

Trial Examination 2008

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	7	7	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.

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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Question 7

The relative surface energies of two substances are shown in the table below.

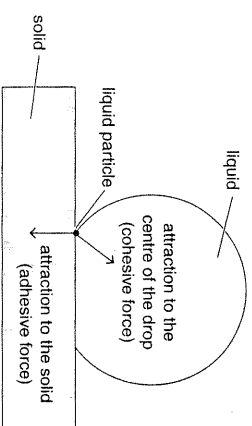
Substance	Relative surface energy
methanol (CH_3OH)	very low
platinum	high

a. i. What is meant by the term 'surface energy'?

ii. Explain why the surface energy of platinum is high.

1 + 1 = 2 marks

b. The forces acting on a liquid particle in contact with a solid surface determine the extent to which the liquid wets the solid. The diagram below illustrates these forces using the terms 'adhesive force' and 'cohesive force'.



A drop of methanol is placed on the surface of a platinum sheet.

i. Name the bond type responsible for the adhesive forces.

ii. Name the bond type responsible for the cohesive forces.

iii. Will the methanol wet the surface of the platinum? Explain your answer.

1 + 1 + 2 = 4 marks
Total 6 marks

END OF QUESTION AND ANSWER BOOKLET

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

Element X is in Group 1 and element Z is in Group 16 of the Periodic Table.

Which of the following represents the most likely compound that elements X and Z would form?

- A. XZ
- B. XZ₂
- C. X₂Z
- D. X₂Z₃

Question 2

The equation below shows the conversion of ethanol to ethanoic acid.



In a balanced equation, the values for coefficients n , w , x and y , respectively, are

- A. 1, 1, 1, 1
- B. 1, 2, 1, 1
- C. 1, 2, 1, 2
- D. 2, 1, 2, 1

Question 3

Organic molecules containing the hydroxyl (OH) group are named systematically using the suffix '-ol'.

Which of the following semi-structural formulas represents 3-methyl-2-hexanol?

**Question 4**

The two atoms represented by the symbols $^{25}_{12}\text{Mg}$ and $^{25}_{13}\text{Al}$ differ in the number of

- A. neutrons only.
- B. protons and neutrons only.
- C. protons and electrons only.
- D. protons, neutrons and electrons.

Question 5

The ground state electronic configurations of four elements are shown below.

Which electronic configuration represents a metallic element?

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

Question 6

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

- A. 1.3×10^{24} molecules of carbon dioxide gas
- B. 4.0×10^{23} atoms of oxygen
- C. 0.25 mole of oxygen gas
- D. 22 g of liquid water

Question 7

Atoms of element Z have high electronegativity, and can bond to two chlorine atoms.

To which group in the Periodic Table does element Z belong?

- A. Group 2
- B. Group 14
- C. Group 16
- D. Group 18

Question 8

The empirical formula of a compound is $\text{C}_2\text{H}_4\text{O}$, and its relative molecular mass is 88.

Which of the listed molecular formulas could represent this compound?

- I $\text{CH}_2\text{CH}(\text{OH})$
 - II $(\text{CH}_3)_2\text{CHCOOH}$
 - III $\text{CH}_3\text{CH}_2\text{COOCH}_3$
 - IV $\text{CH}_2(\text{OH})\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3$
- A. I only
 - B. IV only
 - C. II and III only
 - D. I, II, III and IV

Question 9

Which of the listed properties of elements increase across the period from sodium to chlorine?

- I atomic radius
- II core charge (effective nuclear charge)
- III electronegativity

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

Question 10

In liquid methanol ($\text{CH}_3\text{OH(l)}$) covalent bonds, hydrogen bonds and dispersion forces are present.

Which of these bonds or forces are broken when a sample of methanol is vapourised?

- A. hydrogen bonds only
- B. hydrogen bonds and dispersion forces only
- C. covalent bonds and hydrogen bonds only
- D. covalent bonds, hydrogen bonds and dispersion forces

Question 11

The symbols Q to Z below represent some elements from the Periodic Table. The letter symbols are not the usual symbols for the elements.



Which two symbols represent isotopes of a non-metallic element?

- A. Q and U
- B. Q and X
- C. V and Z
- D. R and Z

Question 12

Consider the sequence of molecules C_2H_2 , C_2H_4 and C_2H_6 .

