

STUDENT NAME:

VCE CHEMISTRY

Unit 3 & 4 Trial Examination 2024

Reading time: 15 minutes

Writing Time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	30	30	30
B	11	11	90
			Total 120

- 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 33 pages
- A VCAA data booklet
- 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 2-amino acids has a double ring in the R component?

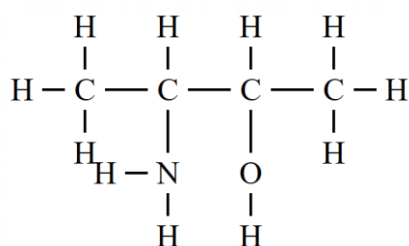
- A. His
- B. Phe
- C. Trp
- D. Tyr

Question 2

A thermochemical equation is best described as a balanced chemical equation that includes

- A. activation energy change
- B. an energy profile diagram
- C. enthalpy change
- D. fuels

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



Question 3

The IUPAC name of the compound is:

- A. 2-aminobutan-3-ol
- B. 3-aminobutan-2-ol
- C. 2-hydroxybutan-3-amine
- D. 3-hydroxybutan-2-amine

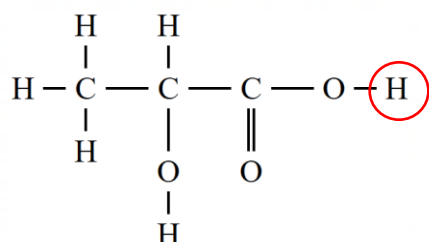
Question 4

This molecule is an example of

- A. a primary alcohol
- B. a secondary alcohol
- C. a tertiary alcohol
- D. a quaternary alcohol

Question 5

Lactic acid is a common name for the following molecule



The peak on a ¹H NMR that corresponds to the circled H will have a chemical shift (ppm) closest to:

- A. 1.0
- B. 3.8
- C. 5.2
- D. 10.0

Question 6

When 10g of bioethanol produces 250kJ of useful energy, the efficiency is to

- A. 21%
- B. 42%
- C. 84%
- D. 100%

Question 7

Which of the following would **not** be considered a fossil fuel?

- A. Methane from fracking
- B. Methane from natural gas reservoirs trapped in rocks
- C. Methane produced from farm waste
- D. Methane produced from fractional distillation of crude oil

Question 8

The Victorian government's container deposit scheme (CDS) has the slogan "For more and better recycling and less waste." Recycling is part of what type of economy

- A. Circular
- B. Linear
- C. Square
- D. Triangular

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

Year 11 Outdoor Ed students are preparing for a 3-day hike. One student decides to take instant noodles. The Nutrition information can be found in the table below:

Nutrition information Serving per package: 5 Serving size: 175g	
	Average quantity per 100.0g
Protein	4.5g
Fat	9.9g
Carbohydrates	29.9g

Question 9

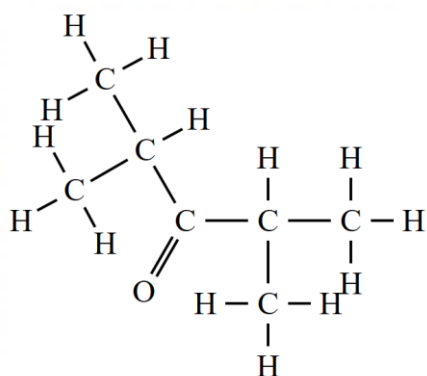
What is the total amount of energy, in kilojoules, a student would obtain from eating two servings of noodles?

- A. 813.2 kJ
- B. 1423.1 kJ
- C. 1626.4 kJ
- D. 3224.2 kJ

Question 10

The student adds an additional 30.5g of protein to the two servings of noodles, by putting in some chicken. Assume that the chicken **does not** add additional fats or carbohydrates. Which of the following statements would be true when referring to the energy content of the meal?

- A. Carbohydrate contributes the highest amount as it has the highest combined mass
- B. Fat contributes the highest amount as it has the highest energy content
- C. Protein contributes the highest amount as it has the highest combined mass
- D. Not enough information is given about the chicken to decide

Question 11

The IUPAC name for this molecule is

- A. 1,1,3,3-tetramethylpropan-2-al
- B. 1,1,3,3-tetramethylpropan-2-one
- C. 2,4-dimethylpentan-3-al
- D. 2,4-dimethylpentan-3-one

Question 12

A technique to extract medicinal compounds from plants is?

