

Trial Examination 2015

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

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A	20	20	20	25
B	4	4	50	65
			Total 70	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 16 pages.

Data Booklet of 3 pages.

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.

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.

Question 1

Which one of the following ideas proposed by Dalton in 1805 is part of modern atomic theory?

- A. Atoms of a particular element are identical in mass and have identical properties.
- B. All matter consists of atoms which cannot be divided into smaller particles.
- C. Compounds are formed from a combination of the atoms of two or more elements.
- D. The most stable compounds of two elements contain atoms in a one-to-one ratio.

Question 2

Solid sodium fluoride (NaF) melts at 992°C, whereas the melting point of magnesium oxide (MgO) is 2800°C.

Which one of the following is **not** a reasonable statement concerning the compounds MgO and NaF?

- A. There is ionic bonding between the particles in the lattice of each solid.
- B. There are stronger forces holding the particles together in MgO than in NaF.
- C. Electrons were transferred between atoms before lattices of the solids were formed.
- D. The electron configuration of the ions accounts for the different values of melting temperature of the two solids.

Question 3

The ground state electronic configuration of atom X is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$.

Which of the following shows the ground state electronic configuration for an atom of an isotope of X?

- A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$
- B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^1$
- C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$
- D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^1$

Use the following information to answer Questions 4 and 5.

In an early attempt to find patterns amongst the elements, the German chemist Dobereiner developed his theory of 'triads'. Within each group of three elements or 'triad', Dobereiner stated that 'the relative atomic weight of the middle element was almost exactly the average of the other two'. Sixty years after Dobereiner, the Russian chemist Mendeleev published his 'Periodic System of the Elements in Groups and Series'.

Question 4

Which one of the following is **not** a Dobereiner 'triad'?

- A. calcium, strontium, barium
- B. lithium, sodium, potassium
- C. chlorine, bromine, iodine
- D. boron, aluminium, gallium

Question 5

Which of the following statements concerning Mendeleev's Periodic Table is **incorrect**?

- A. Mendeleev left gaps where elements had not yet been discovered.
- B. Mendeleev ordered the elements vertically based on their similarity of outer-shell electron configuration.
- C. Mendeleev placed elements horizontally in order of increasing atomic mass.
- D. Mendeleev did not include the noble gases such as neon and argon in his table.

Use the following information to answer Questions 6 and 7.

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

Element	X	Y	Z
Electron configuration	$1s^2 2s^2 2p^6 3s^2 3p^1$	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$	$1s^2 2s^2 2p^6 3s^2 3p^3$

Question 6

Which of the following shows the formula of a compound which is likely to form?

- A. XY_3
- B. X_3Y
- C. X_5Y
- D. X_3Y_7

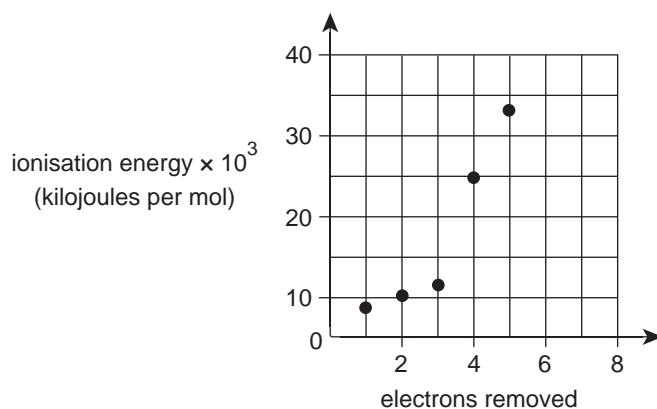
Question 7

Which of the elements, in the solid state, would **not** be expected to be malleable?

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. X, Y and Z

Question 8

The ionisation energy is the minimum amount of energy that is required to remove an electron from an atom or ion in the gaseous state. The first five successive ionisation energies of a particular element are shown below.



Which of the following could be the location of the element in the Periodic Table?

- A. group 2, period 3
- B. group 13, period 2
- C. group 14, period 2
- D. group 15, period 3

Use the following information to answer Questions 9 and 10.

