Neap

Diagnostic Topic Test 2024

# VCE Chemistry Units 3&4

## Question and Answer Booklet

Test time: 45 minutes
Total marks: 35 marks

## Test 8: How is scientific inquiry used to investigate the sustainable production of energy and/or materials?

- Investigation design
- Scientific evidence
- Science communication

Student's Name: _____

Teacher's Name: _____

**Instructions**

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

A data booklet is provided.

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

Answer **all** questions in the spaces provided.

## SECTION A – MULTIPLE-CHOICE QUESTIONS

**Instructions for Section A**

Circle 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**

An uncertainty applies to any experimental value in the laboratory.

Which one of the following statements concerning this uncertainty is correct?

**A.** The reading on a digital balance is 18.954 g. The uncertainty in this measurement is ±0.0001 g.

**B.** A current reading made on an analogue ammeter was recorded as 2.5 amp. The uncertainty in this measurement would be ±1 amp.

**C.** Judging the exact point of a colour change in a titration experiment is an example of an uncertainty.

**D.** Measuring the volume of water in a pipette from the top of the meniscus rather than the bottom is an example of uncertainty in measurement.

**Question 2**

The image below shows a HAZCHEM label that is used to identify dangerous goods.

Which one of the following chemicals would be labelled with the HAZCHEM label shown above?

**A.** ethanol

**B.** nitrogen gas

**C.** hydrochloric acid

**D.** sodium

*Use the following information to answer Questions 3 and 4.*

To check the reliability of a device measuring current, five measurements were made. The results obtained are shown in the following table. The current was known to be 542 mA.

| **Measurement** | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Current (mA)** | 548 | 549 | 550 | 549 | 548 |

**Question 3**

The results show

**A.** high accuracy and high precision.

**B.** high accuracy and low precision.

**C.** low accuracy and high precision.

**D.** low accuracy and low precision.

**Question 4**

The results show evidence of

**A.** random error, which is removed by repeated measurements and taking an average.

**B.** random error, which is not reduced by repeated measurements and taking an average.

**C.** systematic error, which is corrected by repeated measurements and taking an average.

**D.** systematic error, which is not remedied by repeated measurements and taking an average.

**Question 5**

Given the calculation $(5.326 \times 10^{-30}) \times (7.43 \times 10^{11})$, what is the answer reported to the correct number of significant figures?

**A.** $3.96 \times 10^{-20}$

**B.** $39.5722 \times 10^{-19}$

**C.** $3.957 \times 10^{-18}$

**D.** $3.96 \times 10^{-18}$

**Question 6**

A vinegar sample is known to contain ethanoic acid at a concentration of 4.5%m/v. A student tested this claim using a titration experiment and obtained the following results.

| **Trial number** | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **Ethanoic acid concentration (%m/v)** | 4.4 | 3.6 | 4.3 | 4.5 |

Which one of the following statements relating to the results obtained is **incorrect**?

**A.** The result for trial 2 could be regarded as an outlier and the trial should be repeated.

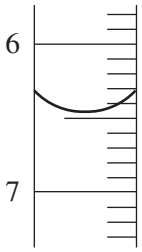
**B.** The result in trial 2 could be due to the student incorrectly rinsing the pipette used to deliver the vinegar with distilled water.

**C.** The result for trial 2 could indicate the presence of a systematic error in the experiment.

**D.** The average result should be recorded as 4.4% m/v.

**Question 7**

Liquid is placed in a burette ready for a titration experiment. The liquid initially in the burette is shown in the diagram below.




The initial reading on the burette, in mL, should be recorded as

**A.** 6.30

**B.** 6.45

**C.** 6.5

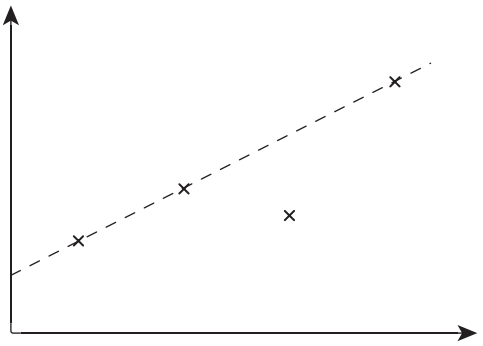
**D.** 7.55

**Question 8**

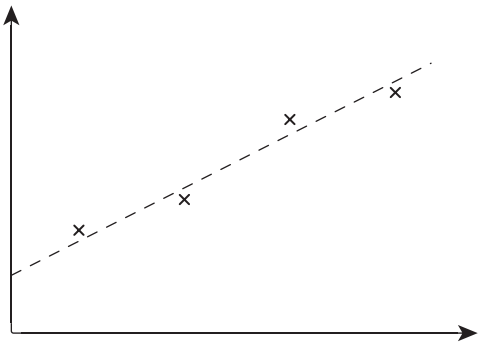
An experiment was conducted to investigate the relationship between two variables. The relationship is shown by the dotted line on each of the following graphs. Measurement of one of the variables may be affected slightly by a change in temperature.

