

Trial Examination 2021

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 14 pages

Data booklet

Answer sheet for multiple-choice questions

Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and 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.

You may keep the data booklet.

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

Which one of the following characteristics applies to transition metals but **not** to the main group metals?

- A. They have atoms with one, two or three electrons in their outer electron shell.
- B. They form ions with variable charges.
- C. They can be hammered into shapes without fracturing.
- D. They conduct electricity in both the solid and molten states.

Use the following information to answer Questions 2 and 3.

A sample of gold metal and a sample of gold nanoparticles were analysed and compared.

Question 2

The properties of gold metal will include

- A. a very low melting point.
- B. magnetic attraction.
- C. malleability.
- D. brittleness.

Question 3

The comparison of the samples is likely to show that

- A. for equivalent sample volumes, gold nanoparticles have the lower total surface area.
- B. both exhibit a high degree of chemical reactivity.
- C. only gold nanoparticles have neutrons located outside the nucleus.
- D. some of the properties exhibited by gold nanoparticles are absent in gold metal.

Question 4

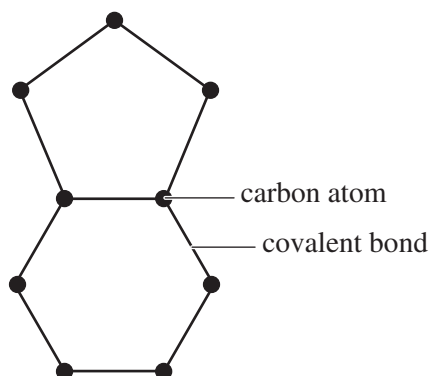
A chemical particle has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$.

This particle is most likely to be an

- A. uncharged atom of an element located in the first transition series.
- B. unreactive, noble gas that is from the third period.
- C. ion of a metallic element that is positively charged.
- D. atom of a non-metallic element that has lost electrons.

Use the following information to answer Questions 5 and 6.

The diagram below shows the arrangement of some of the atoms in a substance that is an elemental form of carbon.



Question 5

Which elemental form of carbon is shown?

- A. graphite
- B. fullerene
- C. diamond
- D. graphene

Question 6

The substance depicted in the diagram will

- A. conduct electricity, as there are delocalised electrons in the structure.
- B. conduct electricity, as carbon ions form and these carry the charge.
- C. not conduct electricity, as all electrons are localised and so no charges move.
- D. not conduct electricity, as only ions carry charge and no ions are present.

Question 7

Which two features of elements are used to formulate the modern periodic table?

- A. mass number and metallic character
- B. atomic number and mass number
- C. chemical reactivity and electron configuration
- D. electron configuration and atomic number

Question 8

Which one of the following is the valence shell electron-pair repulsion (VSEPR) model mainly used to predict?

- A. shapes of molecules
- B. electrical conductivity of substances
- C. polar character of bonds within a molecule
- D. electronegativity of elements

Question 9

Niels Bohr's work on emission spectra and his model of the atom were mainly concerned with the arrangement of

- A. protons.
- B. electrons.
- C. neutrons.
- D. all nuclear particles.

Question 10

Which one of the following rows correctly shows the details of the fourth shell of an atom, using the Schrödinger model?

	Number of subshells	Number of orbitals	Number of d-type orbitals
A.	4	32	1
B.	4	16	5
C.	16	32	1
D.	16	16	5

Question 11

Each of the isotopes ^{12}C , ^{13}C and ^{14}C have the same

- A. number of neutrons and electrons.
- B. ground state electron configuration and nuclear mass.
- C. number of protons and mass number.
- D. atomic number and number of outer-shell electrons.

Question 12

Which one of the following pairs of molecules have the same shape?

- A. CO_2 and HCl
- B. CH_4 and SF_6
- C. NH_3 and H_2O
- D. N_2 and H_2S

Question 13

An experiment was conducted to determine the order of reactivity of four metals: Q, R, X and Y. The observations in the experiment include the following.

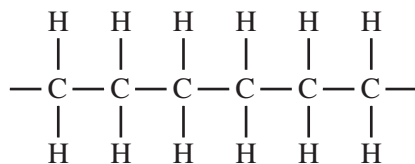
- All metals reacted with air and metal R reacted the fastest.
- There was no visible reaction of metal Q with water and metal Y reacted slowly.
- Metal X did not react with dilute hydrochloric acid, but all other metals produced bubbling.

