

Trial Examination 2011

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 Multiple-choice	20	20	20	25
B Short-answer	5	5	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 with a detachable data sheet in the centrefold.

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 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

A substance has the following properties:

- conducts electricity when molten
- solid at room temperature
- melts on heating with a Bunsen burner

Which of the following examples of bonding are likely to be present in the substance?

- A. metallic or ionic
- B. ionic or covalent
- C. metallic or covalent
- D. metallic or ionic or covalent

Question 2

An element has four isotopes with relative atomic masses of x , $x + 2$, $x + 3$ and $x + 4$. The percentage abundances of these four isotopes are 1.4, 24.1, 22.1 and 52.4 respectively.

If the relative atomic mass of the element is 207.2, the relative mass of the least abundant isotope is

- A. 203
- B. 204
- C. 205
- D. 206

Question 3

The strength of a polymer will usually be decreased by

- A. branching the polymer chains.
- B. cross-linking the polymer chains.
- C. increasing the length of the polymer chains.
- D. adding a polar group to the monomer used to form the polymer.

Question 4

The range of shapes of molecules includes:

- I tetrahedral
- II linear
- III triangular pyramidal

In which of the following sets are the shapes of all the molecules in the list above?

- A. N_2 OF_2 HCN
- B. NH_3 HF H_2O
- C. CS_2 SF_6 CCl_4
- D. HCl PH_3 SiH_4

Question 5

Which of the following shows the appropriate values for the fourth shell using the quantum mechanical model of the atom?

	Number of subshells	Number of orbitals	Maximum number of electrons
A.	4	8	16
B.	4	16	32
C.	8	8	16
D.	16	16	32

Question 6

Members of a homologous series of organic compounds exhibit

- A. the same empirical formula but different molecular formulas.
- B. the same molecular formula but different structural formulas.
- C. similar chemical properties but different physical properties.
- D. similar physical properties but different chemical properties.

Question 7

An oxide is a compound of oxygen with another element. In a particular oxide, the mass of both constituent elements is the same.

Which of the following is the empirical formula of the compound?

- A. Na_2O
- B. SO_2
- C. CO_2
- D. NO

Question 8

Which of the following identifies the nature of the bonds and the overall polarity of the BF_3 molecule?

- A. polar bonds and polar molecule
- B. polar bonds and non-polar molecule
- C. non-polar bonds and polar molecule
- D. non-polar bonds and non-polar molecule

The following information relates to Questions 9 and 10.

A series of experiments were conducted to determine the empirical formula of magnesium oxide by burning a sample of magnesium in a crucible. The results from one experiment include:

mass of crucible	13.8 g
mass of crucible + magnesium	16.2 g

Question 9

If the empirical formula of magnesium oxide was found to be MgO , then the mass of magnesium oxide (in grams) produced was

- A. 2.40
- B. 3.26
- C. 3.98
- D. 4.15

Question 10

In another experiment, the empirical formula was found to be Mg_{10}O_9 .

Which of the following could explain this unexpected result?

- I Some magnesium oxide was lost from the crucible.
- II A larger mass of magnesium was used in this experiment.
- III The magnesium was not completely converted to magnesium oxide.
- IV A smaller crucible was used.

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

Question 11

The element X reacts with oxygen to form the compound $X_2\text{O}_3$ while element Y reacts with hydrogen to form the compound H_2Y .

The formula of a stable compound formed by element X and element Y is most likely to be

- A. XY
- B. X_2Y
- C. X_2Y_3
- D. X_3Y_2

Question 12

Which of the following properties do the substances graphite, silicon carbide (SiC) and silicon dioxide have in common?

They are all

- A. allotropes of carbon with high boiling points.
- B. electrical conductors and hard substances.
- C. brittle and their structure has only covalent bonds.
- D. covalent lattice structures and have high melting points.

Question 13

Consider the following statements about structural isomers:

- I If a non-cyclic hydrocarbon has a structural isomer that is unsaturated, then all non-cyclic structural isomers of the compound are unsaturated.
- II Any hydrocarbon containing three carbon atoms has only one structural isomer.
- III Structural isomers of a compound all have the same physical and chemical properties.

Which of the above statements is correct?

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

Question 14

The electronic configurations of four atoms are shown below.