Which one of the following graphs could represent the results of an experiment where random minor fluctuations in room temperature occurred during the experiment?

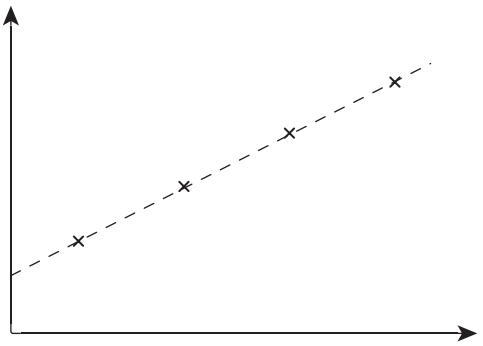
**A.**



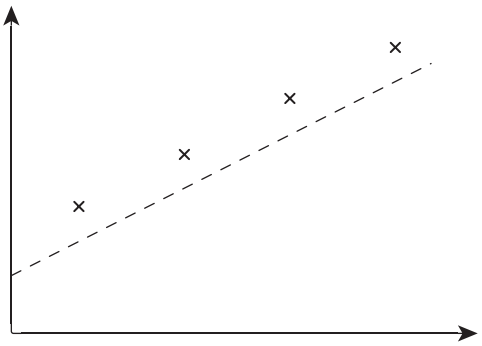
**B.**



**C.**



**D.**



**Question 9**

Which one of the following describes the term 'validity' when conducting an experimental investigation?

**A.** whether the experiment tests the hypothesis

**B.** how close the values are for repeated measurements of a quantity

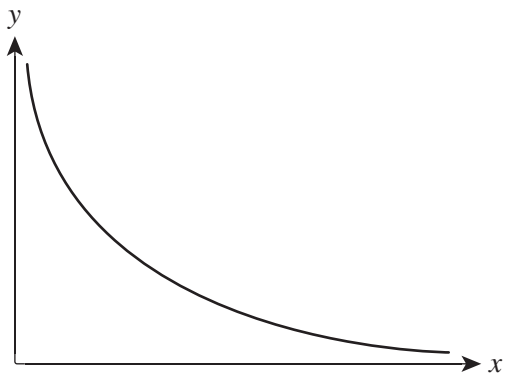
**C.** how close the measured value for a quantity is to the accepted value

**D.** the prediction of the results of the experiment in the form of a cause-and-effect statement

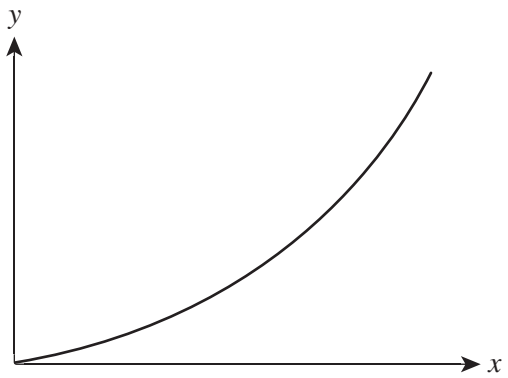
**Question 10**

Which one of the following graphs of data obtained during an experiment shows a positive, non-linear relationship between the two variables investigated?

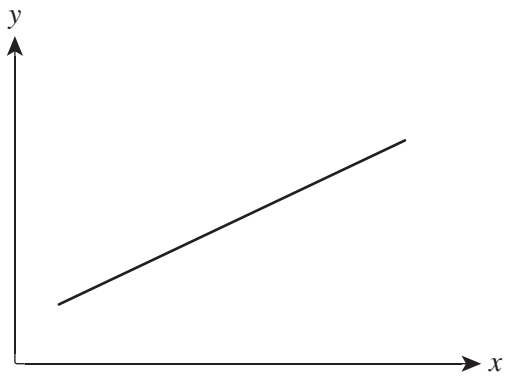
**A.**



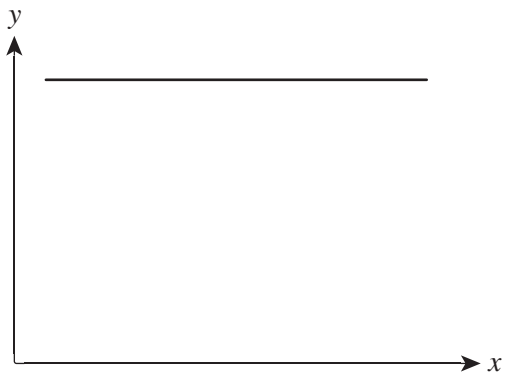

**B.**




**C.**




**D.**




**END OF SECTION A**

## SECTION B

**Instructions for Section B**

Answer **all** questions in the spaces provided.

Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.

Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

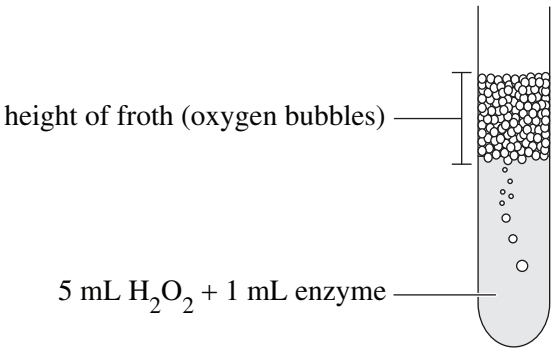
Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $H_2(g)$, NaCl(s).

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

**Question 1** (13 marks)

An experiment was conducted to investigate the effect of temperature on the activity of the enzyme catalase. This enzyme catalyses the breakdown of hydrogen peroxide ($H_2O_2$) to oxygen and water. The oxygen produced in the breakdown creates a froth in the test tube. The height of this froth forming in a set time can be used as a measure of the activity of the enzyme. Extracts from a student's report on the experiment are shown below.

**Method**




Two trials, each at five different temperatures, were conducted. The height of the froth was measured after 10 minutes of reaction.

**Results**

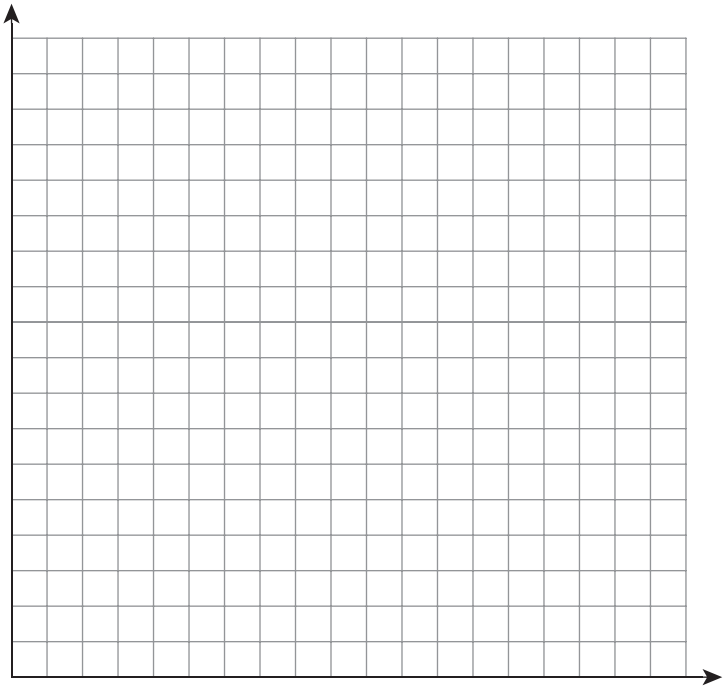
| Temperature (°C) | Height of froth after 10 minutes (cm) | | |
|---|---|---|---|
| | Trial 1 | Trial 2 | Average |
| 7 | 3.5 | 4.5 | 4.0 |
| 25 | 6.7 | 7.3 | 7.0 |
| 40 | 5.3 | 4.9 | 5.1 |
| 60 | 3.1 | 3.5 | 3.4 |
| 80 | 1.7 | 1.5 | 1.6 |