- A. Chromatography
- B. Fractional distillation
- C. Solvent Purification
- D. Steam distillation

Question 13

When 2.7g of propanone is completely combusted, the volume of O_2 required at $150^\circ C$ and 140kpa is closest to:

- A. 0.414L
- B. 1.17L
- C. 1.66L
- D. 4.68L

Question 14

For the half equation



Which statement is correct?

	Change in oxidation number	Oxidation/reduction
A.	C goes from -2 to +2	Oxidation
B.	C goes from 0 to +2	Oxidation
C.	C goes from -2 to +2	Reduction
D.	C goes from 0 to +2	Reduction

Question 15

The bonding involved in the primary 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 **correct**?

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

Question 17

The iodine number (IN) of a fat or oil is defined as the mass of iodine, I_2 , that reacts with 100g of the substance.

The iodine number of arachidonic acid is closest to:

- A. 4
- B. 84
- C. 167
- D. 334

Question 18

“Prevention of waste” is

- A. A green chemistry principle
- B. A laboratory rule
- C. A type of economy
- D. A United Nations Sustainable Development Goal

Question 19

An example of an unethical action is

- A. Changing raw data to fit accepted theories
- B. Citing other people’s work that you have referenced
- C. Recognising the importance of social, economic and political values when forming conclusions
- D. Reporting errors made in your investigation

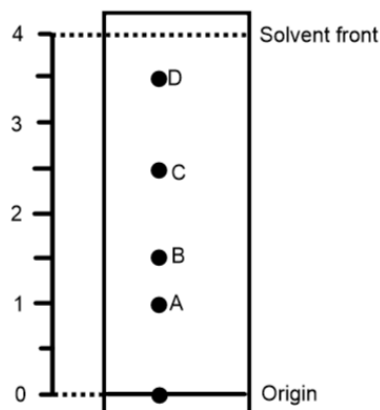
Question 20

Scientists use the facts that atoms and molecules absorb and emit electromagnetic radiation of specific energies, and that the absorption of that radiation changes the atoms and molecules when they use what type of analysis?

- A. Carbon NMR
- B. IR spectroscopy
- C. Mass spectroscopy
- D. Proton NMR

Question 21

This is a Thin Layer Chromatography plate from a student's experiment.



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

- A. Component A has an R_f value of 0.25
- B. Component B has an R_f value of 0.375
- C. Component C is more strongly adsorbed to the stationary phase than component B
- D. Component D is the least strongly adsorbed to the stationary phase

Question 22

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

	Fuel	Advantages	Disadvantages
A.	Coal	Large reserves	Non-renewable
B.	Biogas	Made from waste	High running costs
C.	Petrol	Ease of transport	Limited reserves
D.	Bioethanol	CO ₂ absorbed during photosynthesis	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 50, suggests it might be

- A. Propan-1-ol
- B. Propan-2-ol
- C. Propanal
- D. Propanone

Question 24

Significant research is being undertaken around the world at universities and at public and private research facilities into how to manufacture more efficient energy producing devices. Microbial fuel cells (MFC), hydrogen fuel cells and redox flow batteries are all examples of new technology that might move from experimentation to mainstream usage in the near future.

Which of the following statements is **not** based on a green chemistry principle?

- A. Design for energy efficiency
- B. Moving from a linear to a circular economy
- C. Petroleum based companies going out of business would hurt the economy
- D. Use of renewable feedstock

Question 25

Which of the following reactions is **not** an enzyme catalysed hydrolysis reaction?

- A. Formation of amino acids from proteins
- B. Formation of carboxylic acids and alcohols from esters
- C. Formation of fatty acids from triglycerides
- D. Formation of disaccharides from polysaccharides

Question 26

The purpose of the salt bridge in a Galvanic cell is to allow:

- A. anions to move towards the cathode
- B. cations to move towards the cathode
- C. electrons to complete the circuit
- D. free radicals to move from one half of the cell to the other

Question 27

In a practical experiment where a student was recording the volume of gas evolved when hydrochloric acid was added to a strip of magnesium metal, evidence of a systematic error would be a results graph that clearly shows

- A. a linear graph that passes through the origin with a clear outlier
- B. a linear relationship that doesn't pass through the origin
- C. a linear relationship that passes through the origin, but has data points scattered above and below the trend line
- D. a non-linear relationship that passes through the origin

Question 28

When setting up an electroplating cell, which of the following correctly summarises the cathode?