The semi-structural formulas of a number of hydrocarbon compounds are listed below.

- I $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$
- II $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$
- III $\text{CH}_3\text{CH}(\text{OH})\text{C}=\text{CHCH}_3$
- IV $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$

Question 9

Which of the following is the systematic name of compound I?

- A. 1,1-dimethylprop-1-ene
- B. 2-methylbut-2-ene
- C. 3,3-dimethylprop-2-ene
- D. pent-3-ene

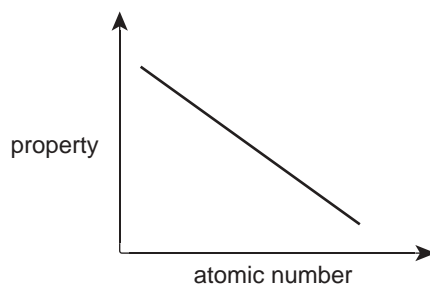
Question 10

Which of the listed formulas are isomers of the same compound?

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

Question 11

The graph below shows the trend in a property with increasing atomic number.

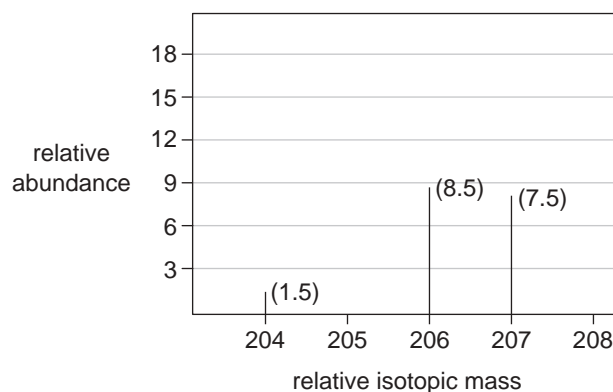


The graph above could represent

- A. electronegativity for elements moving down group 16.
- B. core charge of elements moving across period 3 from group 1 to 17.
- C. metallic character for elements moving down group 14.
- D. ionisation energy for elements moving across period 3 from group 1 to 17.

Question 12

The mass spectrum of three of the four isotopes of lead is shown in the diagram below. The values in brackets indicate the relative abundance of each isotope.



Considering the relative atomic mass of lead (207.2), what is the mass number and approximate relative abundance of the isotope which has not been shown in the mass spectrum?

	Mass number	Approximate relative abundance
A.	205	3
B.	205	18
C.	208	3
D.	208	18

Question 13

Which of the following properties would be the same for a calcium atom and a calcium ion?

- A. atomic number and radius
- B. atomic number and mass number
- C. chemical properties and radius
- D. chemical properties and mass number

Question 14

Some features of metals include:

- I metal alloys usually have lower electrical conductivity than the parent metal
- II mercury is a liquid at room temperature while tungsten melts at 3410°C.
- III silver has ten times the thermal conductivity of lead

Which of the above features cannot be readily explained by the 'sea of electrons' metallic bonding model?

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

Question 15

The 'surface energy' of a substance can be related to the strength of the bonds which need to be broken to create a new surface.

Given that octane is a hydrocarbon with eight carbon atoms per molecule, which of the following shows the surface energy of the substances in decreasing order?

- A. magnesium oxide > water > octane
- B. water > magnesium oxide > octane
- C. octane > magnesium oxide > water
- D. octane > water > magnesium oxide

Question 16

In a molecule of a particular compound, the number of carbon atoms is half the number of hydrogen atoms and double the number of oxygen atoms. The mass of 0.320 mole of the compound is 28.19 g.

Consider the following statements:

- I The relative molecular mass of the compound is 88.1.
- II The molecular formula of the compound can be determined from the information provided.
- III The empirical formula of the compound is $C_4H_8O_2$.

Which of the above statements is/are correct?

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

Use the following information to answer Questions 17 and 18.

Heating carbon and sulfur under certain conditions will produce the compound carbon disulfide (CS₂).