What is the order of increasing reactivity of the metals?

- A. $\text{R} < \text{Y} < \text{Q} < \text{X}$
- B. $\text{X} < \text{R} < \text{Y} < \text{Q}$
- C. $\text{R} < \text{Q} < \text{X} < \text{Y}$
- D. $\text{X} < \text{Q} < \text{Y} < \text{R}$

Use the following information to answer Questions 14–16.

Part of the structure of an addition polymer is shown in the diagram below.



Question 14

This polymer is best described as a

- A. thermosetting plastic, as it will soften when heated to moderate temperatures.
- B. thermosetting plastic, as it will char when heated to high temperatures.
- C. thermosoftening plastic, as it will soften when heated to moderate temperatures.
- D. thermosoftening plastic, as it will char when heated to high temperatures.

Question 15

What is the relative molecular mass of the monomer used to make this addition polymer?

- A. 28
- B. 30
- C. 42
- D. 44

Question 16

A plasticiser is a small molecule that fits between the polymer chains.

Which one of the following will **not** change by use of a plasticiser?

- A. intensity of intermolecular forces
- B. strength of covalent bonds within a polymer chain
- C. percentage of crystalline areas
- D. temperature at which the polymer starts to melt

Question 17

Most of the polymer materials used in society are manufactured from chemicals derived from crude oil.

What is a major disadvantage of the use of these polymers?

- A. the cost of items made from the polymer materials
- B. the prohibitive expense of recycling thermoplastics
- C. limited reserves of the raw materials available
- D. the narrow range of applications for polymer use

Use the following information to answer Questions 18 and 19.

An experiment was conducted to investigate crystal formation using common table salt (NaCl). Different masses of NaCl were dissolved separately in 100 mL of water at the same temperature in numbered beakers. The water in each of the beakers was evaporated over different times until dryness was achieved. The table below shows the set-up of the experiment.

Beaker	1	2	3	4
Mass of NaCl dissolved in 100 mL of water	10 g	10 g	30 g	30 g
Time taken for evaporation to dryness	2 hours	12 hours	2 hours	12 hours

Question 18

Which beaker will contain crystals of the smallest size?

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

Question 19

In the experiment, the size of the crystals in each beaker was determined using a simple binocular microscope.

Which one of the following best describes what could be seen using the microscope?

- A. protons, neutrons and electrons of the ions arranged in a lattice
- B. individual sodium ions and chloride ions arranged in a regular array
- C. crystals consisting of spheres stacked on top of each other
- D. small, regular-shaped pieces with flat sides similar to small cubes

Question 20

An organic compound has the molecular formula $C_5H_{10}O_2$.

Which one of the following could **not** be the name of the compound?

- A. ethyl propanoate
- B. butyl methanoate
- C. pentane-1,2-diol
- D. pentanoic acid

END OF SECTION A

SECTION B**Instructions for Section B**

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

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

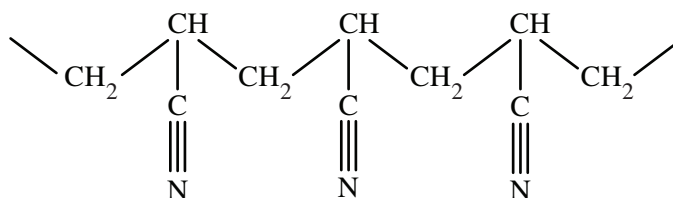
Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

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

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

Question 1 (5 marks)

- a. The addition polymer polyacrylonitrile (PAN) is used in the production of carpets and fibres. A section of the polymer is shown in the diagram below.



Draw a structural diagram for the monomer used to form PAN.

1 mark

- b. i. Draw a structural diagram of a five-carbon alcohol molecule.

1 mark

- ii. Name the molecule drawn in **part b.i.**

1 mark

- c. A metal ion with a +2 charge has 23 protons in its nucleus. It forms a compound with a halogen ion containing 17 protons.

Give the name and formula of the compound.

2 marks

Name _____

Formula _____

Question 2 (12 marks)

The element hydrogen has three isotopes as shown in the table below.

Isotope	Isotopic symbol	Relative isotopic mass
protium	^1H	1.008
deuterium	^2H	2.014
tritium	^3H	3.016

- a. The relative atomic mass of hydrogen is 1.0. Using information from the table above, it might appear that the value should be closer to 2.0.