Which electronic configuration represents an excited state for an atom of a Group 2 element?

- A. $1s^2 2s^2 2p^6 3p^2$
- B. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
- C. $1s^2 2s^1 2p^2 3s^1$
- D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

Question 15

Two samples of copper(II) oxide were made by different methods. Copper was then extracted from each sample and weighed. The results are shown below.

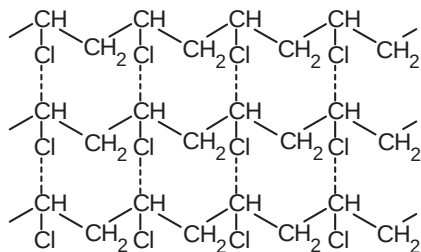
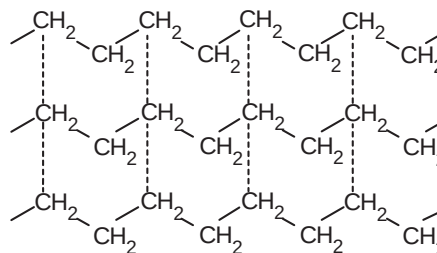
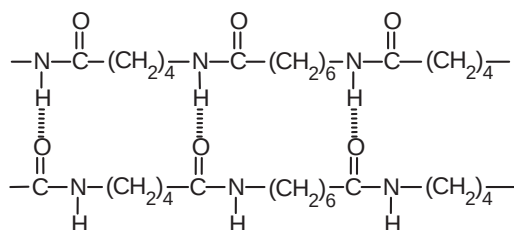
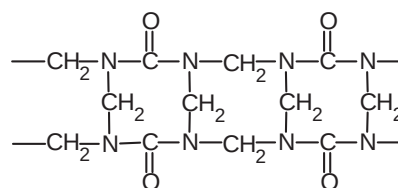
	Sample 1	Sample 2
Mass of copper(II) oxide (g)	12.30	16.87
Mass of copper extracted (g)	9.84	

The mass of copper extracted from Sample 2 is expected to be

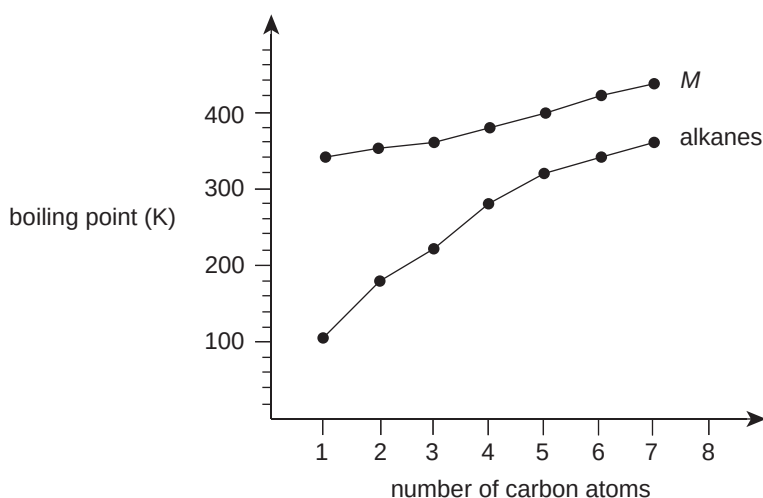
- A. less than 9.84 g.
- B. exactly 9.84 g.
- C. greater than 9.84 g.
- D. unable to be determined from the information given.

Question 16

Which of the polymers represented below would be expected to be rigid and thermosetting?

A.**B.****C.****D.****Question 17**

The graph below shows variation in the boiling points of two different homologous series with the number of carbon atoms per molecule.



Which of the following statements can be deduced from the data presented?

- A.** The compound with six carbon atoms per molecule in homologous series *M* could be hexene.
- B.** Homologous series *M* can only be another group of hydrocarbons similar to the alkanes.
- C.** In homologous series *M*, there is no relationship between the size of the molecule and the strength of intermolecular bonding.
- D.** A polar group of atoms may be present in the compounds of homologous series *M*.

Question 18

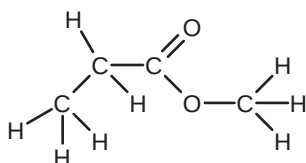
The element Z reacts with oxygen to produce the compound ZO. From an 8.572 g sample of ZO, 6.740 g of the element Z can be extracted.

