

Trial Examination 2018

VCE Chemistry Unit 1

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

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	20	20	20
B	5	5	50
			Total 70

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.

Materials supplied

Question and answer booklet of 15 pages.

Data Booklet.

Answer sheet for multiple-choice questions.

Instructions

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.

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

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 unauthorised electronic 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.

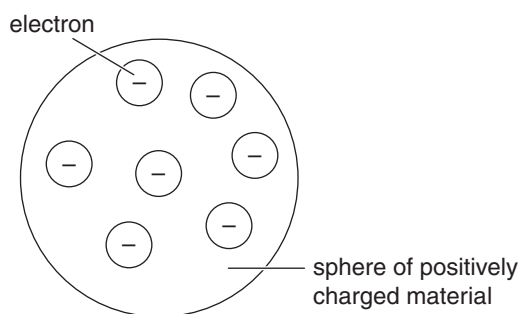
Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

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

Question 1

As scientific knowledge progressed, different models of atomic structure were proposed. One of these models is shown in the diagram below.



The work of the scientists Bohr and Schrödinger contributed greatly to the understanding of the structure of the atom.

The model of atomic structure shown in the diagram above was proposed

- A. after the quantum mechanical model of the atom was formulated.
- B. as a result of the experiments conducted by Bohr.
- C. as a result of the analysis undertaken by Schrödinger.
- D. before Bohr's experiments were conducted.

Question 2

A particular metal produces hydrogen gas when reacted with cold water or with dilute hydrochloric acid.

It is likely that this metal

- A. will react very slowly in air when heated to form an oxide layer.
- B. could be either of the elements silver or gold.
- C. reacts readily with steam to give hydrogen gas.
- D. does not react with oxygen regardless of the conditions.

Question 3

Before carbon-12 was used as the standard for the relative mass scale, different branches of science used the various isotopes of oxygen as the standard.

Why was carbon-12 chosen as the standard to replace oxygen?

- A. Carbon-12 is stable and abundant, so measurements are easily taken.
- B. Carbon is a solid whereas oxygen is a gas at room temperature.
- C. The abundance of carbon-12 is higher than any of the isotopes of oxygen.
- D. None of the isotopes of oxygen have a relative mass which is a whole number.

Use the following information to answer Questions 4 and 5.

A mixture of sand (SiO_2) and salt (NaCl) was separated by adding water to dissolve the salt, and then filtering the liquid. Half of the filtrate was allowed to dry in air and the other half was dried in an oven at 100°C .

Question 4

Which one of the following is the best description of the structure of SiO_2 ?

- A. discrete molecules in which the atoms are held together by covalent bonds
- B. a lattice of positive and negative ions held together by electrostatic attraction
- C. a giant network lattice of silicon and oxygen atoms held together by covalent bonds
- D. molecules of SiO_2 arranged in an array with dispersion forces between the molecules

Question 5

Which filtrate would produce smaller crystals of NaCl ?

- A. the filtrate dried in air
- B. the filtrate dried in the oven
- C. Both filtrates would produce crystals of the same size.
- D. No deduction about crystal size can be made without using a magnifying glass to examine the crystals.

Use the following information to answer Questions 6 and 7.

The element antimony (Sb) has an atomic number of 51.

Question 6

In the ion $^{121}\text{Sb}^{2+}$ the number of neutrons and electrons, respectively, are

- A. 70 and 49.
- B. 70 and 53
- C. 121 and 49.
- D. 121 and 53.

Question 7

Which one of the following statements concerning antimony is correct?

- A. The electronegativity of antimony is greater than that of nitrogen (N) ($Z = 7$).
- B. The atomic radius of antimony is greater than that of rubidium (Rb) ($Z = 37$).
- C. The metallic character of antimony is greater than that of phosphorus (P) ($Z = 15$).
- D. The first ionisation energy of antimony is greater than that of xenon (Xe) ($Z = 54$).

Question 8

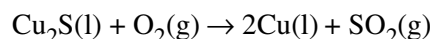
The properties of a linear polymer can be altered by the addition of small compounds known as plasticisers.

Adding a plasticiser results in alteration of the

- A. degree of branching.
- B. softening temperature.
- C. chain length.
- D. percentage of crystalline areas.

Question 9

Copper metal can be extracted at a copper smelter by strongly heating its ore in air:



Information being considered by a mining company intending to set up a copper smelter includes the following.

- I Sulfur dioxide gas is known to kill vegetation.
- II There is a high rate of unemployment in the area of the proposed smelter.
- III The deposit of the ore has a very high percentage concentration of copper.