Explain this apparent contradiction.

2 marks

- b. In some versions of the modern periodic table, hydrogen is placed at the top of the group 1 elements, whereas in other versions it is not placed at the top of any group.

- i. Give **one** reason that supports placing hydrogen at the top of group 1.

1 mark

- ii. Give **one** reason that does **not** support placing hydrogen at the top of group 1.

1 mark

- c. Hydrogen gas consists of diatomic molecules, H_2 , whereas helium gas consists of single atoms, He.

- i. Explain the difference in the composition of the two gases.

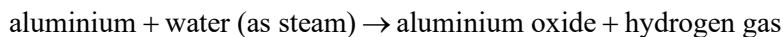
2 marks

- ii. The interaction between the particles of each gas at very low temperatures is of the same type.

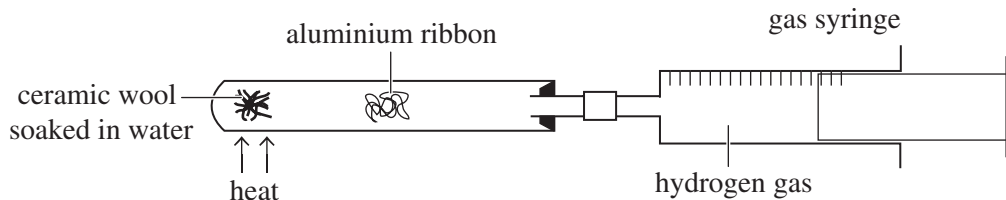
Name this type of intermolecular attraction.

1 mark

- d. Hydrogen gas is produced during the reaction of aluminium metal with steam. The relevant reaction is represented by the following equation.



This chemical reaction was used in the experiment shown below.



Mass of aluminium ribbon reacted in the experiment 0.859 g

Mass of hydrogen gas formed in the experiment 0.0954 g

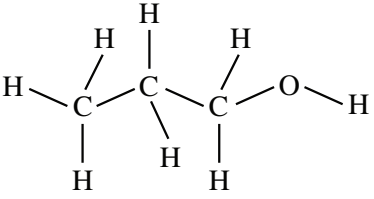
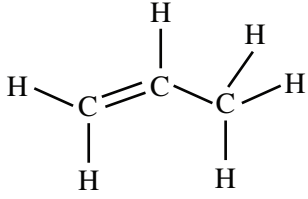
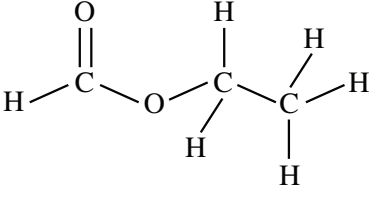
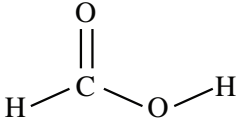
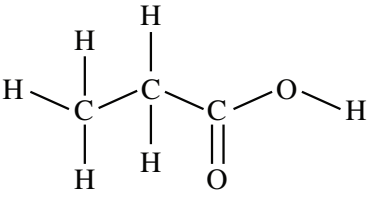
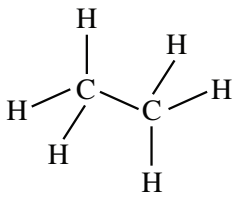
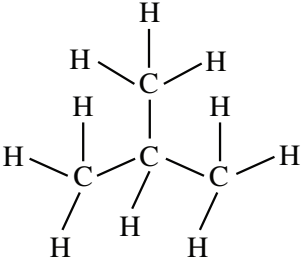
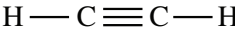
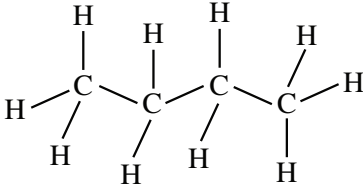
- i. Based on its chemical formula, calculate the percentage by mass of hydrogen in water. 1 mark

- ii. Using the information in **part d.i.** and the mass of hydrogen gas formed in the experiment above, calculate the mass of oxygen atoms that reacted with the aluminium to produce aluminium oxide. 2 marks

- iii. By calculation, show that the empirical formula of aluminium oxide is Al_2O_3 . 2 marks

Question 3 (12 marks)

The structural formulas of a range of carbon-based compounds are shown in the table below.