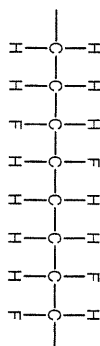
Which of the following increases for the bonding between carbon atoms in this sequence of molecules?

- I polarity
- II length
- III strength

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

Question 13

The diagram below represents a segment of a copolymer.



The two monomers used to form this polymer are

- A. $\text{CH}_2\text{FCH}_2\text{F}$ and CH_3CH_3
- B. CH_2CF_2 and CH_2CH_2
- C. CHFCHF and CF_2CF_2
- D. CHFCHF and CH_2CH_2

Question 14

The table below lists information about three species: X, Y and Z (the symbols X, Y and Z are not the correct symbols for the elements).

	Number of protons	Number of neutrons	Number of electrons
X	53	74	54
Y	55	72	54
Z	53	72	53

Which of the following statements about species X, Y and Z is **incorrect**?

- A. X and Z represent the same element.
- B. X is a negatively charged ion.
- C. X and Z are isotopes.
- D. Y and Z have the same mass number.

Question 15

Which of the following ions would undergo the greatest deflection in a mass spectrometer?

- A. ${}^{14}\text{N}^+$
- B. ${}^{14}\text{N}^{2+}$
- C. ${}^{15}\text{N}^+$
- D. ${}^{15}\text{N}^{2+}$

Question 16

When comparing the molecules Cl_2 and HCl , it is correct to say that

- A. both molecules contain a polar bond.
- B. neither molecule contains a polar bond.
- C. both molecules are polar.
- D. one of the molecules is non-polar.

Question 17

The attractive forces present in metallic bonding are best described as attraction between

- A. cations and electrons.
- B. nuclei and electrons.
- C. cations and anions.
- D. anions and electrons.

Question 18

For which of the following elements is the Periodic Table group number and period number the same?

- A. Li
- B. Mg
- C. Al
- D. Be

Question 19

Which of the following properties increases with increasing atomic number for both Group 14 and Group 17 elements?

- A. melting point
- B. atomic radius
- C. electrical conductivity
- D. electronegativity

Question 20

Which of the following is least likely to be a subject of nanotechnology investigation?

- A. a mitochondrion, which has a length of $0.5\ \mu\text{m}$ ($1\ \mu\text{m} = 10^{-6}\ \text{m}$)
- B. a buckyball, which has a diameter of $10\ \text{\AA}$ ($1\ \text{\AA} = 10^{-10}\ \text{m}$)
- C. a virus, which has a length of $3 \times 10^{-8}\ \text{m}$
- D. DNA, which has a width of $2\ \text{nm}$

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

A sample of antimony (Sb) (a Group 15 element) was found to contain two isotopes (Sb-121 and Sb-123) with masses 120.9 and 122.9. The percentage abundances of these isotopes were found to be 32.7 and 67.3 respectively.

- a. Using the above data to provide examples, explain the meaning of the term
 - i. 'relative isotopic mass'

- ii. 'mass number'.

- a.
 - i. Determine the relative atomic mass of antimony based on the data provided.

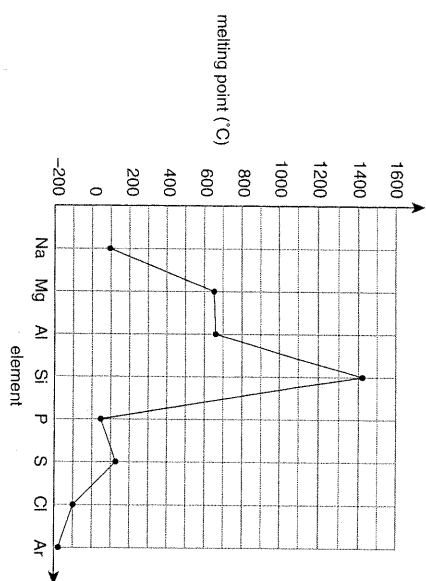
2 + 2 = 4 marks

- ii. Was the sample of antimony taken from a naturally occurring deposit? Explain your choice.

2 + 1 = 3 marks
Total 7 marks

Question 2

- a. The graph below shows the melting points of the elements Na to Ar.



- By referring to the structure and bonding of the elements, briefly explain why
- aluminium has a higher melting point than sodium.

- Argon has a lower melting point than chlorine.

2 + 2 = 4 marks

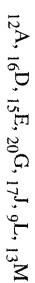
- b. The table below shows the atomic radii for the elements Li to F.