**a.** **i.** Identify the dependent variable in the experiment. 1 mark

**ii.** Identify the independent variable in the experiment. 1 mark

**iii.** Identify **two** controlled variables in the experiment. 2 marks

**b.** Using the grid below, plot a suitable graph showing the results of the experiment. 3 marks



**c.** **i.** Identify the temperature that produced the highest rate of reaction. 1 mark

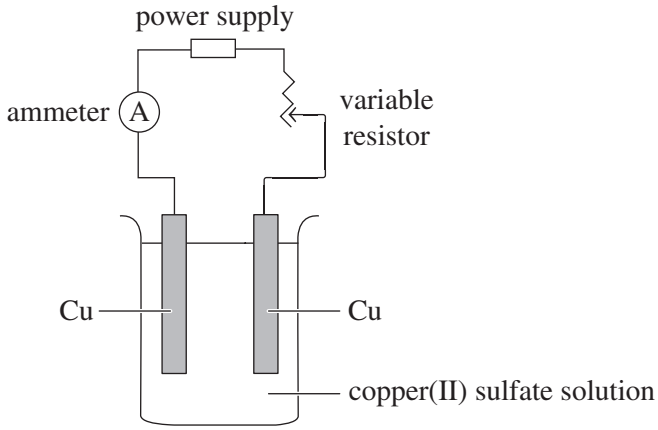
**ii.** Suggest **one** improvement that could be made to the design of the experiment in order to more accurately determine the optimum temperature for the enzyme activity. 1 mark

**d.** State **two** possible sources of random error in the experiment. 2 marks

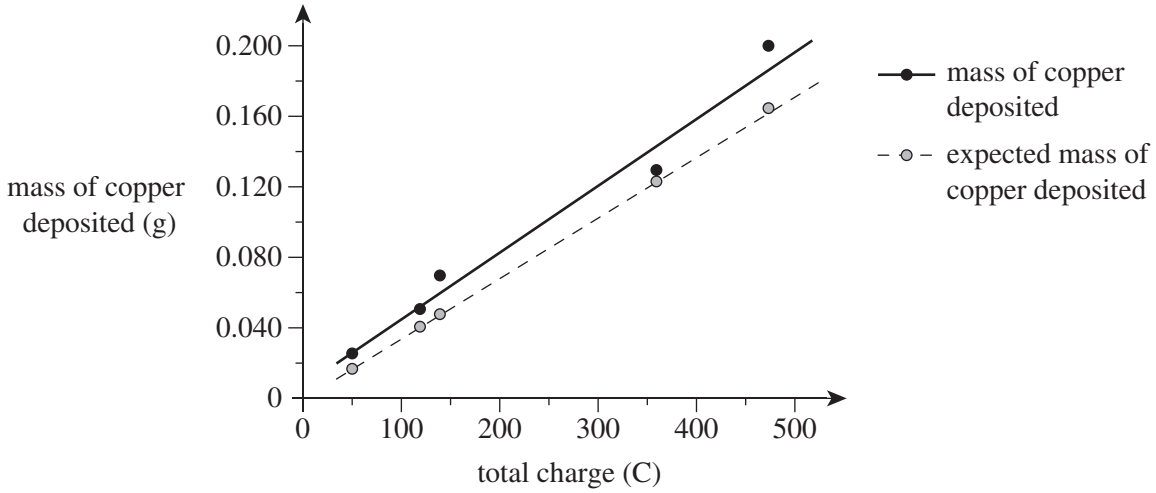
**e.** Analyse the validity of the experiment. 2 marks

**Question 2** (6 marks)

A student conducted an experiment to investigate the gain in mass at the cathode when different amounts of charge were passed through an electrolytic cell containing a copper(II) sulfate solution and copper electrodes. The design of the experiment is shown in the diagram below.




The results of the experiment are shown in the following graph. The theoretical mass of copper expected for each amount of charge passed through the cell, shown on the graph, was calculated using Faraday's Laws and the reaction stoichiometry.




**a.** State a suitable hypothesis for this experiment. 1 mark

**b.** The student's 'Discussion' section in their report included the statements in the following table.

For each statement, indicate whether the statement relates mainly to validity, reliability, precision or accuracy. (Indicate your responses by writing the appropriate term in the second column of the table.) 3 marks

| **Statement from 'Discussion' section of the report** | **The statement most closely relates to _____ (*validity, reliability, precision or accuracy*)** |
|---|---|
| The ammeter was calibrated immediately prior to the experiment. | |
| For each amount of charge, three separate trials were conducted and the mass of copper deposited in each case was recorded. | |
| All variables, such as temperature, concentration of copper(II) sulfate solution, volume of solution used, distance between the electrodes and size of electrodes, remained constant throughout the experiment. | |

**c.** **i.** Comment on the comparison of the student's results with the theoretical results for mass of copper deposited for a given charge passed through the cell. 1 mark

_____

_____

**ii.** Suggest **one** possible source of error that would account for the difference between the theoretical and measured masses of copper deposited. 1 mark