- A. It is made of the material that will coat the object
- B. It is the location of the oxidation reaction
- C. It is the object that is being plated
- D. It supplies the electrons

Question 29

A laboratory technician is tidying up the chemical storeroom at the end of the school year. They find two bottles of clear liquid with labels that are hard to read. The lab tech can read that both labels have “pent**ne” on them; where the ** is a small section that is unreadable. They remember that a Year 12 student wanted pentane and pent-2-ene for the practical investigation.

What simple test could the lab tech carry out that will allow them to distinguish the compounds in the bottles?

- A. Addition of acidified potassium permanganate (KMnO_4)
- B. Addition of ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) and sulfuric acid (H_2SO_4)
- C. Addition of red coloured bromine (Br_2)
- D. Addition of sodium hydrogen carbonate (NaHCO_3)

Question 30

What is the main purpose of a logbook in a scientific investigation?

- A. Authentication of the generated primary data
- B. Back up in case the internet crashes
- C. To make the poster look pretty by making a practice one first
- D. Validity

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 (11 marks)

When chlorine gas is mixed with hexane, in the presence of UV light, a substitution reaction takes place.

- a. If only one H atom is substituted in every hexane that reacts, how many possible isomers of chlorohexane can be produced? 1 mark

Chlorohexane can undergo a further substitution reaction to produce an amine.

- b. i. Write a balanced chemical equation for the reaction of 1-chlorohexane to form an amine. States are not required. 2 marks

- ii. Draw the skeletal structure of the organic product from **part i** and name that product. 2 marks
-

Amines can be converted into amides by reacting the amine with an acid anhydride.

- c. Draw the structural formula of a primary amide with four carbons 2 marks

Amines can also react with carboxylic acids to form an amide functional group.

- d. i. Use aspartic acid and glutamic acid to show how an amide functional group can form. 3 marks

- ii. Circle the peptide link on the product above. 1 mark

Question 2 (8 marks)

There are over 35 structural isomers for the molecular formula C_4H_8O .

Butan-2-one is one of the structural isomers. At room temperature it is a colourless liquid with a sweet smell. Whilst it can be found naturally in some fruits and vegetables, it is manufactured on an industrial scale to be used in paints.

- a. Name, and draw skeletal structures, for two other isomers of C_4H_8O . 4 marks

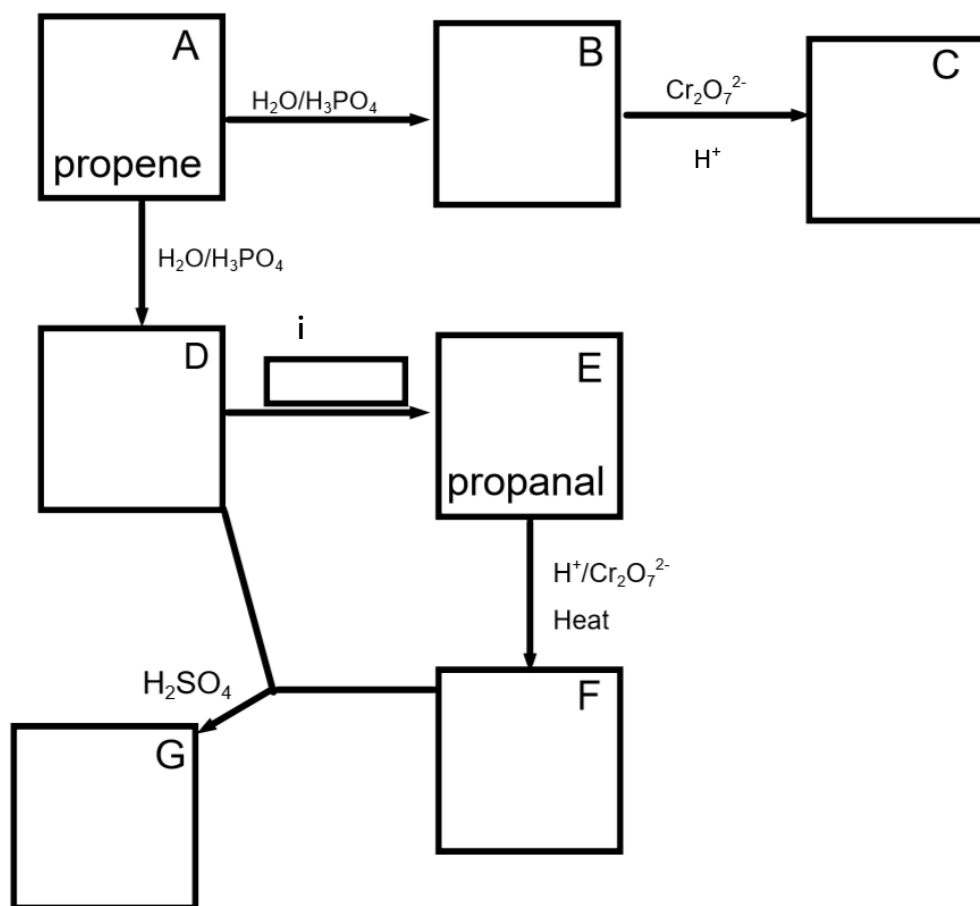
- b. Write the chemical equation for the complete combustion of butan-2-one? 2 marks