What is the relative atomic mass of the element Z?

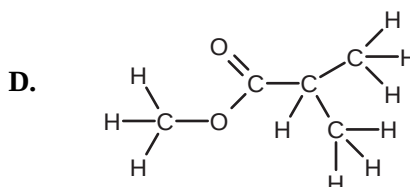
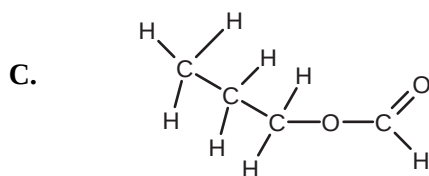
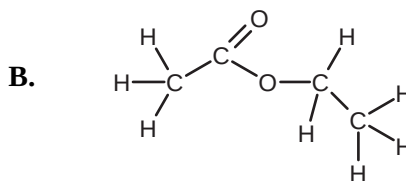
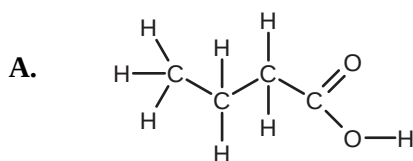
- A. 20.4
- B. 29.3
- C. 58.9
- D. 74.9

Question 19

The structural formula of the ester methyl propanoate is shown below.



Which of the following structural diagrams does **not** represent an isomer of methyl propanoate?

**Question 20**

A plasticiser is a small molecule which fits between polymer chains to make a plastic less rigid.

Which of the following is an **incorrect** statement about the plastic resulting from the addition of a plasticiser?

- A. Adding a plasticiser will strengthen the covalent bonds in the polymer chains.
- B. The plastic produced should soften at a lower temperature than the original plastic.
- C. The overall strength of intermolecular forces between polymer chains will be reduced by adding a plasticiser.
- D. Using a plasticiser causes the polymer chains to be held further apart.

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

Before Mendeleev, the English scientist John Newlands formulated a Periodic Table based on his ‘law of octaves’. He observed that ‘*each eighth element, starting with a given one, is a kind of repetition of the first, like the eighth note in an octave of music*’. His Periodic Table is shown below.

1 H	2 Li	3 Be	4 B	5 C	6 N	7 O
8 F	9 Na	10 Mg	11 Al	12 Sc	13 P	14 S
15 Cl	16 K	17 Ca	18 Cr	19 Ti	20 Mn	21 Fe
22 Co; Ni	23 Cu	24 Zn	25 Y	26 In	27 As	28 Se
29 Br	30 Rb	31 Sr	32 Ce; La	33 Zr	34 Di; Mo	35 Ro; Ru

- a. i. On what basis did Newlands order the elements moving across his Periodic Table?

- ii. In some instances, Newlands found it necessary to place two elements in one space. Why would he have done this?

1 + 2 = 3 marks

- b. There were a number of criticisms of Newlands’ table. One of these was that the metals Co and Ni were in the same vertical grouping as the reactive gases F, Cl and Br.

- i. In the modern Periodic Table, in what block are the metals Co and Ni located?

- ii. Write the electronic configuration of Ni using shell and subshell notation.

iii. The metals Co and Ni have some common properties including:

- electrically conductive
- malleable and ductile
- magnetic
- high melting and boiling point

With the aid of a labelled diagram, explain why these metals conduct electricity.

iv. Which of the metallic properties listed above cannot be explained simply using the metallic bonding model?

1 + 1 + 3 + 1 = 6 marks

c. In the modern Periodic Table, F, Cl and Br belong to a group known as the halogens. The melting points of the halogens are shown below.

Element	Fluorine	Chlorine	Bromine	Iodine
Melting point (°C)	-220	-101	-7	114

Explain the trend in melting points of these elements.

2 marks

d. The modern Periodic Table allows trends in properties of the elements to be identified.

For each sequence of elements in the table below, indicate the trend in the specified property by ticking one box in each row.

