Neap:

Trial Examination 2012

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	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 14 pages with a detachable data sheet in the centrefold.

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 communication devices into the examination room.

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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 compounds have an empirical formula which is the same as the molecular formula?

I C_6H_5Cl

II C_2H_5COOH

III $C_6H_{12}O_6$

IV $C_{10}H_8$

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

Question 2

Which of the following contains the smallest number of oxygen atoms?

A. 2.3×10^{23} molecules of sulfur trioxide gas
B. 19 g of ice
C. 0.95 mol of oxygen atoms
D. 0.6 mol of oxygen gas

Question 3

Which one of the following statements about thermosetting plastics is **incorrect**?

A. The number of crosslinks will influence the temperature at which these plastics soften and can be moulded.
B. These plastics tend to be rigid, brittle materials which can be used in applications that require the use of moderate heat.
C. If a high enough temperature is used, these plastics will char and burn, leaving a black residue which is mostly carbon.
D. These plastics are quite difficult to recycle and many are disposed of in landfill waste.

Question 4

Alkanes are compounds composed of carbon and hydrogen. Silicon also forms compounds with hydrogen, known as silanes.

How many different molecular structures are expected for the silane compound Si_4H_{10}?

A. 1
B. 2
C. 3
D. 4

Use the following information to answer Questions 5 and 6 .

The metallic bonding model describes the basic structure of metals and can be used to explain typical metallic properties.

Question 5

The basic structure of solid metals is best described as

A. a lattice of cations and localised electrons held firmly by electrostatic forces.
B. delocalised cations and electrons which are free to move throughout a lattice.
C. positively charged particles held in place by attraction to free-moving electrons.
D. cations held in a lattice by delocalised inner shell electrons.

Question 6

Which of the following **cannot** be explained simply using the metallic bonding model?

I The range of melting temperatures and densities of different metals
II The magnetic nature of some metals
III The variation in electrical conductivity between metals

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

Question 7

A sample of aluminium sulfide, Al_2S_3, contains 0.25 mol of sulfur atoms.

The total mass of aluminium in the sample is

A. 0.17 g.
B. 4.5 g.
C. 6.8 g.
D. 10 g.

Question 8

Which of the following is a correct description of part of the structure of solid silicon dioxide?

A. Each oxygen atom is covalently bonded to four silicon atoms.
B. Each silicon atom is covalently bonded to four oxygen atoms.
C. Each oxide ion is ionically bonded to two silicon ions.
D. Each silicon ion is ionically bonded to two oxide ions.

Question 9

The properties of metals can be modified by heat treatment.

If a metal is heated to red hot and then cooled slowly in air, which of the following crystal sizes and properties is the heat treated metal likely to have?

	Size of metal crystals	Properties of the treated metal
A.	tiny	hard and brittle
B.	tiny	soft and malleable
C.	large	hard and flexible
D.	large	soft and ductile

Question 10

Element *X* has the following properties:

- high electronegativity
- small atomic radius
- one of the highest first ionisation energies of any element

The location of element *X* in the Periodic Table is most likely to be in

A. Period 2 and Group 17.
B. Period 3 and Group 3.
C. Period 4 and Group 18.
D. Period 5 and Group 16.

Question 11

A substance is insoluble in water, and melts at a high temperature. The substance does not conduct electricity in the solid state, but conducts when molten.

The substance is most likely to be

A. NaCl.
B. Ni.
C. CuO.
D. S.

Question 12

Which of the following shows the correct molecular polarity and molecular shape of the listed molecules?

	Molecule	Molecular polarity	Molecular shape
A.	CO_2	polar	V-shaped
B.	NH_3	polar	tetrahedral
C.	CCl_4	non-polar	trigonal pyramidal
D.	SF_6	non-polar	octahedral

Question 13

An experiment was conducted to determine the percentage by mass of the elements in a compound consisting of tin and oxygen. The mass of oxygen reacting with a sample of tin can be determined by heating the metal in a crucible until no further reaction occurs.

Some steps in the experiment are shown below in the **incorrect** order.

1. Weigh the metal and record its mass.
2. Ignite the burner and heat the metal.
3. Allow the crucible to cool and then weigh it.
4. Remove any oxide layer on the metal by scrubbing.
5. Continue heating the crucible until any reaction is complete.
6. Put metal into crucible of known mass and cover with lid.

What order of steps should be used to conduct an accurate experiment?

A. 1, 4, 6, 2, 3, 5
B. 6, 2, 5, 3, 4, 1
C. 4, 1, 6, 2, 5, 3
D. 2, 5, 3, 4, 1, 6

Question 14

The total number of atoms in 90.0 g of $(NH_4)_3PO_4$ is

A. 3.64×10^{23}.
B. 1.46×10^{24}.
C. 6.56×10^{24}.
D. 7.27×10^{24}.

Question 15

Which of the following shows the correct order of discovery of the listed items, beginning with the earliest discovered?