- c. If 27g of Butan-2-one is completely combusted, what volume of CO_2 gas will be produced at SLC?

2 marks

Question 3 (8 marks)

Propene was used as the starting compound for series of reactions.



- a. When propene is reacted with steam, in the presence of phosphoric acid, compounds B and D are produced in a 1:1 ratio.
Compounds B and D are known as what sort of isomers? 1 mark

Half of compound D is reserved to react with compound F and half is reacted to form propanal

- b. i. What reactant should go in the box marked i, so that D reacts to form propanal? 1 mark

- ii. What is the name of compound C?

1 mark

- c. Compound G is a sweet-smelling organic liquid. Write a balanced chemical equation for the reaction of compounds D and F forming compound G. All reactants and products should be in full structural form. States are not required.

4 marks

- d. What is the name of the reaction type that occurs between compounds D and F?

1 mark

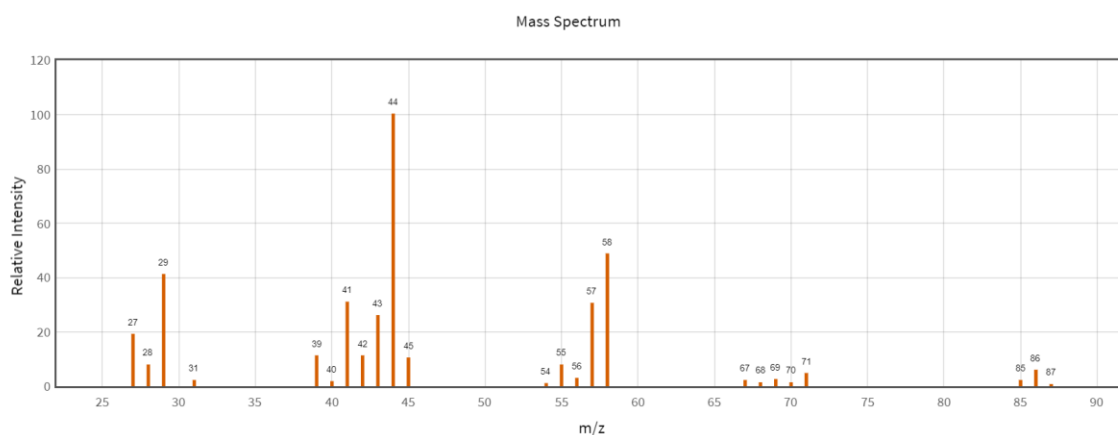
Question 4 14 marks)

An unknown organic substance is being analysed in a laboratory. It is known that it is 69.8% by mass carbon, 11.6% by mass hydrogen and the rest oxygen.

- a. Determine the empirical formula of the unknown substance.

3 marks

A read out from the mass spectrometer is shown below.



