitamin C, as a fuel source in a new fuel cell. AA is oxidised to dehydroascorbic acid (DHA)  $C_6H_6O_6$ . Whilst this type of cell is called a Direct Liquid Fuel Cell (DLFC), the researchers have been trialling various gels to carry the AA into the cell. The cell uses an acid as the electrolyte and oxygen, from the air, is converted to water.

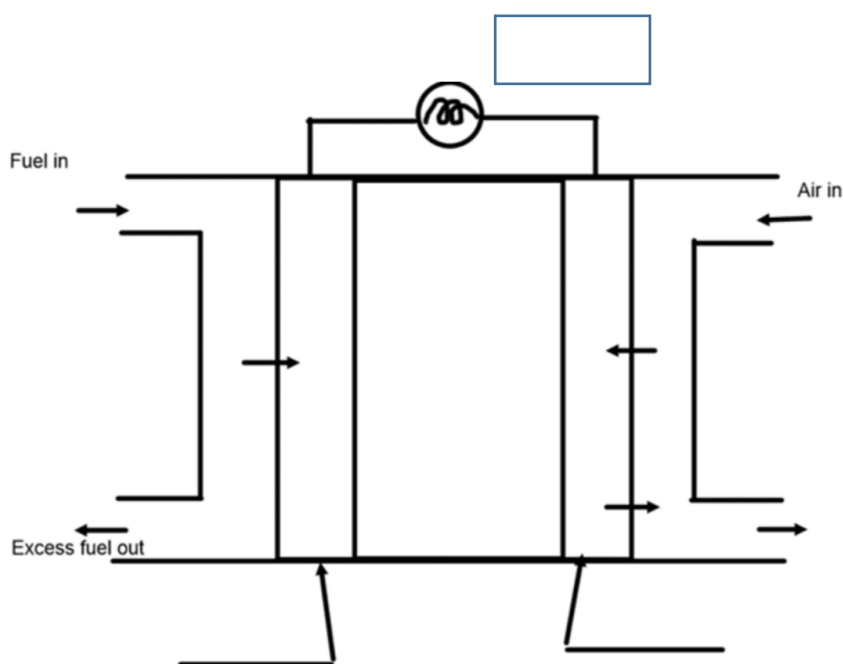
- a) Write the half equation for the oxidation of AA to DHA. (No need to include states.)

[2 marks]

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- b) Label the anode and the cathode on the lines above. [1 mark]
- c) In the box above, draw an arrow to indicate the direction of the electron flow. [1 mark]
- d) What is the reductant in this cell? [1 mark]

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- e) Write the overall reaction for the fuel cell. (No need to include states.) [2 marks]

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**Question 9** (7 marks)

In recent years there has been a push by governments for households to monitor and check old gas heaters. Old heaters can become inefficient, wasting money for the home owner, but more importantly, they can become dangerous if they start producing carbon monoxide.

- a) Write a balanced equation for the incomplete combustion of methane, where carbon monoxide is the only carbon based-product. [1 mark]

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The heat of combustion of methane when CO is produced, is 556 kJ/mol. An old gas heater in a particular home is checked and it is determined that only 80% of the methane is converted to CO<sub>2</sub> and 20% is converted to CO.

- b) If 2000g of gas is used (assume it is 100% methane), what is the total energy produced, in MJ, by the heater that is operating at 80% complete combustion. [3 marks]

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If a person suffers from carbon monoxide poisoning, the treatment is to give pure oxygen.

- c) Discuss how this treatment removes carbon monoxide. In your response, refer to the competing equilibria between the formation of carboxyhaemoglobin and oxyhaemoglobin. [3 marks]

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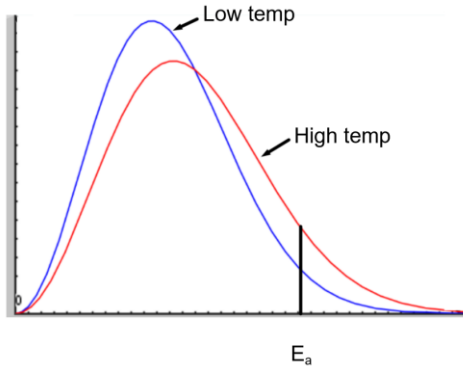
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**Question 10** (7 marks)

Ethene and hydrogen have a relatively slow reaction rate at SLC. On the Maxwell-Boltzmann distribution below, this is represented by the *Low temp* line. The reaction rate increases when the gases are heated to 400K, represented by the *High temp* line.



