

Trial Examination 2006

VCE Chemistry Unit 2

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A Multiple-choice	20	20	20	30
B Short-answer	6	6	40	60
			Total 60	Total 90

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 white out liquid/tape.

Materials supplied

Question and answer booklet of 14 pages, with a detachable data sheet in the centrefold.
Answer sheet for multiple-choice questions.

Instructions

Detach the data sheet from the centre of this booklet during reading time.
Please ensure that you write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.
All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

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

SECTION A: MULTIPLE-CHOICE QUESTIONS**Instructions for Section A**

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

Question 1

Which of the following is both an empirical formula and a molecular formula?

- A. CH_3COOH
- B. H_3PO_4
- C. N_2O_4
- D. Zn

Question 2

Which of the following statements concerning 1.0 mol of ethene gas (C_2H_4) and 1.0 mol of nitrogen gas (N_2) is **incorrect**?

- A. Both have the same number of atoms.
- B. Both have the same number of molecules.
- C. Both have the same mass.
- D. Both have the same density (at constant temperature and pressure).

Question 3

Lithium consists of two isotopes, with relative isotopic masses of 6.02 and 7.02. The relative atomic mass of lithium is 6.94. The ratio of abundance of the lighter isotope to the abundance of the heavier isotope is closest to

- A. 1 to 1
- B. 1 to 3
- C. 1 to 12
- D. 12 to 1

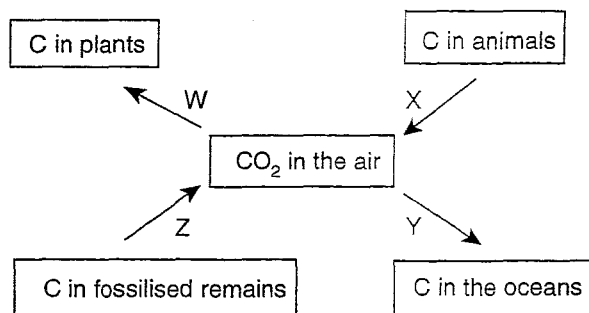
Question 4

In which of the following reactions is the species written in bold type acting as a Lowry-Brønsted acid?

- A. $\text{HSO}_4^-(\text{aq}) + \text{NH}_3(\text{aq}) \rightarrow \text{SO}_4^{2-}(\text{aq}) + \text{NH}_4^+(\text{aq})$
- B. $\text{Mg}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2(\text{g})$
- C. $2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$
- D. $\text{HCO}_3^-(\text{aq}) + \text{HPO}_4^{2-}(\text{aq}) \rightarrow \text{PO}_4^{3-}(\text{aq}) + \text{CO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$

Question 5

The diagram below shows a simplified version of the carbon-oxygen cycle.

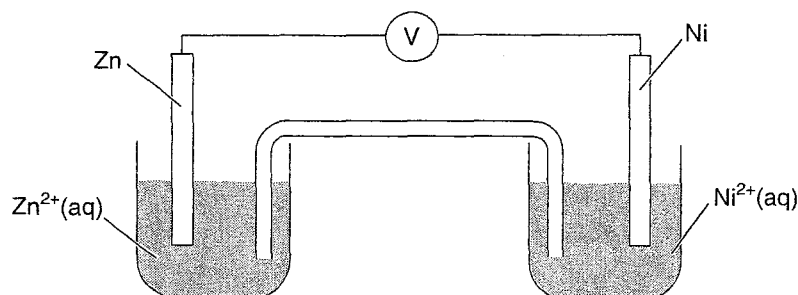


Which of the following statements concerning the reactions shown on the diagram above is **incorrect**?

- A. W could represent anaerobic respiration by yeast.
- B. X could represent respiration by a mouse.
- C. Y could represent the dissolution of carbon dioxide in sea water.
- D. Z could represent the combustion of methane.

Questions 6 and 7 refer to the following information.