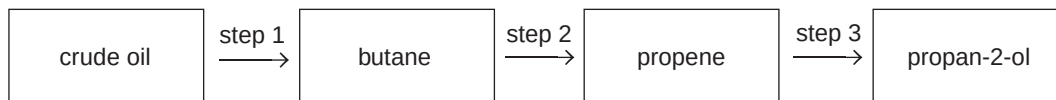
Property and sequence of elements	Change in the property		
	increases	unchanged	decreases
Atomic radii from N to Li (N, C, B, Be, Li)			
Electronegativity from Te to O (Te, Se, S, O)			
Number of electrons in the sequence Ar, Cl ⁻ , S ²⁻			

3 marks

Total 14 marks

Question 2

A series of possible steps in the preparation of the compound propan-2-ol ($\text{C}_3\text{H}_7\text{OH}$) are shown in the flowchart below.



- a. One component of crude oil is a **branched** alkane which contains 84% carbon by mass.

i. Determine the molecular formula of the alkane.

ii. Draw a possible structural formula of the branched alkane.

1 + 1 = 2 marks

- b. In step 2, butane is passed over a heated catalyst in the absence of air to produce propene and one other product.

i. Name the other product formed in step 2.

ii. Explain why this step is performed in the absence of air.

1 + 1 = 2 marks

- c. In one production run, step 2 produced 100 kg of propene.
Calculate the number of molecules of propene in this mass.

2 marks

- d. Step 3 involves the reaction of propene with steam to produce propan-2-ol.
Write an equation to show this reaction (symbols of state are not required).

1 mark

- e. Ethanol ($\text{C}_2\text{H}_5\text{OH}$) is also produced industrially using products from crude oil. Its molar mass is similar to that of propene but its boiling point differs significantly.

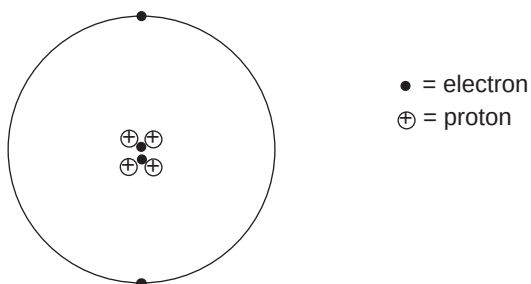
Compound	Molar mass (g mol^{-1})	Boiling point ($^{\circ}\text{C}$)
Propene	42	-48
Ethanol	46	78

Explain the difference in boiling points for these compounds.

3 marks
Total 10 marks

Question 3

- a. In 1914 the scientist Ernest Rutherford had observed that a helium atom had a nuclear charge of +2 and was four times heavier than a hydrogen atom. He proposed that the helium nucleus contained four protons and two electrons, as illustrated below.



- i. Explain how Rutherford's model of the helium atom was consistent with his scientific observations of the helium atom.

- ii. Using knowledge of the current model of the structure of the atom, identify two errors in Rutherford's model of the helium atom.

2 + 2 = 4 marks

- b. In later years, when working with the element thorium, Rutherford discovered a radioactive material (which he called thorium-X) that was chemically similar to thorium, but of different mass to other atoms in the sample.

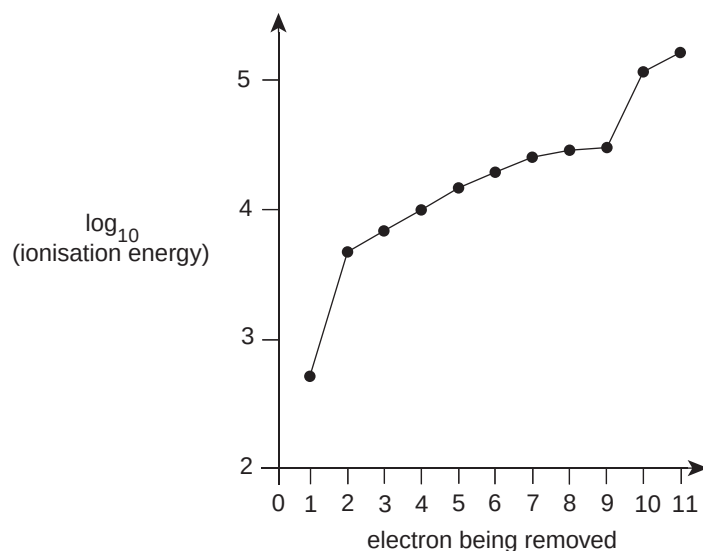
- i. Any element E may be represented by the notation ${}^A_Z E$.