A. proton, neutron, nucleus, electron, isotopes
B. electron, proton, nucleus, isotopes, neutron
C. electron, neutron, proton, isotopes, nucleus
D. nucleus, proton, neutron, isotopes, electron

Question 16

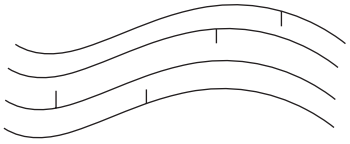
Which of the following substances could **not** be used to form an addition polymer?

A. $ClCH_2CHCl_2$
B. CH_3CHCCl_2
C. $CH_3CH_2C(OH)CH_2$
D. $C_2H_2Br_2$

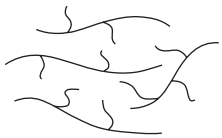
Question 17

The polyethene molecule can have different amounts of branching, depending on the conditions used during polymerisation. Two different types of polyethene are shown in the simplified drawings below.

type I polyethene



type II polyethene



Type II polyethene is likely to

A. melt at a lower temperature than type I polyethene.

B. be a stronger and denser material than type I polyethene.

C. exhibit stronger dispersion forces between the polymer chains than type I polyethene.

D. display a lower amount of flexibility than type I polyethene.

Question 18

The percentage by mass of nitrogen in the fertiliser urea $(NH_2)_2CO$ is closest to

A. 20.

B. 30.

C. 50.

D. 60.

Question 19

In the modern model of atomic structure, the number of subshells and orbitals in the fifth shell are, respectively,

A. 5 and 5.

B. 5 and 25.

C. 10 and 25.

D. 10 and 50.

Question 20

At 25°C, the surface tension (surface energy) of water is almost four times greater than that of the liquid hydrocarbon octane.

The main reason for this difference is that

A. water consists of smaller molecules which can pack together more closely in the liquid.

B. the dipole-dipole forces between octane molecules are weaker than the dipole-dipole bonds between water molecules.

C. the covalent bonds in octane molecules are not as strong as those in water.

D. the intermolecular forces between water molecules are much stronger.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer all questions in the spaces provided.

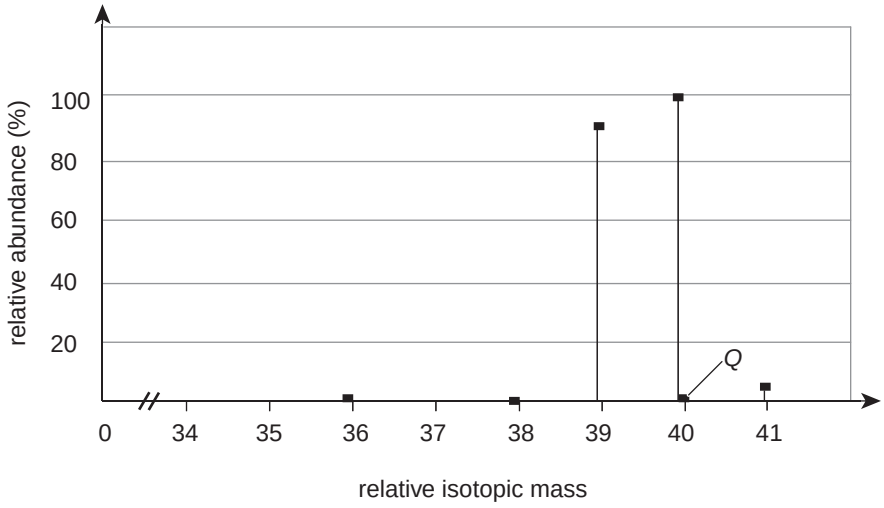
To obtain full marks for your responses you should

- 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 $H_2(g)$; NaCl(s).

Question 1

Analysis of a mixture of equimolar quantities of argon and potassium produced the data shown in the table and the spectrum displayed below.

Element	Atomic number	Relative isotopic mass	Relative abundance (%)
Argon	18	35.978 37.974 39.974	0.307 0.060 99.633
Potassium	19	38.975 39.976 40.974	93.3 0.011 6.69



a. Using the notation ${}^{A}_{Z}X^{x}$, give the symbol for the chemical species that produced the result in the spectrum marked *Q*.

_____

2 marks

b. Relative isotopic mass has no units. Explain why.

_____

_____

_____

1 mark

c. When asked to calculate the relative atomic mass of argon, a student used the method:

$$\frac{(35.978 + 37.974 + 39.974)}{3} = 37.975$$

The accepted value for the relative atomic mass of argon is 39.9.

i. Identify the error in the student's method.