- a) Use collision theory to explain why the rate of reaction increases at the higher temperature. In your answer refer to the Maxwell-Boltzmann distribution and include shading at least one area. [4 marks]

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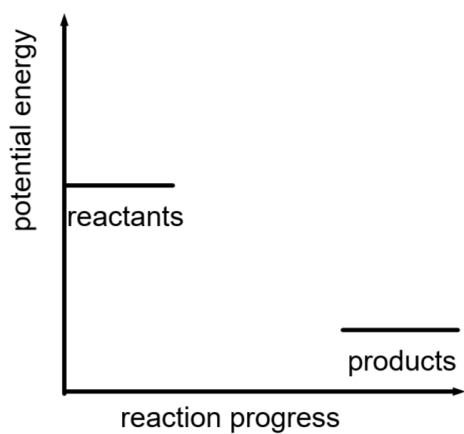
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- b) By using a platinum catalyst, the low temp reaction will occur much quicker.
- Indicate on the diagram above, the change to the activation energy that occurs when a catalyst is used. [1 mark]
  - Indicate on the energy profile diagram below the effect the catalyst has. Draw and label the energy profile both with, and without, a catalyst. [2 marks]



**Question 11** (9 marks)

Two year 12 students decided to investigate if the presence of a double bond in a molecule changed the heat of combustion. They decided to use cyclohexane and cyclohexene to test their hypothesis that,

“The presence of a double bond in a hydrocarbon will result in a higher heat of combustion”

They used the following method:

**Method**

1. Set up according to model.
2. Fill a can with 100ml of water, record initial temperature.
3. Weigh spirit burner containing fuel, record mass.
4. Light spirit burner to heat water, Stir continuously.
5. Once temperature has risen 6 - 7°C, extinguish flame and record the highest temperature reached by the water.
6. Repeat for the second fuel.

The following are extracts from their Discussion and Conclusion

The results of the experiment found that Cyclohexane had a heat of combustion of 14kJ/mol and that Cyclohexene had a heat of combustion of 240kJ/mol. This shows that Cyclohexene has a much higher heat of combustion than that of Cyclohexane. This suggests that the presence of a double bond results in a higher heat of combustion.

Limitations of this experiment include: the assumption that all energy released from the combustion of a fuel was transferred into thermal energy in the water was not scientifically accurate – some energy was more likely lost into surroundings. This means the calculated heat of combustion would have been lower than in reality. However, as this experiment was used to compare the energy content *differences* between each fuel, the heat loss was not all that relevant, as this does not change the relative *difference* in energy transferred to water.

Possible errors may have occurred in the measuring of the volume of the water and the measuring of the mass of the fuel, with inaccuracies in the scales and measuring cylinder.

Some additional notes about the student’s report.

- There is no mention of the accepted values of Heat of Combustions from other experiments. These are listed below:
  - Cyclohexane -3920 kJ/mol
  - Cyclohexene -3800 kJ/mol
- There were no sample calculations given
- Only one experiment per fuel was carried out, as per the method

- a) i. Identify the independent variable for this investigation. [1 mark]

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- ii. Identify one control variable [1 mark]

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- b) Rewrite the students' hypothesis using the *If..... then..... because.....* model [3 marks]

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- c) The *Conclusion* mentions two possible errors in the final sentence. Classify the type of each error that was suggested. [2 marks]

- i. Scales:

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- ii. Measuring cylinder:

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- d) Give an example of a parallax error that applies to this investigation. [1 mark]

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- e) Without changing the method, list one thing the students could have done that would give more credibility to their results. [1 mark]

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**END OF QUESTION AND ANSWER BOOK**