Data: NIST Chemistry Webbook webbook.nist.gov
National Institute of Standards and Technology

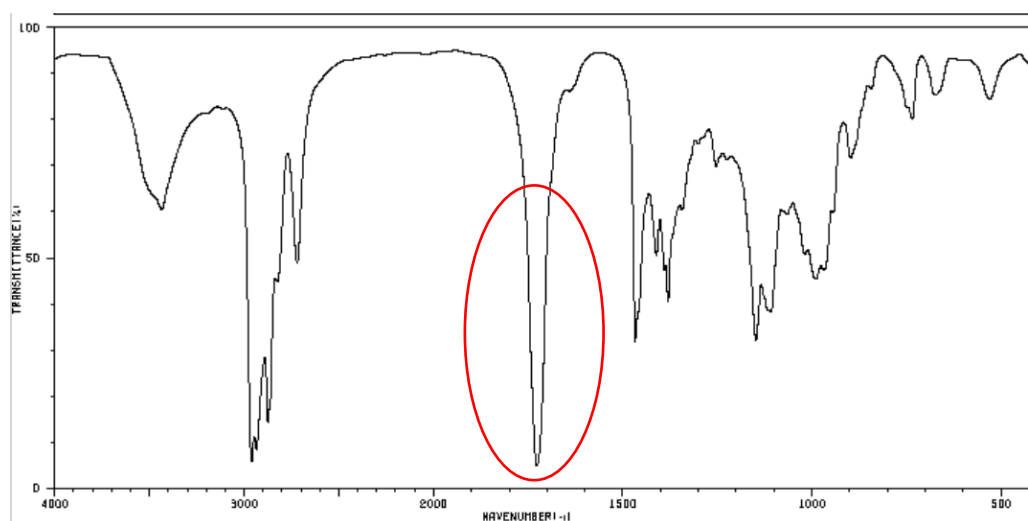
- b. i. Use the value of the molecular ion to determine the molecular formula of the unknown substance.

1 mark

- ii. What is the value of the base peak and what is the significance of it?

3 marks

The IR spectrum for the unknown substance is given below.



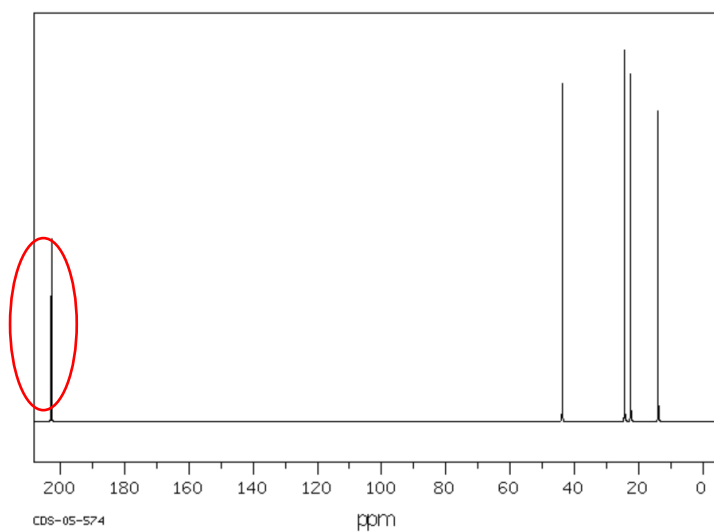
Data: SDBS web <http://sdb.sdb.aist.go.jp>

National Institute of Advanced Industrial Science and Technology

- c. There are five C=O bonds listed in **item 22** of the data book that might account for the absorption band that is circled. Explain why the “acids” bond can be discounted.