_____

_____

ii. Show how the relative atomic mass of argon should be calculated using the data provided.

_____

_____

1 + 1 = 2 marks

d. Potassium has a higher atomic number than argon, but a smaller relative atomic mass.

Explain how this situation occurs.

_____

_____

_____

_____

_____

2 marks

e. A similar situation occurs with the elements tellurium and iodine, with the higher atomic number iodine having a smaller mass than tellurium. In the Periodic Table produced by Mendeleev in 1869, elements were ordered horizontally by increasing atomic mass. However, in Mendeleev's table, the element tellurium was placed before iodine (just as it is in the modern table).

On what basis did Mendeleev place tellurium before iodine?

_____

_____

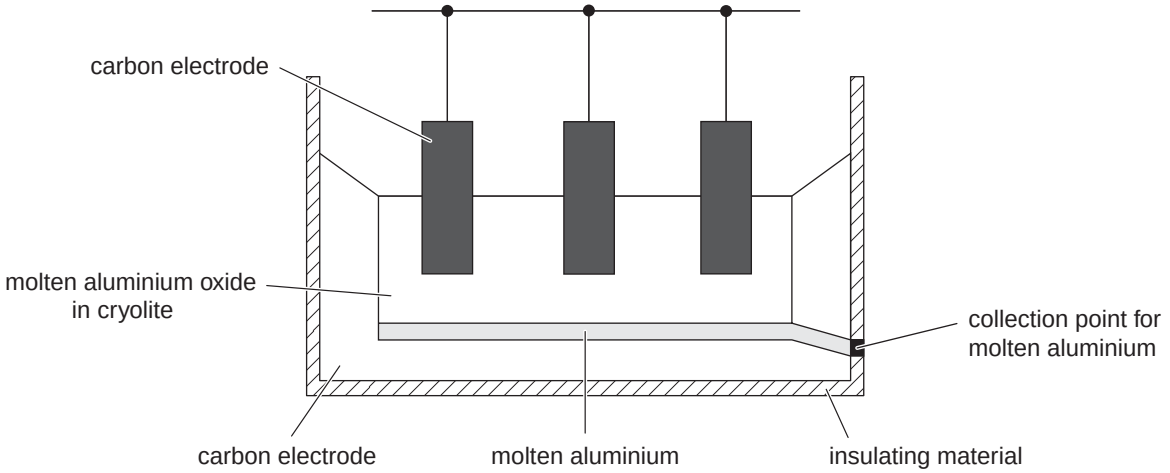
_____

1 mark

Total 8 marks

Question 2

Aluminium metal is produced from aluminium oxide dissolved in a compound known as cryolite. A simplified diagram of the industrial process is shown below. Electricity passing from one carbon electrode to the other causes the aluminium oxide to become molten, and aluminium to be produced by electrolysis.



a. The melting point of aluminium oxide is 2020°C.

In terms of structure and bonding, explain why a very high temperature is needed to melt aluminium oxide.

_____

_____

_____

_____

_____

2 marks

b. Both the molten aluminium oxide and the solid carbon electrodes conduct electricity.

i. State one similarity in the way in which molten aluminium oxide and solid carbon conduct electricity.

_____

_____

ii. State one difference in the way in which aluminium oxide and carbon conduct electricity.

_____

_____

_____

1 + 1 = 2 marks

c. Aluminium oxide is a compound of oxygen and a Period 3 element. Several other oxides of Period 3 elements, together with their melting points, are shown in the table below.

Formula of oxide	Na_2O	MgO	SiO_2	P_2O_5	SO_3
Melting point (°C)	920	2800	1700	250	62

i. SO_3 forms a trigonal planar molecule.

Name the bond types present in a sample of liquid SO_3.

_____

_____

ii. Explain why the melting point of MgO is much higher than that of Na_2O.

_____

_____

_____

_____

2 + 2 = 4 marks

d. Cryolite is a compound composed of fluorine (54.3%), aluminium (12.9%) and sodium.

Determine the empirical formula of cryolite.

_____

_____

_____

_____

2 marks

e. Aluminium is often combined with other metals to produce alloys. An alloy of aluminium and the element scandium is used in spacecraft manufacture. Scientists have designed this alloy to form nanoparticles, which produces an extremely strong material.

i. In terms of structure and bonding, explain why alloying metals often produces a stronger metal.

_____

_____

_____

_____

ii. Explain why the alloy composed of nanoparticles produces a much stronger material.