The diagram below shows a galvanic cell constructed of the half-cells $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$ and $\text{Ni}^{2+}(\text{aq})/\text{Ni}(\text{s})$, connected by an external circuit and a salt bridge.

**Question 6**

When this cell is operating

- A. Zn undergoes oxidation at the positively charged anode.
- B. Zn undergoes oxidation at the negatively charged anode.
- C. Ni undergoes oxidation at the positively charged anode.
- D. Ni undergoes oxidation at the negatively charged anode.

Question 7

Which of the following chemicals would be **unsuitable** for use in the salt bridge?

- A. KNO_3
- B. Na_2SO_4
- C. KCl
- D. NaOH

Question 8

Which of the following is a property of Lowry-Brønsted acids?

- A. Acids feel slippery.
- B. Acids form non-conducting aqueous solutions.
- C. Acids are molecular in structure.
- D. Acids react with alkalis to form a salt and hydrogen gas.

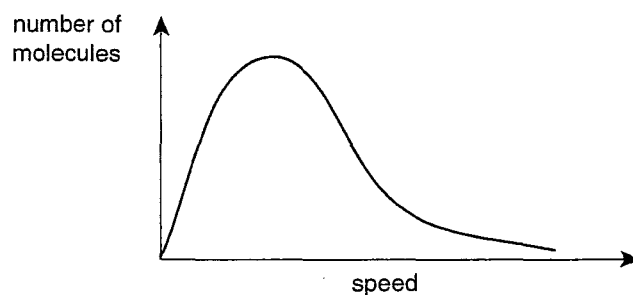
Question 9

The pH of 50.0 mL of a 0.015 mol L^{-1} nitric acid (HNO_3) solution is

- A. 0.020
- B. 1.5
- C. 1.8
- D. 3.1

Question 10

The graph below shows the distribution of speeds of gaseous molecules for a gas sample in a closed container of fixed volume.



When the temperature of the gas sample was increased, which of the following would **not** be expected to increase?

- A. The pressure exerted by the gas.
- B. The average kinetic energy of the molecules.
- C. The spread of molecular speeds on the distribution of speeds graph.
- D. The area under the curve on the distribution of speeds graph.

Question 11

Which of the following contains the greatest number of moles of nitrogen atoms?

- A. 26 g of nitrogen gas (N_2).
- B. 9.0×10^{24} atoms of nitrogen.
- C. 490 mL of ammonia gas (NH_3) at standard temperature and pressure (STP).
- D. 0.25 mol of nitrogen dioxide gas (NO_2).

Questions 12 and 13 refer to the following information.

0.70 g of hydrogen gas was mixed with 6.5 g of oxygen gas and the mixture ignited. From this reaction 6.2 g of liquid water was obtained. Tests showed that the only gas remaining was oxygen.

Question 12

What mass of oxygen remained after the reaction?

- A. 0.70 g
- B. 1.0 g
- C. 5.5 g
- D. Cannot be determined unless the temperature and pressure of the gases is known.

Question 13

A lighted splint test was used to test a small sample of the remaining gas. Which of the following observations would confirm that the gas was oxygen?

- A. A 'popping' sound.
- B. The splint was extinguished.
- C. The splint flared.
- D. A bright, white light was produced.

Questions 14 and 15 refer to the following information.

Four metals, W, X, Y and Z, were placed in separate solutions containing the cations W^{2+} , X^{2+} and Y^{2+} . If any reaction occurred a tick was placed in the appropriate column of the results table shown below.

	W	X	Y	Z
W^{2+}				✓
X^{2+}	✓		✓	✓
Y^{2+}	✓			✓

Question 14

Which of the following shows the metals in order of decreasing reductant strength?

- A. Z W Y X
- B. W Y X Z
- C. X Y W Z
- D. Z X Y W

Question 15

Which metals would cause a deposit of Z to form if they were placed in a solution containing the cation Z^{2+} ?