Which of these factors would negatively impact on a proposal to establish the copper smelter?

- A. I only
- B. I and II only
- C. II and III only
- D. III only

Question 10

Which one of the following is a major **disadvantage** in the use of polymer materials?

- A. Very little modification to the properties of a polymer is possible.
- B. The cost of an item is much greater than an identical item made from other materials.
- C. The main source of the raw materials used to make polymers is limited.
- D. When subjected to very high temperatures, the polymer materials decompose.

Question 11

Which one of the following correctly gives the molecules with their corresponding shape?

	V-shaped	Tetrahedral
A.	HF	NH ₃
B.	CO ₂	SiH ₄
C.	N ₂	SF ₆
D.	H ₂ S	CCl ₄

Question 12

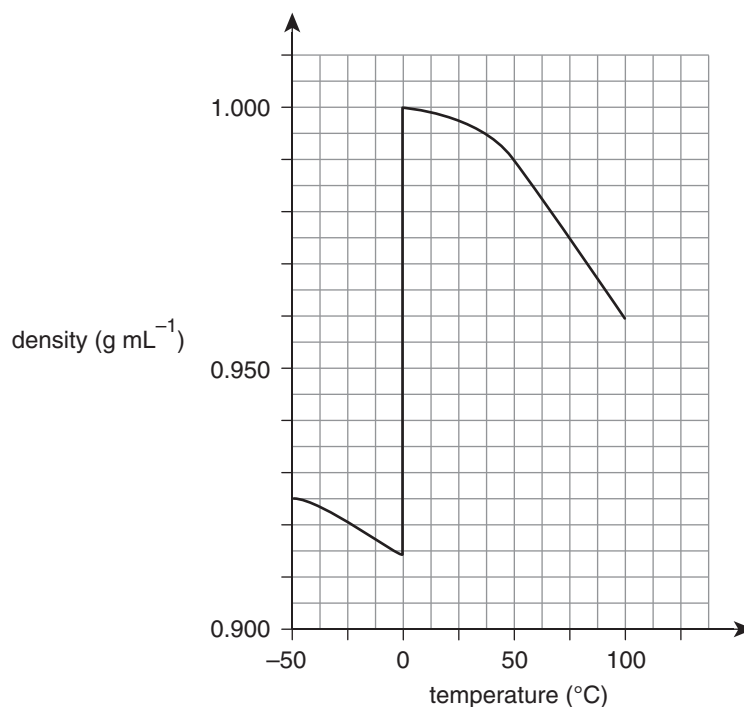
There are limitations in using the ionic bonding model to explain the properties of an ionic compound.

Which one of the following is **not** easily explained using the model?

- A. the ability to conduct electricity in different states
- B. hardness with a tendency to shatter in certain situations
- C. that melting generally requires high temperatures
- D. that some ionic compounds are insoluble in water

Use the following information to answer Questions 13 and 14.

The variation of the density of water with temperature is shown in the graph below.



Question 13

Consider the following statements which relate to the data in the graph.

- I Water at 75°C will float on water at 25°C.
- II Changing the temperature of water from -50°C to -25°C requires energy to be removed and results in a decrease in density.
- III Water molecules in ice are packed closer together than water molecules in liquid water at 0°C.

Which of these statements are **incorrect**?

- A. I and II only
- B. II and III only
- C. I and III only
- D. I, II and III

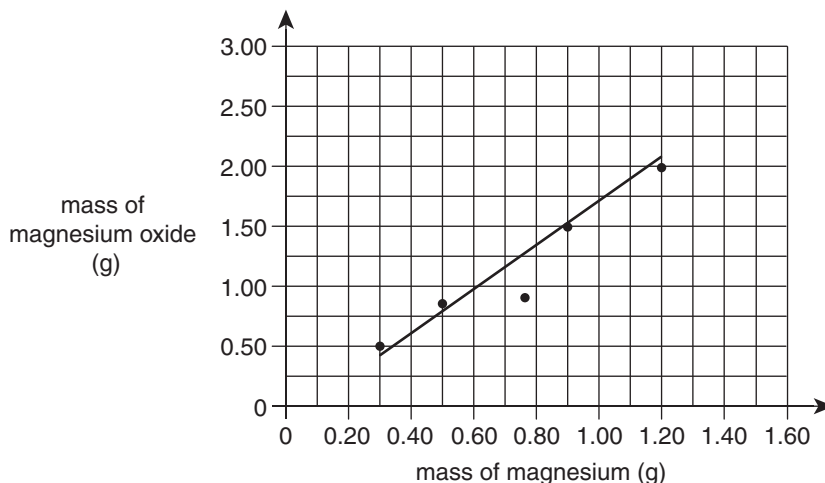
Question 14

Which type of interaction would be disrupted as water is being heated from 0°C to 50°C?