Given that the mass number of thorium-X is 234, write the ${}^A_Z E$ notation for an atom of thorium-X.

- ii. Using modern atomic theory, explain Rutherford's observations regarding the properties of thorium and thorium-X.

1 + 1 = 2 marks

- c. Information about the structure of the atom can be gained by measuring the amount of energy required to remove successive electrons from an atom. This ionisation energy can then be plotted against the number of electrons being removed. The ionisation energy graph for one element is shown below.



- i. Explain what information about the structure of the atom can be deduced from the graph.

- ii. Write the symbol of the most likely ion formed by the element used to generate this graph.

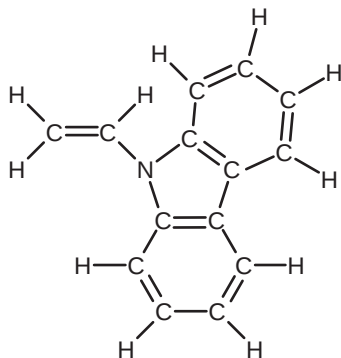
2 + 1 = 3 marks

Total 9 marks

Question 4

Some photocopiers use a polymer which exhibits photoconductivity. The electrical conductivity of this polymer changes in the presence of light. A very thin layer of the polymer is coated onto a metal drum and the polymer becomes charged. If the polymer is exposed to light the charge disappears. In the dark the charge is retained. Production of a photocopy uses these charge characteristics to create an image and attract a fine layer of ink to the image.

One photoconductive polymer is polyvinyl carbazole. The structural formula of the monomer (vinyl carbazole) of this polymer is shown below.



- a. i. Which feature of the structure of vinyl carbazole enables it to undergo addition polymerisation?

- ii. State the empirical formula of the polymer polyvinyl carbazole.

1 + 1 = 2 marks

- b. Given that the molar mass of vinyl carbazole is 193 g mol^{-1} , calculate

- i. the mass of nitrogen present in a 1.55 g sample of vinyl carbazole.

- ii. the amount (in mol) of vinyl carbazole in 0.205 g of the compound.

1 + 1 = 2 marks

- c. Based on their structure, would you expect polymers to be electrical conductors? Justify your answer.

2 marks

- d. The structural diagram of vinyl carbazole provided incorrectly shows the length of all covalent bonds to be the same.

Complete the table below to correctly compare various bond strengths and bond lengths (answer by writing the appropriate terms in each space in the table).

Type of bond	Strength of bond compared with that of a carbon-carbon single covalent bond (<i>answer as greater than, less than or equal to</i>)	Length of bond compared with that of a carbon-carbon single covalent bond (<i>answer as longer than, shorter than or equal to</i>)
Carbon-carbon double covalent bond		
Carbon-carbon bond between the layers in graphite		

2 marks

- e. Another type of nitrogen containing addition polymer is acrylonitrile. The monomer for this polymer contains a carbon-nitrogen triple bond and has the molecular formula C_3H_3N .

Draw a small section of the acrylonitrile polymer.

2 marks

Total 10 marks

Question 5

- a. The properties of materials found in a school laboratory (macroscale size) can change significantly when the materials are reduced in size to the nanoscale. Two examples of this change are given in the table below.

Material	Property of macroscale particle	Property of nanoparticle
Aluminium	stable	highly combustible
Zinc oxide	white appearance	transparent appearance

- i. When aluminium nanoparticles burn, they combine with oxygen to produce aluminium oxide. Write a balanced equation to show this chemical reaction.

- ii. Zinc oxide absorbs ultraviolet radiation from the sun and is used in suncreams to prevent sunburn.

Explain why zinc oxide nanoparticles are much more efficient at absorbing ultraviolet radiation than macroscale particles.

2 + 2 = 4 marks

- b. The surface properties of a material control many aspects of its interaction with other substances. The surface energy of a material is a measure of the strength of the bonding within the material. The relative surface energies of two materials are shown in the table below.

Substance	Relative surface energy
Octane (C_8H_{18})	very low
Diamond	high

Both diamond and octane have covalent bonding in their structures.

Explain why the relative surface energy of diamond is much higher than that of octane.

3 marks

Total 7 marks

END OF QUESTION AND ANSWER BOOKLET