1 mark

C-NMR

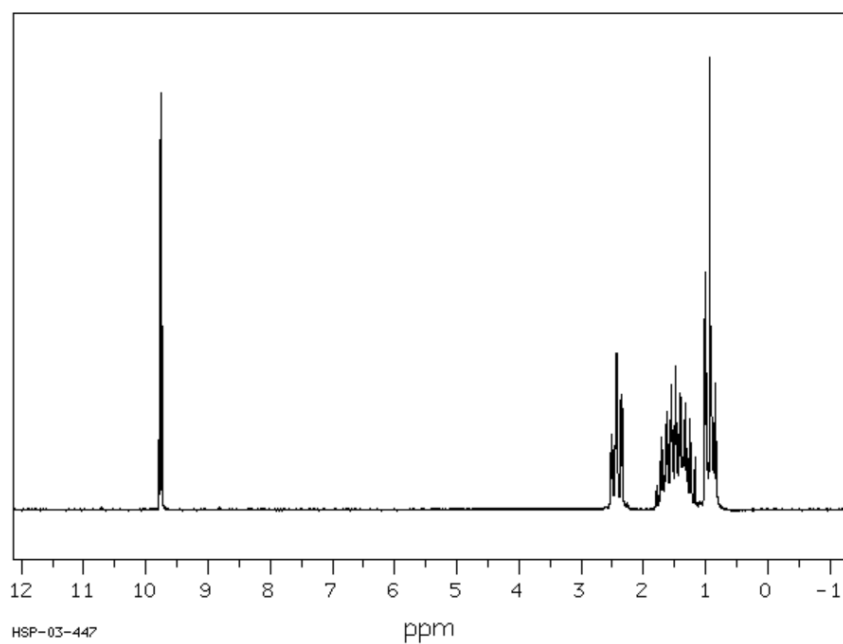


Data: SDBS web <http://sdb.sdb.aist.go.jp>

National Institute of Advanced Industrial Science and Technology

- d. Using **item 23** of the data book, draw two possible “Type of carbon” that might have generated the circled peak on the C-NMR above. 2 marks

H-NMR

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

National Institute of Advanced Industrial Science and Technology

- e. The three peaks on the right side of the high-resolution H-NMR above are split. Explain what causes the signals to split. In your response, make mention of the “n+1 rule”.

2 marks

- f. Based on all the information provided, what is the name and structure of the unknown molecule?

2 marks

Question 5 (5 marks)

Acetylene is the common name for ethyne. It is a colourless gas that is widely used in the welding industry. It has the structural formula:



- a. Write a balanced chemical equation for the complete combustion of acetylene. 1 mark

-
- b. Use **items 10 and 11** of the Data Book to calculate the theoretical enthalpy change for the complete combustion of 1 mole of acetylene.

3 marks

- c. Using your answer from **part b.** identify if the reaction is exothermic or endothermic.

1 mark

Question 6 (6 marks)

Enzymes catalyse multiple reactions within the human body. Some of these reactions are healthy e.g. they help us breathe and process nutrients. Other enzyme catalysed reactions are unhealthy, like those responsible for inflammation.

Describe the process of how competitive and non-competitive enzyme inhibitors stop enzymes from acting as catalysts. In your response include examples and diagrams.

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Question 7 (6 marks)

The molecule $\text{C}_2\text{H}_5\text{ClO}$ has multiple isomers. Use it to show the difference between structural isomers and optical isomers. As part of your answer, you are required to name two structural isomers. Diagrams are not required to obtain full marks, but maybe helpful in demonstrating your understanding of these concepts.

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Question 8 (7 marks)

To help engage the year 8 science class during the Olympics games, a chemistry teacher decides to make some “Olympic medals” with the students. Whilst gold and silver are too expensive, the teacher does have some old copper pipe left over from a bathroom renovation a few years ago. The teacher collects some empty tin cans that once contained tomatoes, corn and beans. After carefully cutting the circular ends off, and washing them thoroughly, they are ready to use these as the medals.

- a. Draw a labelled diagram and describe how the teacher could use some common school chemicals and laboratory equipment, and the left-over copper, to set up an electrolytic cell to make “Olympics medals” with the year 8 students.

3 marks

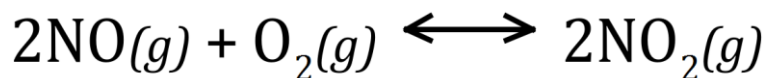
The teacher believes that to make a well-coated medal, it will need 2.5g of copper to be used per medal. There are 22 students in the class. The teacher will have students work in pairs. The class runs for 45 minutes, but the teacher knows that the students will only have 30 minutes to run the practical due to set up and instruction time.

- b.** If the power supply runs at 8.5 amps, and the students run the equipment for exactly 30.0 minutes, will each student have enough time to coat their medal with 2.5g of copper?