- A. Metals W and Y only.
- B. Metals W and X only.
- C. Metals W, X and Y.
- D. None of the metals.

Question 16

Which of the following represents a balanced ionic equation for the reaction of solid magnesium oxide with dilute hydrochloric acid?

- A. $\text{MgO(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{O(l)}$
- B. $\text{MgO(s)} + 2\text{H}^+\text{(aq)} + 2\text{Cl}^- \rightarrow \text{Mg}^{2+}\text{(aq)} + \text{H}_2\text{O(l)} + \text{Cl}_2\text{(g)}$
- C. $\text{MgO(s)} + 2\text{H}^+\text{(aq)} \rightarrow \text{Mg}^{2+}\text{(aq)} + \text{H}_2\text{O(l)}$
- D. $\text{Mg}^{2+}\text{(aq)} + \text{O}^{2-}\text{(aq)} + 2\text{H}^+\text{(aq)} \rightarrow \text{Mg}^{2+}\text{(aq)} + \text{H}_2\text{O(l)}$

Question 17

A solution containing the iron(II) ion is to be stored. A container made from which of the following metals would **not** be suitable for this storage?

- A. Cu
- B. Ag
- C. Ni
- D. Al

Question 18

When magnesium carbonate is heated strongly it decomposes to magnesium oxide and carbon dioxide gas according to the following equation.



The mass of magnesium carbonate required to produce 78.0 g of magnesium oxide in this reaction would be

- A. 37.3 g
- B. 78.0 g
- C. 156 g
- D. 163 g

Question 19

20.0 mL of an acid solution of pH 3.0 was mixed with 20.0 mL of another acid solution of pH 4.0. The pH of the resultant solution was

- A. 2.8
- B. 3.3
- C. 3.5
- D. 4.7

Question 20

Which of the following shows the reaction occurring at the cathode during the corrosion of a piece of iron?

- A. $2\text{H}_2\text{O(l)} + \text{O}_2\text{(g)} + 4\text{e}^- \rightarrow 4\text{OH}^-\text{(aq)}$
- B. $\text{Fe}^{2+}\text{(aq)} + 2\text{OH}^-\text{(aq)} \rightarrow \text{Fe(OH)}_2\text{(s)}$
- C. $\text{Fe(s)} \rightarrow \text{Fe}^{2+}\text{(aq)} + 2\text{e}^-$
- D. $\text{Fe}^{3+}\text{(aq)} + \text{e}^- \rightarrow \text{Fe}^{2+}\text{(aq)}$

SECTION B: SHORT-ANSWER QUESTIONS**Instructions for Section B**

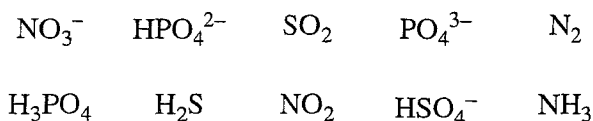
Answer **all** questions in the spaces provided.

To obtain full marks for your responses 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 credit 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 an indication of state, for example $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$.

Question 1

The list below shows a number of molecules and ions.



Use the above list to identify the molecules and ions described below.

- a. Two species which make up a conjugate acid-base pair.

and

1 mark

- b. A gas at room temperature which dissolves to form an acidic solution.

1 mark

- c. A nitrogen source that is readily absorbed by plants.

1 mark

- d. A species which is 33% sulfur by mass.

1 mark

- e. An amphiprotic ion.

1 mark

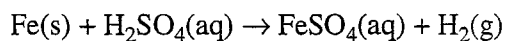
- f. The product of the denitrification process.

1 mark

Total 6 marks

Question 2

An early expedition to the North Pole was attempted in a balloon filled with hydrogen gas. The hydrogen gas was prepared according to the following equation.