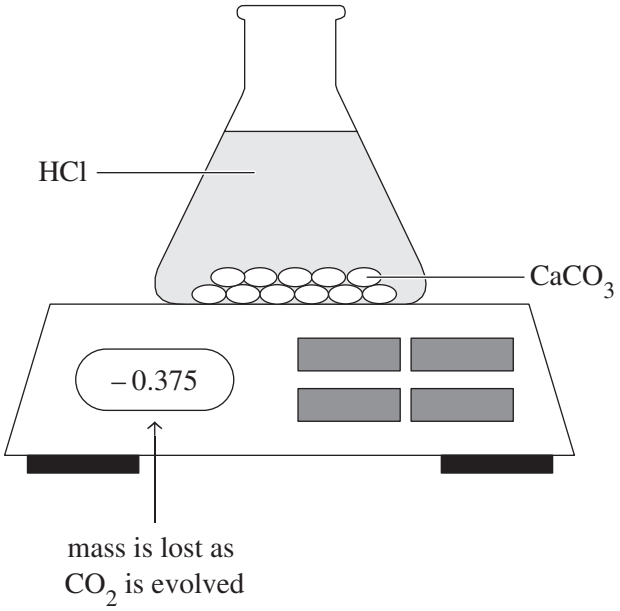
_____

_____

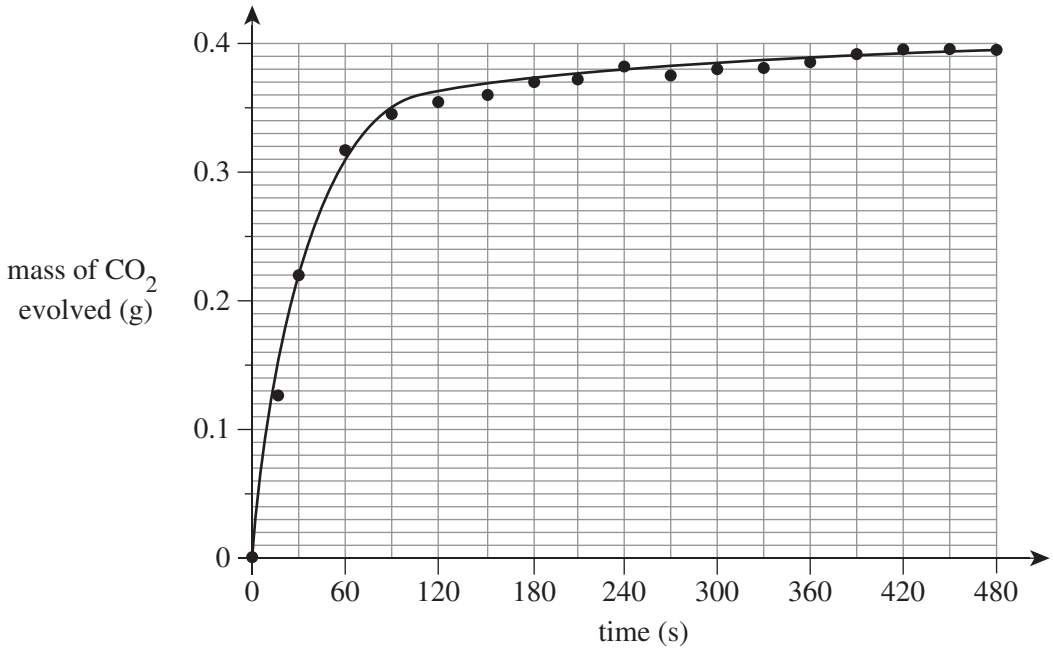
**Question 3** (6 marks)

The equipment shown below was used to investigate the rate of reaction when calcium carbonate, $CaCO_3$, is mixed with hydrochloric acid, HCl, and reaction occurs according to the following equation.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$




The mass of carbon dioxide produced over time can be used as a measure of the reaction rate. The mass of carbon dioxide produced is taken to be equal to the mass loss from the flask. A graph of the results of the experiment is shown below.



**a.** **i.** If 20.0 g of calcium carbonate (an excess) is added to the flask and reacted with 20.0 mL of 1.0 M hydrochloric acid, calculate the expected mass of carbon dioxide that will be produced. 3 marks

**ii.** Explain **one** error in the design of the experiment that may account for the graph plateau forming at a mass of carbon dioxide less than that calculated in **part a.i.** 2 marks

**b.** Calculate the average rate of reaction, in g of $CO_2$ $min^{-1}$, for the time period of 0 to 3 minutes. 1 mark

**END OF TEST**