4 marks

Question 9 (10 marks)

Scientists are observing the equilibrium system

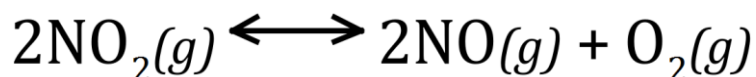


The scientists observe that at a particular time, the concentration of NO is 0.5 M, O₂ is 0.1 M and NO₂ is 0.2 M. This reaction is taking place at 300 °C

- a. If the equilibrium constant, K, is 350 M⁻¹ at 300 °C, by first calculating the reaction quotient, Q, determine if the reaction is moving left or right towards equilibrium

2 marks

Another group of scientists were studying the same system, but had written the equation:



- b. In this case what would the value of K (including units) be at 300 °C.

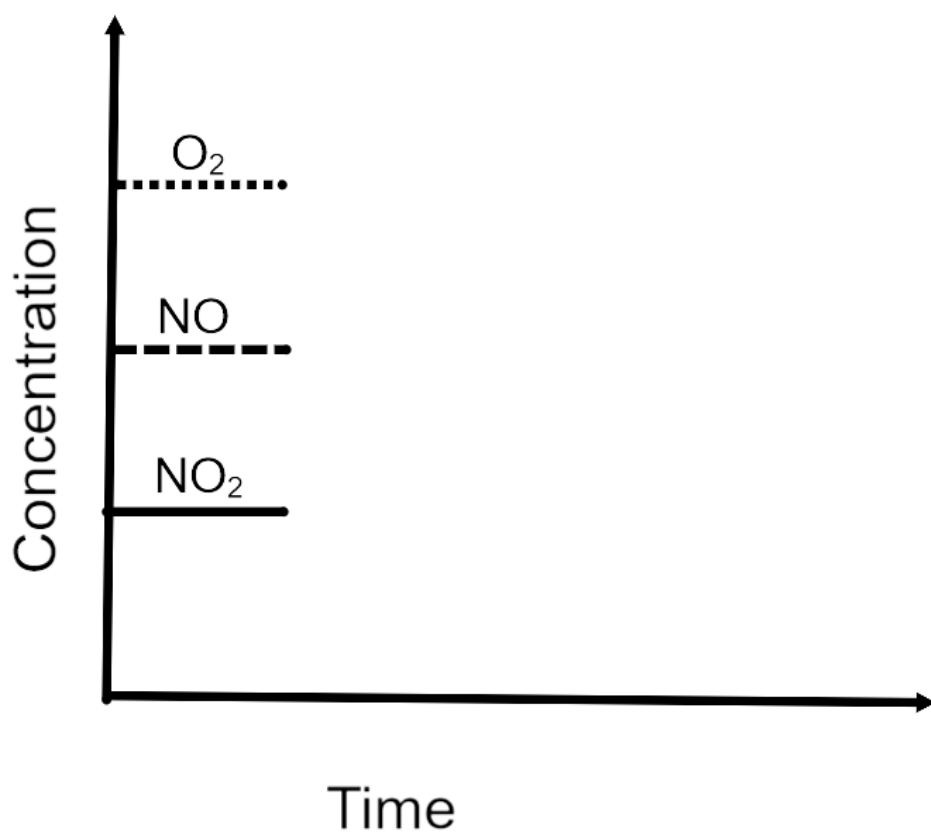
2 marks

- c. Given that NO₂ is a brownish red colour, and that both NO and O₂ are colourless, use Le Chatelier's principle to describe how the colour would change if additional O₂ was injected into the system. In your answer indicate the colour change immediately after the injection and then some time later.

3 marks

- d. On the Concentration versus time graph below, show what would happen to the concentrations of all three gases if the size of the container was instantly doubled.

3 marks



Question 10 (4 marks)