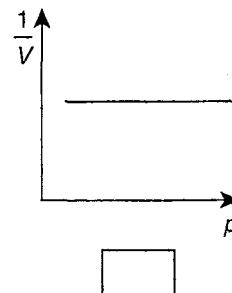
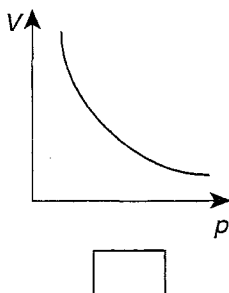
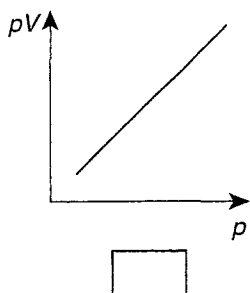
- a. i. Calculate the amount (in mol) of hydrogen gas required to completely fill the 4800 m³ balloon, assuming a temperature of 15°C and a pressure of 1.0 atm.

- ii. Calculate the mass of iron (in kg) needed to produce the required amount of hydrogen gas.

2 + 2 = 4 marks

- b. i. As the balloon ascends, the temperature decreases. In terms of the kinetic molecular theory of gases, explain why the volume of the balloon would be expected to decrease as it ascends (assuming constant pressure).

- ii. As the balloon ascends, the pressure decreases, and so the balloon's volume will alter. Which of the following graphs shows the relationship between the pressure and volume of the balloon (assuming constant temperature)? Indicate your answer by placing a tick in the appropriate box.



2 + 1 = 3 marks

- c. i. Use half-equations to show that the iron/sulfuric acid reaction used to produce the hydrogen gas is a redox reaction.

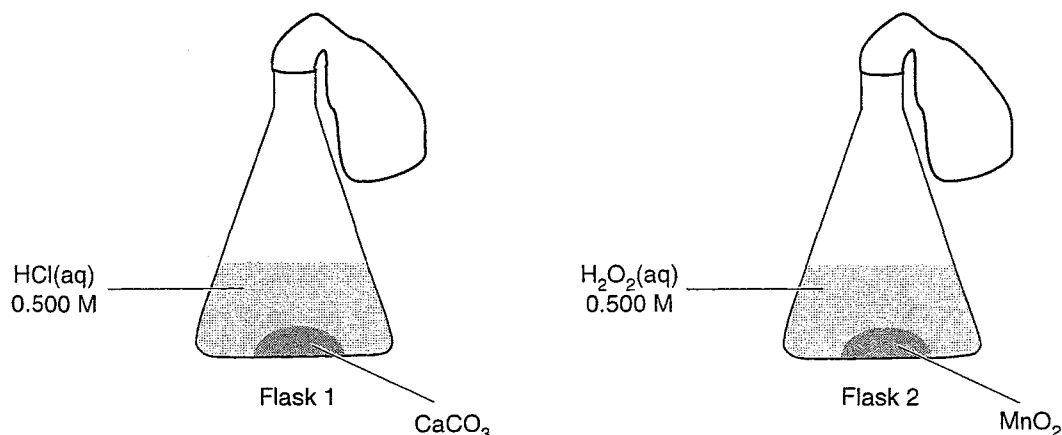
- ii. Name the oxidant in this reaction.

2 + 1 = 3 marks

Total 10 marks

Question 3

An experiment was conducted to investigate two gas-producing reactions. Two flasks and balloons were arranged as shown below. Flask 1 contained 100.0 mL of 0.500 M hydrochloric acid. Flask 2 contained 100.0 mL of 0.500 M hydrogen peroxide solution. Both flasks were maintained at the same temperature and pressure.



2.40 g of crushed calcium carbonate was added to Flask 1 and 0.500 g of manganese dioxide powder was added to Flask 2. After 10 minutes no further bubbling was occurring in either flask. No solid remained in Flask 1, but some solid was present in Flask 2.

a. Write an equation for the reaction occurring in

i. Flask 1.

ii. Flask 2.

1 + 1 = 2 marks

b. Suggest why the calcium carbonate was crushed before adding it to Flask 1.