Question 17

The mass of carbon required to produce 33 g of carbon disulfide is closest to

- A. 5 g
- B. 10 g
- C. 15 g
- D. 20 g

Question 18

At room temperature, carbon disulfide is likely to

- A. be a liquid which has high electrical conductivity.
- B. have ionic bonds and be hard but brittle.
- C. consist of triatomic molecules with weak bonds between the molecules.
- D. be a covalent network solid with a high melting temperature.

Use the following information to answer Questions 19 and 20.

Copper piping supplied to plumbers is usually heated on-site, using a torch flame produced by burning propane gas from a cylinder. The heated piping is allowed to cool slowly before use.

Question 19

Which one of the following equations best represents the complete combustion of propane?

- A. $2\text{C}_3\text{H}_8(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 6\text{CO}(\text{g}) + 8\text{H}_2\text{O}(\text{g})$
- B. $\text{C}_3\text{H}_8(\text{g}) + 4\text{O}_2(\text{g}) \rightarrow \text{C}(\text{s}) + 2\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
- C. $2\text{C}_3\text{H}_8(\text{g}) + 9\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 2\text{CO}(\text{g}) + 8\text{H}_2\text{O}(\text{g})$
- D. $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$

Question 20

Which one of the following correctly identifies the process used in heating the copper and the resultant properties of the metal?

- A. quenching; softer, more pliable metal
- B. quenching; harder, more brittle metal
- C. annealing; softer, more pliable metal
- D. annealing; harder, more brittle metal

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

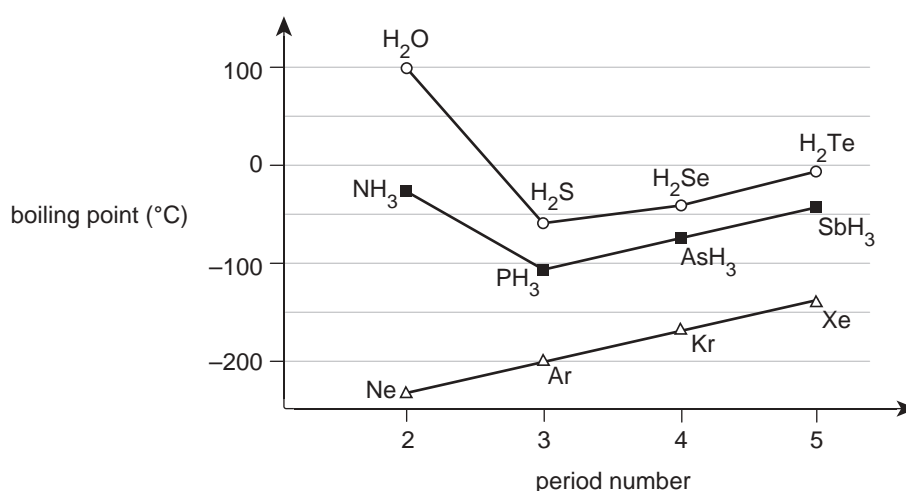
Answer **all** questions in the spaces provided. Write using black or blue pen.

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 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 an indication of state; for example, $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$

Question 1 (9 marks)

Hydrides are compounds containing hydrogen and another element. The boiling points of the group 18 elements and some hydrides of group 15 and 16 elements are shown in the graph below.



- a. Explain why there are two hydrogen atoms in the group 16 hydrides but three hydrogen atoms in the group 15 hydrides. 2 marks

- b. i. Draw the structural formula of PH_3 , showing all bonding and non-bonding electron pairs. 1 mark

- ii. Name the shape of the PH_3 molecule. 1 mark

- c.** Explain why the hydrides shown in the graph all have higher boiling points than the group 18 elements.