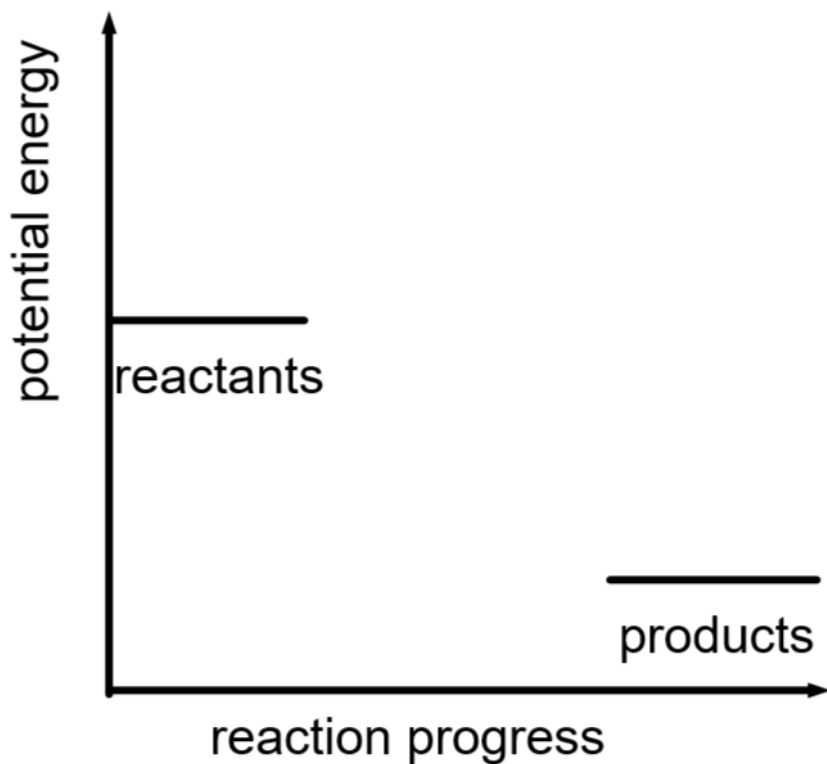
Platinum is used as a catalyst in a number of applications that help reduce energy usage.

- a. Discuss how using a platinum catalyst, can lower the energy requirements of a reaction.

2 marks

- b. Draw and label the energy profile of an exothermic reaction with, and without, a catalyst.

2 marks



Question 11 (11 marks)

Halogens react with carbon-carbon double bonds via addition reactions. Iodine is used to determine the degree of unsaturation of organic molecules with carbon-carbon double bonds. Iodine is used as it is safer and more stable than bromine.

As part of their extended practical investigation, two students plan to investigate the iodine number (IN) of an unknown vegetable oil. To do this, they will react the oil with an excess amount of iodine that has been added to a mixture of cyclohexane and acetic acid. Once the reaction has gone to completion, the excess iodine will be titrated with sodium thiosulfate to determine how much iodine reacted with the oil.

Starch turns blue in the presence of iodine. It will go clear once the iodine has been used up.

AIM: To determine the iodine number of sunflower

Method:

- Step 1.** Dissolve six separate samples of 0.400g of the unknown oil in a mixture of cyclohexane and acetic acid.
- Step 2.** Add 0.800g of iodine in each sample. This is a known excess of I_2 .
- Step 3.** Leave the samples in dark for a fixed period of time to allow the reaction to come to completion.
- Step 4.** Titrate the excess iodine with standard 0.100M sodium thiosulfate ($Na_2S_2O_3$). Use starch as an indicator.
- Step 5.** Repeat Step 4 until three concordant titres are found. (If samples run out, return to Step 1 and start again.)

- a. What is the independent variable?

1 mark

- b. List two controlled variables.

2 marks

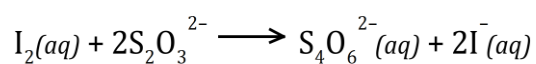
Results

Table 1 Results for first unknown oil			
Titration	Initial burette reading (mL)	Final burette reading (mL)	Titre (mL)
1	0.55	6.55	
2	6.55	12.51	
3	12.51	18.39	
4	18.39	24.25	

- c. What is the average of the concordant titres?

1 mark

The ionic equation for the reaction between iodine and sodium thiosulfate is:



- d. Calculate the mass of excess iodine that was reacted with thiosulfate

3 marks

- e. Use your answer from **part d.** to calculate the IN of the unknown oil.

1 mark

The students were told by their teacher that the unknown oil was sunflower oil, and that sunflower oil is primarily linoleic oil.

- f. The students misheard the teacher and thought they said linolenic oil. Calculate the IN of linolenic oil.

1 mark

- g. Identify one systematic error that might have occurred during this practical. Discuss what affect this error would have had on the results, if any.

2 marks

END OF TRIAL EXAMINATION

Extra space for responses.

Clearly number all responses in this space.

[illegible]

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