1 mark

c. i. Explain why no solid remained in Flask 1 after the reaction had stopped.

ii. Explain why solid remained in Flask 2 after the reaction had stopped.

1 + 1 = 2 marks

- d. Which balloon would be expected to have the largest volume when the reactions had stopped? Show any calculations used to obtain your answer.

3 marks

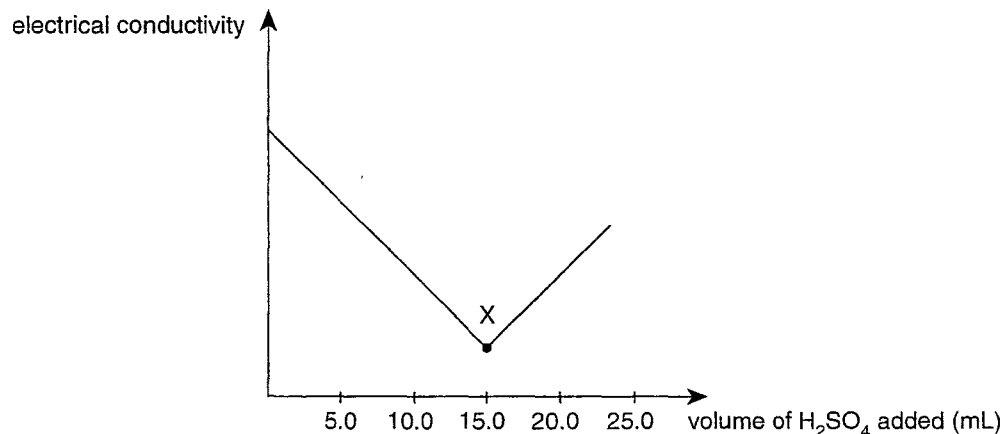
- e. What is the expected volume of gas collected from Flask 1 at standard laboratory conditions (SLC)?

1 mark

Total 9 marks

Question 4

The graph below shows the change in electrical conductivity, at 25°C, of 25.0 mL of a 0.100 M barium hydroxide solution ($\text{Ba}(\text{OH})_2$) as a sulfuric acid solution (H_2SO_4) was slowly added to it.



- a. Calculate the pH of the 0.100 M $\text{Ba}(\text{OH})_2$ solution (before any H_2SO_4 solution was added).

2 marks

- b. Write an equation for the reaction occurring as the acid was added.

1 mark

- c. Explain why the conductivity of the solution decreases to a minimum at point X on the graph.

1 mark

- d. What is the expected pH of the solution at point X on the graph?

