

Trial Examination 2020

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 16 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

Alkanes

- A. are a series of related compounds with the general formula C_nH_{2n} .
- B. have the same empirical formula as alkenes and alkynes.
- C. can be polymerised to make a wide variety of polymer materials.
- D. differ by a $-CH_2$ grouping between consecutive members of the series.

Use the following information to answer Questions 2 and 3.

Samples of solid KCl, molten KCl and an aqueous solution of KCl were tested for electrical conductivity.

Question 2

Which of the samples are likely to conduct electricity?

- A. molten KCl and an aqueous solution of KCl only
- B. solid KCl and molten KCl only
- C. solid KCl and an aqueous solution of KCl only
- D. all of the samples of KCl

Question 3

Which one of the following statements correctly explains the results of the electrical conductivity experiment?

- A. The metal potassium is a component of KCl and all metals conduct electricity.
- B. Only the samples of KCl with delocalised electrons will conduct electricity.
- C. Any sample that did not conduct electricity must not contain any ions.
- D. Charged particles must be able to move freely in order to conduct electricity.

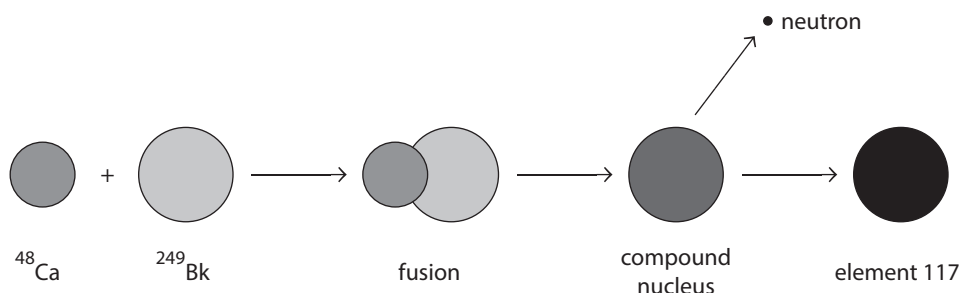
Question 4

Crude oil

- A. consists of one type of compound that has a single molecular formula.
- B. is mostly made from the elements carbon, hydrogen and oxygen.
- C. is formed from the remains of aquatic organisms over many millions of years.
- D. is used directly after extraction from underground to provide a fuel source.

Use the following information to answer Questions 5–7.

Scientists have synthesised element 117 by firing ^{48}Ca nuclei at high speed at ^{249}Bk atoms. The process is shown in the simplified diagram below.



Question 5

The following statements refer to the process shown above:

- I There are fewer nuclear particles in element 117 than in a ^{48}Ca nucleus and a ^{249}Bk atom combined.
- II Element 117 is likely to have 117 protons and 117 neutrons in each atom.
- III Element 117 would have a smaller atomic radius than any element in the same group of the periodic table.

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 6

Calcium has numerous isotopes, with ^{48}Ca being the isotope of lowest naturally occurring mass number.

Using the information provided in the Data Booklet, what prediction can be made about the percentage abundance of the ^{48}Ca isotope in a sample of calcium?

- A. very low abundance
- B. very high abundance
- C. equal to the abundance of all the other isotopes
- D. no prediction can be made without knowing the abundance of all other isotopes

Question 7

Calcium atoms are able to form ions with a double-positive charge.

Which of the following is correct for an ion of ^{48}Ca with a double-positive charge?

	Protons	Neutrons	Electrons
A.	20	28	22
B.	28	20	18
C.	28	20	22
D.	20	28	18

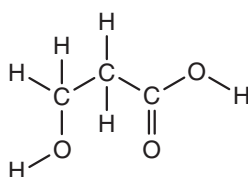
Question 8

Which of the following gives the correct names for the shapes of the molecules listed?

	Pyramidal	V-shaped
A.	NF ₃	C ₂ H ₂
B.	BF ₃	H ₂ O
C.	PH ₃	OF ₂
D.	SO ₃	CS ₂

Use the following information to answer Questions 9 and 10.