_____

_____

_____

_____

2 + 2 = 4 marks

Total 14 marks

Question 3

a. The element seaborgium (Z = 106) was named in honour of the scientist Glenn Seaborg who was involved in the discovery of elements 94 to 102. Most of these elements were produced by firing a neutron at the nucleus of an atom of another element. If the neutron is captured by the nucleus, the neutron disintegrates to produce a proton and a beta particle which is ejected.

i. How are scientists able to claim that a new element has been produced by this neutron capture process?

_____

_____

_____

_____

ii. Some of these new elements are produced in minute quantities and exist for as briefly as 10^{-14} seconds.

Suggest how chemists could predict the properties of these elements.

_____

_____

_____

iii. Seaborg also identified the actinides as a separate grouping in the modern Periodic Table.

Which type of subshell is being progressively filled in the elements of the actinide series?

_____

2 + 1 + 1 = 4 marks

b. An atom of seaborgium can be made by initially forcing a zinc (Z = 30) nucleus to combine with a lead (Z = 82) nucleus. This produces an unstable nucleus which emits an alpha particle to form the nucleus of an atom of a different element. Alpha particles continue to be emitted until a stable nucleus is formed. An alpha particle consists of two protons and two neutrons.

i. An alpha particle is simply the nucleus of a particular element.

Name this element.

_____

ii. In total, how many alpha particles are emitted after the zinc and lead nuclei combine before a seaborgium nucleus is produced?

_____

1 + 1 = 2 marks

c. The electron configuration of atoms and ions can be written in simplified form using the symbol of the previous noble gas in the Periodic Table as part of the configuration. Examples are shown in the table below.

Element	Simplified electron configuration
Nitrogen	$[He]2s^2 2p^3$
Potassium	$[Ar]4s^1$

i. Write the **simplified** electron configuration of a sulfur atom.

_____

ii. Write the **simplified** electron configuration of a cobalt ion, Co^{2+}.

_____

iii. Identify the correct electron configuration of an actinide in the table below by placing a tick in the appropriate box in the second column.

$[Rn]5f^{14}6d^7 7s^2$	
$[Xe]4f^8 5d^1 6s^2$	
$[Rn]5f^7 6d^1 7s^2$	
$[Rn]6f^1 7s^2$	

1 + 1 + 1 = 3 marks

d. Elements in the Periodic Table show various trends in properties when moving across a period from left to right.

i. What is the trend (increasing or decreasing) in the atomic radius of atoms moving across Period 3 from Na to Cl?

_____

ii. The actinides and the transition metals do not show an increasing or decreasing trend in their atomic radii moving from left to right across the table. These atomic radii are relatively constant.

How can this be explained?

_____

_____

_____

_____

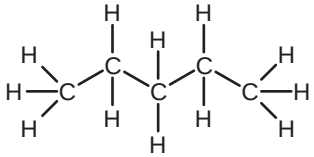
_____

1 + 2 = 3 marks
Total 12 marks

Question 4

The structural formulas of some carbon-based compounds are shown below.

A



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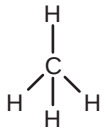
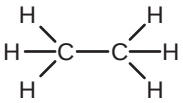


C



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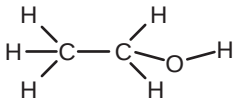
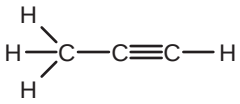
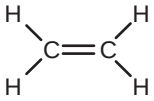


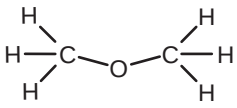
E



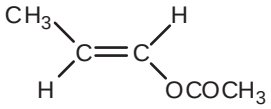
F



G



H



Use the letters **A** to **H** to identify compounds when answering the following questions. (Letters may be used more than once.)

a. **i.** Identify two compounds which have the same molecular formula.

_____

ii. Identify one unsaturated hydrocarbon compound.

_____

iii. Identify one compound which would undergo a substitution reaction.

_____

1 + 1 + 1 = 3 marks

b. Which of the compounds **C**, **D** or **F** would have the higher boiling point? Explain your choice.

_____

_____

_____

_____

_____

_____

3 marks

c. **i.** Write a balanced chemical equation for the reaction by which compound **C** is produced from compound **F**. Include any necessary reaction conditions.

_____

_____

ii. Write a balanced chemical equation for the complete combustion of a gaseous sample of compound **E**.

_____

_____

2 + 2 = 4 marks

d. Give the structural formula and systematic name of another isomer of compound **A**.

structural formula	
name	

2 marks

e. Draw a section of the product formed when compound **H** undergoes addition polymerisation.

2 marks

f. Calculate the mass, in grams, of one molecule of compound **H**.

_____

_____

_____

_____

2 marks
Total 16 marks

END OF QUESTION AND ANSWER BOOKLET