1 mark

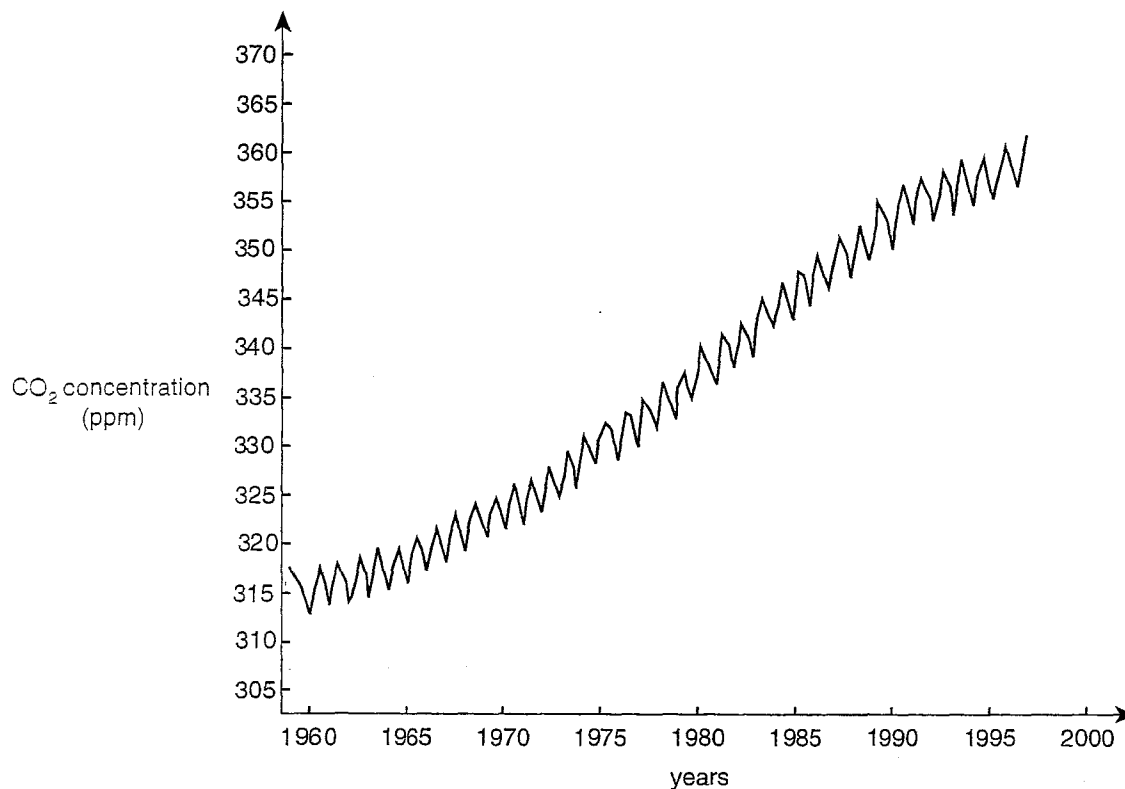
- e. Determine the concentration of the H_2SO_4 solution.

2 marks

Total 7 marks

Question 5

The graph below shows the atmospheric concentration of carbon dioxide over the past 40 years.



- a. Account for the annual fluctuations in atmospheric CO₂ levels.

1 mark

- b. Suggest one reason for the gradual increase in the average annual CO₂ level.

1 mark

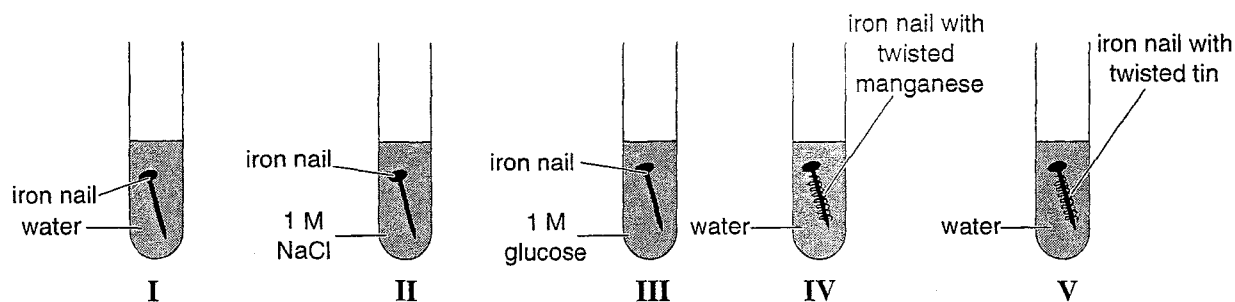
- c. Suggest one possible consequence of this gradual increase in the average annual CO₂ level.

1 mark

Total 3 marks

Question 6

A series of test tubes were arranged (as shown below) to investigate the corrosion of iron nails under different conditions.



- a. Write a balanced equation to show the corrosion of iron by oxygen in the presence of water.

1 mark

- b. In which tube, II or III, would the iron nail show the fastest rate of corrosion? Explain your choice.

2 marks

- c. In which tube, IV or V, would the iron nail show the fastest rate of corrosion? Explain your choice.

2 marks

Total 5 marks

END OF QUESTION AND ANSWER BOOKLET