The structural formula of a particular compound is shown below.

**Question 9**

How many moles of atoms are present in 6.59 g of the compound?

- A. 0.073
- B. 0.879
- C. 9.10
- D. 79.1

Question 10

A student was asked which bond within the compound (C–O, O–H, C–C or C–H) would be expected to be the most polar.

In order to answer this question, which of the following sets of data would be most useful for the student?

- A. bond lengths for the four bonds listed
- B. bond strengths for the four bonds listed
- C. electronegativity values for the three elements involved in the bonds listed
- D. atomic radii for the three elements involved in the bonds listed

Question 11

The formation of crystals in an aqueous solution of an ionic compound was investigated in an experiment. Consider the following factors:

- I rate at which the heated solution cooled
- II concentration of the solution of the ionic compound

Which of these factors would affect crystal formation?

- A. I only
- B. II only
- C. I and II
- D. neither I or II

Use the following information to answer Questions 12 and 13.

The compound zinc oxide, ZnO, is used in sunscreen as its particles stop the penetration of UV rays from the sun.

Question 12

Which other properties are zinc oxide crystals likely to exhibit?

- A. brittle and high melting point
- B. hard and low melting point
- C. high melting point and malleable
- D. soft and low melting point

Question 13

Nanoparticles of zinc oxide have been shown to produce a much more effective sunscreen.

What is the probable reason for this observation?

- A. Sunscreen with nanoparticles is transparent, while normal sunscreen is white.
- B. Nanoparticles of zinc oxide have a very small surface area-to-volume ratio.
- C. All properties of ZnO nanoparticles are different to those of the bulk material of ZnO.
- D. As nanoparticles pack tighter, there is less area that is not covered by ZnO.

Question 14

Ice floats on liquid water because

- A. covalent bonds are stronger in solid water than in liquid water.
- B. ice crystals have water molecules in a more open arrangement than in liquid water.
- C. hydrogen bonding has no effect at very low temperatures.
- D. solids always have a higher density than liquids of the same substance.

Question 15

Consider the following alcohol compounds and their boiling points:

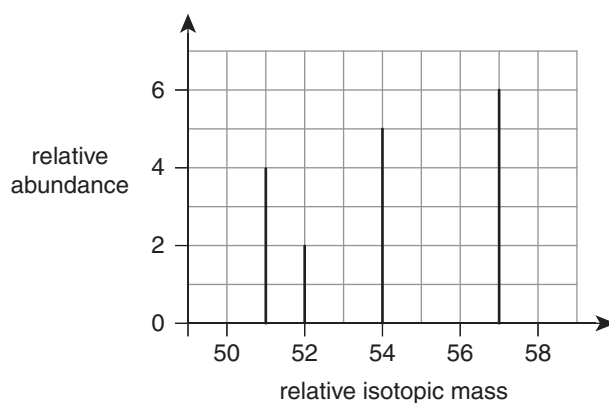
Compound	CH ₃ OH	C ₂ H ₅ OH	C ₃ H ₇ OH	C ₄ H ₉ OH
Boiling point (°C)	65	78	97	118

The major type of bonding responsible for the increasing boiling points of the four alcohols is

- A. dispersion forces.
- B. hydrogen bonding.
- C. covalent bonding.
- D. dipole-dipole bonding.

Use the following information to answer Questions 16 and 17.

The mass spectrum of an imaginary element Z is shown below.

**Question 16**

What is the percentage abundance of the heaviest isotope?

- A. 6
- B. 23
- C. 35
- D. 57

Question 17

What is the relative atomic mass of the element Z?

- A. 53.5
- B. 54.1
- C. 54.7
- D. 55.9

Use the following information to answer Questions 18 and 19.

The properties of polymers depend on the percentage of crystalline areas, amongst other factors.

Question 18

Which one of the following is **not** a property of a polymer with a high percentage of crystalline areas?