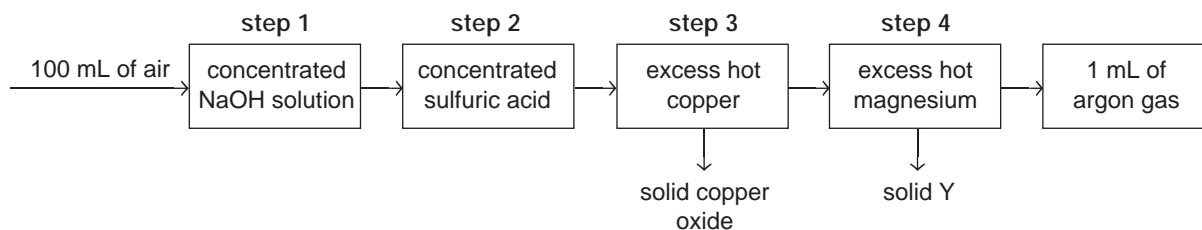
3 marks

- d.** Water and ammonia (NH_3) have boiling points which do not follow the trends in the graph. Explain this in terms of structure and bonding.

2 marks

Question 2 (17 marks)

The gaseous element argon was discovered by passing 100 mL of air through a series of steps to remove the other constituent gases.



- a. Step 1 removed carbon dioxide gas by reaction with the sodium hydroxide to produce dissolved sodium carbonate (Na_2CO_3) and water.
- i. Calculate the percentage by mass of sodium in sodium carbonate. 1 mark
- _____
- _____
- _____
- ii. Write a balanced equation for the chemical reaction occurring in step 1. 1 mark
- _____
- b. Step 2 uses concentrated sulfuric acid (H_2SO_4). One sample of concentrated sulfuric acid contains 10.0 g of molecules.
- Calculate the total number of atoms in these molecules. 3 marks
- _____
- _____
- _____
- _____
- c. Step 3 removes oxygen from the air sample. The solid formed in step 3 does not conduct electricity. However, if this solid is heated to become molten, it will conduct electricity.
- Explain these observations in terms of the structure and bonding of copper oxide. 3 marks
- _____
- _____
- _____
- _____
- _____

- d.** Step 4 removes nitrogen from the air sample by forming a compound of nitrogen and magnesium. Solid Y is composed of 27.8% nitrogen.
Determine the empirical formula of solid Y. 2 marks

- e.** In the modern Periodic Table, the element argon is placed before potassium. The relative atomic masses of argon and potassium are 39.9 and 39.1 respectively.

- i.** Why do the relative atomic masses have no units? 1 mark

- ii.** Given that the relative atomic mass of argon is greater than that of potassium, why is potassium placed after argon in the Periodic Table? 1 mark

- iii.** The symbol for the isotope carbon-12, the standard used for determination of the relative atomic masses of the elements, is $^{12}_6\text{C}$.
Write the symbol for the isotope of argon with 20 neutrons in the nucleus. 1 mark

- iv.** Write the symbol for a cation which is isoelectronic (has the same number of electrons) with an atom of argon. 1 mark

- v.** Which particle – an atom of argon or the isoelectronic cation given in part **iv.** – would be expected to have the smaller radius? Explain your choice. 2 marks

- vi.** What is the total number of electrons in all the p orbitals of an atom of argon? 1 mark

Question 3 (14 marks)

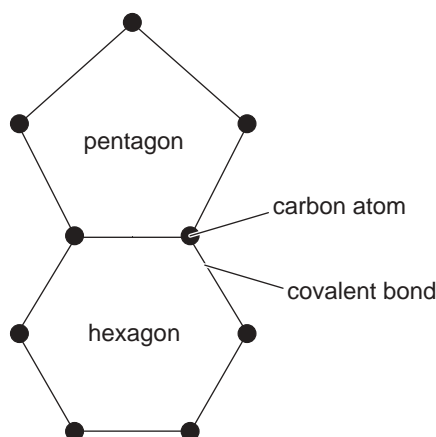
Carbon exists in numerous elemental forms and in a vast range of compounds.