- A. hydrogen bonding only
- B. hydrogen bonding and dispersion forces only
- C. covalent bonds and dispersion forces only
- D. covalent bonds, hydrogen bonding and dispersion forces

Use the following information to answer Questions 15 and 16.

To confirm the empirical formula of magnesium oxide (MgO), a known mass of pure magnesium ribbon was burnt in oxygen gas. The product was cooled and weighed to find the mass of oxygen which had reacted with the magnesium. The experiment was repeated with different masses of magnesium ribbon and the results were graphed as shown below.



Question 15

If 3.29 g of magnesium ribbon had been burnt in oxygen, how many grams of oxygen gas would be expected to be used in the reaction?

- A. 1.09
- B. 2.17
- C. 3.29
- D. 5.46

Question 16

One of the values in the graph does not fit with the trend of the other values.

Which one of the following is **not** a possible explanation for the value which does not fit?

- A. Some magnesium oxide was lost during the experiment.
- B. The mass of magnesium ribbon was recorded incorrectly.
- C. A portion of magnesium ribbon was left unreacted.
- D. An excess of oxygen gas was used in the reaction.

Question 17

Element X has an outer electron shell configuration of $5s^25p^3$.

In the periodic table, element X is located in

- A. group 3 and period 5.
- B. group 5 and period 3.
- C. group 13 and period 3.
- D. group 15 and period 5.

Question 18

The results of an investigation into the properties of a carbon-based polymer sample are shown in the table below.

Appearance	flexible and clear
Strength	strip of sample stretches and breaks when 500 g weight is attached
Heated rod applied	softens when heated polymer hardens after metal rod is removed

Which one of the following is the best description of the polymer?

- A. a thermosetting plastic with little cross-linking
- B. a thermosetting plastic which could not be recycled
- C. a thermosoftening plastic which could be recycled
- D. a thermosoftening plastic with extensive cross-linking

Question 19

Two elements with their electron configurations are listed in the table below.

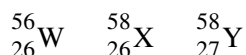
Element	Electron configuration
M	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$
Q	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$

Which one of the following is the most likely compound to be formed by a combination of these elements?

- A. an ionic compound of formula MQ_3
- B. an ionic compound of formula M_3Q
- C. a molecular compound of formula MQ_3
- D. a molecular compound of formula M_3Q

Question 20

Listed below are three atomic species, identified using the symbols W, X and Y.



Which of these species are isotopes of the same element?

- A. W and X, as they have the same atomic number.
- B. W and X, as they have the same mass number.
- C. X and Y, as they have the same atomic number.
- D. X and Y, as they have the same mass number.

END OF SECTION A

SECTION B**Instructions for Section B**

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

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

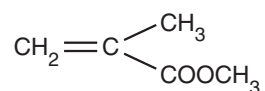
Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $\text{H}_2(\text{g})$, $\text{NaCl}(\text{s})$.

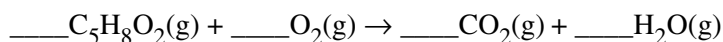
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Question 1 (5 marks)

The structural formula of methyl 2-methylpropenoate, also known as methyl methacrylate, is shown below.



- a. The following *unbalanced* equation represents the chemical reaction occurring when methyl methacrylate undergoes complete combustion.



Balance the equation by writing the correct coefficients in the spaces in the equation above.

1 mark

- b. Tick **one** box in the grid below to show whether all bonds in $\text{C}_5\text{H}_8\text{O}_2$ are polar, and whether the $\text{C}_5\text{H}_8\text{O}_2$ molecule is polar.

1 mark

	All bonds are polar	Not all bonds are polar
Molecule is polar		
Molecule is not polar		

- c. Pentenoic acid is a structural isomer of methyl methacrylate.

- i. Give the semi-structural formula of the carboxyl functional group found in pentenoic acid.

1 mark

- ii. What does the term 'pent' reveal about the structure of pentenoic acid?

1 mark

- d. Methyl methacrylate is a monomer used to form an addition polymer.

Draw a small section of this polymer.

1 mark

Question 2 (11 marks)

An organic compound is known to have the following composition by mass: 48.7% carbon, 8.1% hydrogen and 43.2% oxygen. The relative molecular mass (RMM) of the compound is 74.

- a. i.** Determine the empirical formula of the compound (working must be shown). 2 marks

- ii.** Show that the molecular formula of the compound is $C_3H_6O_2$. 1 mark

- b.** The compound was found to be an ester.