- A. high strength
- B. low flexibility
- C. high density
- D. high transparency

Question 19

Which one of the following characteristics is likely to be present in a polymer with a high percentage of crystalline areas?

- A. polymer chains that are packed close together
- B. a high level of branching of the polymer chains
- C. polymer chains containing side groups arranged irregularly
- D. bulky ring-structure side groups on the polymer chains

Question 20

Using certain chemical reactions, all of the metal was isolated from a sample of a metal chloride compound.

The following data were recorded:

Mass of beaker	32.39 g
Mass of beaker and metal chloride sample	43.71 g
Mass of metal isolated	8.27 g

Using the same process, 2.73 g of the metal was isolated from a second sample of the metal chloride.

How many grams of chlorine are present in this second sample?

- A. 0.32
- B. 1.01
- C. 1.72
- D. 3.05

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, $\text{H}_2(\text{g})$, $\text{NaCl}(\text{s})$.

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

Question 1 (11 marks)

The condensed (semi-structural) formulas of four different isomers of the alcohol $\text{C}_4\text{H}_9\text{OH}$ are shown in the table below.

Compound	Condensed formula
A	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
B	$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
C	$\text{CH}_3\text{C}(\text{CH}_3)(\text{OH})\text{CH}_3$
D	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$

- a. Using the information from the table above, define the term 'isomer'. 1 mark

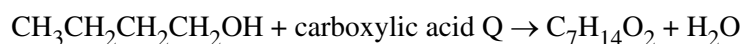
- b. Draw the structural formula of **compound B**, showing all bonds. 1 mark

- c. Give the systematic name of **compound C**. 1 mark

- d. Place a tick in the right-hand column for any feature listed in the table below that would be different for the isomers of C_4H_9OH shown. 1 mark

number of covalent bonds in each molecule	
empirical formula	
ability to conduct electricity	
boiling point	
percentage by mass of carbon	

- e. An ester was produced in the following chemical reaction using **compound A**:



- i. State a major use of esters in the manufacture of consumer products. 1 mark

- ii. Write the name of carboxylic acid Q. 1 mark

- f. An alcohol in the same family of compounds as C_4H_9OH has the following composition by mass: 37.5% carbon, 12.5% hydrogen and 50.0% oxygen.

- i. Showing all necessary calculations, determine the empirical formula of this alcohol. 2 marks

- ii. In 0.195 g of the alcohol there are 3.67×10^{21} molecules of the compound. Determine the molecular formula of the alcohol. 3 marks

Question 2 (10 marks)

Various properties of four metals are shown in the table below.

Metal	Melting point (°C)	Boiling point (°C)	Density (g cm ⁻³)	Reactivity with oxygen	Reactivity with dilute acid
potassium	63	759	0.89	rapid reaction	violent reaction
lead	328	1749	11.3	no reaction	no reaction
iron	1538	2862	7.9	very slow reaction	slow reaction
magnesium	650	1091	1.74	slow reaction	rapid reaction

- a. i. State a common property of the four metals that is **not** shown in the table above. 1 mark

- ii. Explain the property stated in **part a.i.** using the metallic bonding model. 2 marks

- b. The information in the table above highlights differences in physical properties between main-group metals and transition-group metals.

State **one** difference.

1 mark

- c. Using their elemental symbols, write the four metals in order of decreasing reactivity. 1 mark

- d. The uses of particular metals relate to their particular properties.

State the use of **one** named metal and indicate the property most closely related to the stated use.

2 marks

- e. Three common methods used to extract metals from their ores are shown in the table below.

Extraction method	roasting and then reacting with C or CO or H ₂	using a blast furnace	using electrolysis
Metals extracted with this method			

Place each of the four metals (K, Pb, Fe and Mg) in the appropriate column in the table to show their method of extraction from ores.

1 mark

- f. Some of the ways that iron is modified before being used for particular applications are shown in the table below.

Explain the purpose of **one** of these modifications by writing in the appropriate space in the table.