- a. The most familiar allotropes of carbon are diamond and graphite, but many others have been identified in recent times.

i. What is meant by the term 'allotrope'? 1 mark

ii. State one property shared by graphite and diamond. 1 mark

- b. In 1985 chemists identified a nanoparticle (C_{60}) consisting of 60 carbon atoms arranged in a structure known as a 'fullerene'. In C_{60} , each nanoparticle is composed of 20 hexagons and 12 pentagons which connect the carbon atoms in a hollow spherical shape. The arrangement of some of these carbon atoms is shown in the diagram below.



i. Calculate the number of mole of nanoparticles in 500 g of the substance. 1 mark

ii. One of the suggested uses for the fullerene nanoparticles is as superconductors (materials with very little resistance to electrical current).

In terms of structure and bonding, explain why fullerene nanoparticles would be expected to be good electrical conductors. 2 marks

c. Scientists have developed a new material comprised of a sheet of carbon atoms. The material, known as graphene, is only one atom thick.

i. An early method for making graphene was to apply adhesive tape to ordinary graphite and peel off a layer.

In terms of its structure, why is it possible to remove a layer of carbon atoms from graphite using this method?

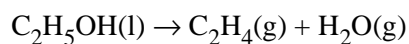
2 marks

ii. A graphene sheet is 100 times stronger than an equivalent sheet of steel of the same dimensions. Steel is an interstitial alloy consisting of a closely packed array of iron cations with carbon atoms positioned in some spaces within the lattice.

Using structure and bonding, explain why steel is much harder than its parent metal iron.

2 marks

- d.** Ethene is an important carbon compound which can be produced in the laboratory by heating ethanol in the presence of concentrated sulfuric acid. The chemical equation for the reaction is shown below.



Ethene reacts with bromine (Br_2) at room temperature to form a single organic product.

- i.** Draw a structural formula for a molecule of ethanol, showing all bonding and non-bonding electron pairs. 1 mark
- ii.** Name the product of the reaction between ethene and bromine. 1 mark

- iii.** Name the general type of reaction shown by ethene reacting with bromine. 1 mark

- iv.** Ethene belongs to the homologous series known as alkenes.
Give the molecular formula for the alkene containing six carbon atoms. 1 mark

- v.** Ethanol and diethyl ether are structural isomers.
Draw a structural formula for a molecule of diethyl ether, showing all bonding and non-bonding electron pairs. 1 mark

Question 4 (10 marks)

- a. The addition polymers R, S and T shown in the table below were produced from the same monomer using different reaction conditions.

Polymer	Section of the structure of the polymer
R	$ \begin{array}{cccccccccccc} \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & & & \\ -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}- \\ & & & & & & & & & & & \\ \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} \end{array} $
S	$ \begin{array}{cccccccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & & & \\ -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}- \\ & & & & & & & & & & & \\ \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} \end{array} $
T	$ \begin{array}{cccccccccccc} \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & & & \\ -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}- \\ & & & & & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 & \text{H} \end{array} $

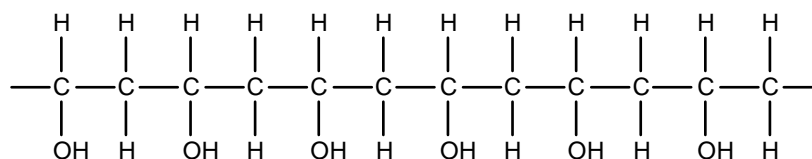
- i. Showing all bonds, draw the structural formula of the monomer used to produce the polymers R, S and T. 1 mark

- ii. Polymers R, S and T all have the same chemical name.
What is this chemical name? 1 mark

- iii. Which of polymers S or T is likely to have the strongest intermolecular bonding in plastic samples made from each? Explain your choice. 2 marks

- iv.** Given plastic samples made from each polymer, describe a laboratory experiment that could be used to test which polymer has the strongest intermolecular bonding. 2 marks

- b.** A section of the addition polymer polyvinyl alcohol (PVA) is shown below.



If this polymer material is heated to a very high temperature, it chars to a black appearance.

- i.** What is the cause of this black charring? 1 mark

- ii.** From the information provided about heating the polymer, is it possible to classify PVA as a thermoplastic or thermosetting plastic? Explain your choice. 2 marks

- iii.** State one change that could be made to the PVA polymer which would increase its melting temperature. 1 mark

END OF QUESTION AND ANSWER BOOKLET