A. 	B. 	C. 
D. 	E. 	F. 
G. 	H. 	I. 

- a.** Use the letters (A to I) from the table to identify the compounds in the following questions. The letters may be used once, more than once or not at all.

i. Identify the alkyne in the table. 1 mark

ii. Identify **one** carboxylic acid in the table. 1 mark

iii. Which compound has a relative molecular mass of 46? 1 mark

iv. Which **two** compounds are isomers but are not alkanes? 1 mark

v. Identify **one** compound that has the molecular formula identical to its empirical formula. 1 mark

vi. Identify the compound with all of the features listed below. 1 mark

- unbranched molecule
- component of crude oil with molar mass greater than 30 g mol^{-1}
- used primarily as a fuel

vii. Of the compounds with three carbon atoms per molecule, which one has the lowest boiling point? 1 mark

b. Compounds G and I have the same molar mass.
Explain which compound, if either, has the higher boiling point. 2 marks

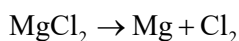
c. Compound E has a relative molecular mass of 74.0.
What is the total number of atoms in 0.935 g of this compound? 3 marks

Question 4 (12 marks)

Magnesium is an industrially important metal that is found in deposits only as an ore. Magnesium ore is a compound of magnesium.

- a. Explain why magnesium is only found as an ore and never in deposits as a pure metal, in the way that gold is found. 2 marks

- b. One method used to extract magnesium from its ore involves converting magnesium hydroxide to magnesium chloride. This is then melted and, using electricity, magnesium is isolated according to the following equation:



- i. Magnesium chloride must be molten to conduct electricity because solid magnesium chloride is not conductive.

In terms of structure and bonding, explain why the molten compound conducts, but the solid compound does not.

2 marks

- ii. A temperature of 700°C is used to melt solid magnesium chloride.

In terms of structure and bonding, explain why such a high temperature is required to melt the magnesium chloride.

2 marks

- iii. Apart from electrical conductivity and high melting point, name **one** other property that magnesium chloride is likely to exhibit.

1 mark

c. Magnesium is located in period 3 of the periodic table.

i. Which metallic element in period 3 is least reactive? 1 mark

ii. Which element in period 3 has the largest atomic radius? 1 mark

iii. Which element in period 3 has the lowest first ionisation energy? 1 mark

d. Magnesium and other metals are often modified before application in industry and in household uses. This modification of metals can include the use of coatings, heat treatment and alloy production. The main purpose of the modifications is to change the properties of the metal to better suit the application. A range of these modifications are listed in the table below.

1. Musical instruments are made of brass – an alloy of copper and zinc.
2. Steel food cans are coated with tin.
3. Steel support beams are made from iron with some carbon.
4. A frying pan surface is coated with Teflon.

Select and circle **one** number (1–4) in the table above. For your selected modification, identify the desired property of the modified metal and explain how the modification achieved this desired property.

2 marks

Question 5 (9 marks)

Give concise explanations for the following observations using relevant chemical concepts.

- a.** A thin stream of water will be bent towards a charged rod that is brought close to the water. It makes no difference whether the rod is positively charged or negatively charged. 3 marks

- b.** Plastic items consisting of unbranched polymer chains are usually not transparent. 3 marks

- c.** Ice floats on liquid water. 3 marks

END OF QUESTION AND ANSWER BOOKLET

Trial Examination 2021

VCE Chemistry Unit 1

Written Examination

Data Booklet

Instructions

This data booklet is provided for your reference.
A question and answer booklet is provided with this data booklet.