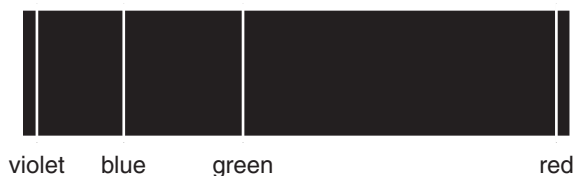
2 marks

Modification	Purpose of this modification (fill only one row)
coating iron with zinc to make galvanised iron sheets	
annealing by heating iron to red-hot and then cooling slowly	
mixing molten iron with carbon and other molten metals to make stainless steel	

Question 3 (8 marks)

The current model of atomic structure has been developed over many years using the results of experimental work and analysis by scientists.

- a. To develop the model of atomic structure, scientist Niels Bohr analysed the emission spectrum of hydrogen atoms, which showed four different coloured lines on a black background as shown below.



Outline the structure of the atom proposed by Bohr and state how it is consistent with the spectral evidence that he observed.

3 marks

- b. The current model of the atom is known as the 'quantum mechanical model' and is a complex mathematical model developed by Erwin Schrödinger to refine Bohr's ideas.

- i. Complete the table below showing features of the **third shell** of an atom, using the quantum mechanical model.

4 marks

number of subshells	
total number of orbitals	
maximum number of electrons	
number of p-type orbitals	

- ii. Write the electron configuration (using subshell notation) of an atom of atomic number 32.

1 mark

Question 4 (13 marks)

The naturally occurring elements of group 14 in the periodic table range from the non-metal carbon, C, to the metallic element lead, Pb.

a. Moving down the group from C to Pb, state the trend in the following properties:

i. electronegativity 1 mark

ii. first ionisation energy 1 mark

b. Element 114 in group 14 was made synthetically by scientists.

Without completing any experiments, how can the physical and chemical properties of element 114 be predicted? 2 marks

c. The various structural forms of carbon, the first element in group 14, include diamond, graphite and fullerenes.

Identify which of these forms of carbon, if any, will conduct electricity. Explain the conductivity, or lack of conductivity, for each form. 3 marks

d. Like all of the group 14 elements, carbon and silicon react with oxygen to produce oxide compounds. CO_2 is a gas at room temperature whereas SiO_2 is a hard, brittle solid with the very high melting temperature of 1700°C .

i. Even though these compounds, CO_2 and SiO_2 , have similar formulas, explain how it can be concluded that SiO_2 does **not** consist of individual or discrete molecules. 2 marks

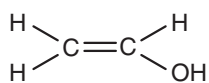
ii. The carbon to oxygen bonds in CO_2 are polar but the molecule has no overall polarity.
Draw the structural formula of CO_2 and use it to explain why the molecule is non-polar. 2 marks

iii. Name all of the bond types and interactive forces present in a sample of solid carbon dioxide (dry ice). 2 marks

Question 5 (8 marks)

The polymer polyvinyl alcohol (PVA) has many uses in the production of consumer items.

- a. The monomer involved in the polymerisation is vinyl alcohol or ethenol, shown below.



- i. Draw a section of polyvinyl alcohol that contains at least six carbon atoms. 1 mark

- ii. Polyvinyl alcohol is a thermoplastic polymer.

Outline how this polymer is different to a thermosetting polymer with reference to structure, bonding and properties.

3 marks

b. A major use of polyvinyl alcohol is the production of the widely used PVA glue. This is composed of the polymer chains with water molecules between them. The PVA glue takes effect when the water molecules evaporate and the polymer bonds to surfaces such as paper, cloth or wood. These objects have many –OH groups on their surfaces.

i. Why does PVA glue bond strongly to these surfaces? 2 marks

ii. PVA glue is **not** effective for bonding metals together.
Explain why. 1 mark

iii. PVA glue is **not** recommended for use outdoors.
Suggest **one** reason why. 1 mark

END OF QUESTION AND ANSWER BOOKLET