- i.** Give a common use of esters in industry or consumer products. 1 mark

- ii.** The alcohol used to produce the ester is ethanol.
Give the systematic name of the ester. 1 mark

- iii.** Write the semi-structural (condensed) formula of the ester. 1 mark

- c.** Draw the structural formula, showing all bonds, for **an isomer** of the ester named in **part b. ii.** 1 mark

d. Ethanol can be produced by an addition reaction between ethene and steam.

i. Give the semi-structural formula for ethene. 1 mark

ii. Ethene is a gas at room temperature, while ethanol is a liquid.

Explain why the boiling point of ethanol is much higher than that of ethene. 3 marks

Question 3 (18 marks)

The first transition series in the periodic table consists of metallic elements from scandium (Sc) to zinc (Zn).

- a. i.** Other than ductility (that is, able to be drawn into wires), state **one** property which is common to main group metals and transition series metals. 1 mark

- ii.** Using the metallic bonding model, explain why metals are ductile. 2 marks

- b.** State **one** property of transition series metals which is **not** a property of the main group metals. 1 mark

- c.** Scandium is the first element in the first transition series.

- i.** Write the electronic configuration for a scandium atom using subshell notation. 1 mark

- ii.** Write the electronic configuration for a doubly charged scandium cation using subshell notation. 1 mark

- d. Information about the first transition series elements cobalt (Co) and nickel (Ni) is shown below.

Element	Atomic number	Relative atomic mass
Co	27	58.9
Ni	28	58.7

- i. Explain why Ni has a higher atomic number than Co. 1 mark

- ii. Generally, the relative atomic mass (RAM) values of the elements increase across the series.

Explain why Ni has a lower RAM than Co. 2 marks

- iii. Explain why there are ten elements in the first transition series. 2 marks

- e. The following information about copper was obtained using a mass spectrometer.

Isotope	^{63}Cu	^{65}Cu
RAM	62.93	64.93

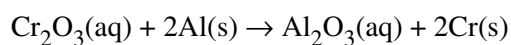
Calculate the percentage abundance of the heavier isotope. 2 marks

- f. The transition metal iron is usually modified by particular treatments prior to being used. Complete only **one** column in the table below to explain the *purpose* of the treatment of iron by using coatings OR heat treatment OR production of alloys.

1 mark

Possible methods of modifying iron prior to its use		
Coating the iron	Heat treatment of iron	Making an alloy from iron

- g. The transition metal chromium is extracted from chromium oxide by reaction with aluminium:



- i. Calculate the percentage composition by mass of chromium in chromium oxide. 2 marks

- ii. In one reaction, 100 kg of aluminium was used.
How many atoms of aluminium are present in this mass? 2 marks

Question 4 (10 marks)

a. Lithium chloride, diamond and glucose ($C_6H_{12}O_6$) were tested for their ability to conduct electricity.

i. Which of these compounds, if any, will conduct electricity as a solid? Explain your choice for each compound in terms of structure and bonding. 3 marks

ii. Which of these compounds, if any, will conduct electricity as a liquid? Explain your choice for each compound in terms of structure and bonding. 3 marks

b. Draw a diagram of the structure of solid diamond. 2 marks

c. Small diamonds are part of the drilling heads which are used to drill through rock in oil and gas exploration.

i. Which property of diamond is utilised in this application? 1 mark

ii. Explain how the property identified in **part c. i.** is consistent with the structure of diamond drawn in **part b.** 1 mark

Question 5 (6 marks)

- a.** The following list contains both accurate and inaccurate statements about nanoparticles.
- I Nanoparticles are typically in the size range of 500 to 700 nanometres.
 - II The surface area-to-volume ratio in nanoparticles is exceedingly small compared to the corresponding bulk material.
 - III The behaviour of metallic nanoparticles cannot be explained using the metallic bonding model.
 - IV Nanoparticles are more sensitive to the action of heat than larger particles.
 - V The tendency of nanoparticles to clump together is due to the formation of covalent bonds between the nanoparticles.
 - VI The ability of a metal to act as a catalyst will be greatly enhanced by using nanoparticles of the metal.

Give the numerals (I to VI) corresponding to **two** incorrect statements and explain why each of these statements is incorrect.

4 marks

- b.** Graphene and fullerenes are non-metallic nanomaterials.

- i.** Give **one** structural feature which is common to both graphene and fullerenes. 1 mark

- ii.** Outline **one** difference in the structure of graphene compared to fullerenes. 1 mark

END OF QUESTION AND ANSWER BOOKLET