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

1. Periodic table of the elements

1 H hydrogen 1.0		atomic number																2 He helium 4.0	
3 Li lithium 6.9		relative atomic mass																10 Ne neon 20.2	
11 Na sodium 23.0		symbol of element																9 F fluorine 19.0	
12 Mg magnesium 24.3		name of element																8 O oxygen 16.0	
19 K potassium 39.1		79 Au gold																7 N nitrogen 14.0	
37 Rb rubidium 85.5		21 Sc scandium 45.0																6 C carbon 12.0	
55 Cs caesium 132.9		22 Ti titanium 47.9																5 B boron 10.8	
87 Fr francium (223)		23 V vanadium 50.9																13 Al aluminium 27.0	
		24 Cr chromium 52.0																14 Si silicon 28.1	
		25 Mn manganese 54.9																15 P phosphorus 30.1	
		26 Fe iron 55.8																16 S sulfur 32.1	
		27 Co cobalt 58.9																17 Cl chlorine 35.5	
		28 Ni nickel 58.7																36 Kr krypton 83.8	
		29 Cu copper 63.5																35 Br bromine 79.9	
		30 Zn zinc 65.4																54 Xe xenon 131.3	
		31 Ga gallium 69.7																86 Rn radon (222)	
		32 Ge germanium 72.6																118 Og oganesson (294)	
		33 As arsenic 74.9																	
		34 Se selenium 79.0																	
		35 Br bromine 79.9																	
		36 Kr krypton 83.8																	
		37 Rb rubidium 85.5																	
		38 Sr strontium 87.6																	
		39 Y yttrium 88.9																	
		40 Zr zirconium 91.2																	
		41 Nb niobium 92.9																	
		42 Mo molybdenum 96.0																	
		43 Tc technetium (98)																	
		44 Ru ruthenium 101.1																	
		45 Rh rhodium 102.9																	
		46 Pd palladium 106.4																	
		47 Ag silver 107.9																	
		48 Cd cadmium 112.4																	
		49 In indium 114.8																	
		50 Sn tin 118.7																	
		51 Sb antimony 121.8																	
		52 Te tellurium 127.6																	
		53 I iodine 126.9																	
		54 Xe xenon 131.3																	
		55 Cs caesium 132.9																	
		56 Ba barium 137.3																	
		57-71 lanthanoids																	
		72 Hf hafnium 178.5																	
		73 Ta tantalum 180.9																	
		74 W tungsten 183.8																	
		75 Re rhenium 186.2																	
		76 Os osmium 190.2																	
		77 Ir iridium 192.2																	
		78 Pt platinum 195.1																	
		79 Au gold 197.0																	
		80 Hg mercury 200.6																	
		81 Tl thallium 204.4																	
		82 Pb lead 207.2																	
		83 Bi bismuth 209.0																	
		84 Po polonium (210)																	
		85 At astatine (210)																	
		86 Rn radon (222)																	
		87 Fr francium (223)																	
		88 Ra radium (226)																	
		89-103 actinoids																	
		104 Rf rutherfordium (261)																	
		105 Db dubnium (262)																	
		106 Sg seaborgium (266)																	
		107 Bh bohrium (264)																	
		108 Hs hassium (267)																	
		109 Mt meitnerium (268)																	
		110 Ds darmstadtium (271)																	
		111 Rg roentgenium (272)																	
		112 Cn copernicium (285)																	
		113 Nh nihonium (280)																	
		114 Fl flerovium (289)																	
		115 Mc moscovium (289)																	
		116 Lv livermorium (292)																	
		117 Ts tennessine (294)																	
		118 Og oganesson (294)																	

57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium (145)	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
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89 Ac actinium (227)	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium (237)	94 Pu plutonium (244)	95 Am americium (243)	96 Cm curium (247)	97 Bk berkelium (247)	98 Cf californium (251)	99 Es einsteinium (252)	100 Fm fermium (257)	101 Md mendelevium (258)	102 No nobelium (259)	103 Lr lawrencium (262)
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2. Chemical relationships

Name	Formula
number of moles of a substance	$n = \frac{m}{M}$

3. Physical constants and standard values

Name	Symbol	Value
Avogadro constant	N_A or L	$6.02 \times 10^{23} \text{ mol}^{-1}$

4. Metric (including SI) prefixes

Metric (including SI) prefixes	Scientific notation	Multiplying factor
giga (G)	10^9	1 000 000 000
mega (M)	10^6	1 000 000
kilo (k)	10^3	1000
deci (d)	10^{-1}	0.1
centi (c)	10^{-2}	0.01
milli (m)	10^{-3}	0.001
micro (μ)	10^{-6}	0.000001
nano (n)	10^{-9}	0.000000001
pico (p)	10^{-12}	0.000000000001

END OF DATA BOOKLET

VCE Chemistry Unit 1

Written Examination

Multiple-choice Answer Sheet

Student's Name: _____

Teacher's Name: _____

Instructions

Use a **pencil** for **all** entries. If you make a mistake, **erase** the incorrect answer – **do not** cross it out. Marks will **not** be deducted for incorrect answers.

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

All answers must be completed like this example:

A	B	C	D
----------	----------	----------	----------

Use pencil only

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D