Element	Li	Be	B	C	N	O	F
Atomic radius ($\times 10^{-12}$ m)	152	106	88	77	70	66	64

Explain the trend in atomic radii of these elements.

2 marks

- c. The symbols A to M below represent some elements from the Periodic Table. The letter symbols are not the usual symbols for the elements. Use these letters when answering the questions which follow.



From the list given above identify the element that

- has a ground state outer shell configuration of $2s^2 2p^5$.
- is the most reactive metal.
- reacts with three bromide ions to form a compound.

1 + 1 + 1 = 3 marks
Total 9 marks

Question 3

- a. i. Complete the table below by drawing structural diagrams for each of the molecules (showing all bonding and non-bonding electron pairs and the overall shape of the molecules) and naming the shape of each molecule.

Molecule	Structural diagram	Name of shape
SiCl_4		
SCl_2		

- ii. Give the formula for another molecule with the same shape as SCl_2 .

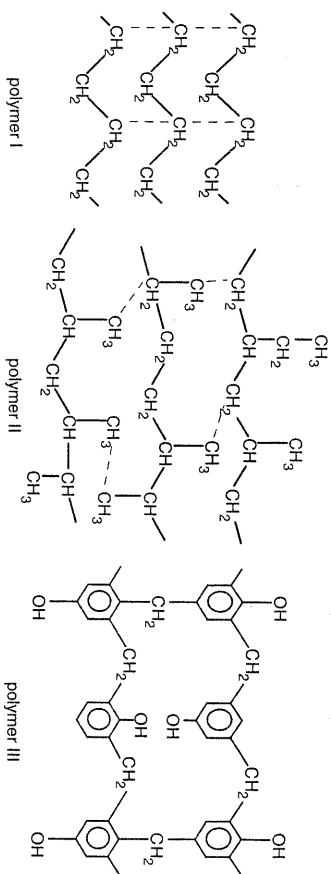
4 + 1 = 5 marks

- b. In terms of structure and bonding, explain why solid calcium oxide does not conduct electricity, but molten calcium oxide is a good conductor. Include a diagram in your answer.

3 marks
Total 8 marks

Question 4

- a. The diagrams below represent sections of three polymers.



- i. Draw the structural formula of the monomer used to generate polymer I.

- ii.

Which polymer, I or II, would you expect to have the higher melting point? Explain your choice. (Assume that the molar masses of polymers I and II are similar.)

- iii.

Properties x to z can be used to describe features of certain substances.

- x conducts electricity in the solid state
- y melts when heated
- z chars when heated, but does not melt

In the table below, circle the letter or letters (x to z) that apply to each of the polymers.

polymer I	x	y	z
polymer II	x	y	z
polymer III	x	y	z

1 + 2 + 3 = 6 marks

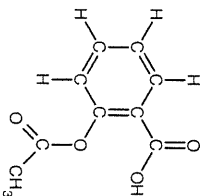
- b. i. State and explain the trend in the boiling points of the first six members of the alkane homologous series.

- ii. Other homologous series show the trend in boiling point described in part i. State **two** other characteristics of homologous series.

2 + 2 = 4 marks
Total 10 marks

Question 5

- a. Aspirin was the first non-steroidal anti-inflammatory drug used commercially. Its active ingredient is acetylsalicylic acid, a compound with a molar mass of 180 g mol^{-1} . One analgesic (pain relieving) tablet normally contains 300 mg of acetylsalicylic acid. The structure of acetylsalicylic acid is shown below.



- i. Write the empirical formula for acetylsalicylic acid.

- ii. Determine the mass (in g) of one molecule of acetylsalicylic acid.

- iii. Calculate the amount (in mol) of acetylsalicylic acid in one analgesic tablet.

- iv. Determine the number of atoms of carbon in one analgesic tablet.

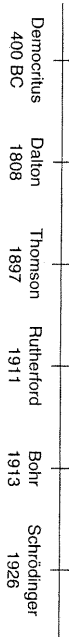
1 + 1 + 1 + 1 = 4 marks

- b. A 2.00 g sample of an organic compound was found to contain 0.800 g carbon , 8.03×10^{22} hydrogen atoms and $0.0666 \text{ mol of oxygen}$. Determine the empirical formula of the compound.

3 marks
Total 7 marks

Question 6

The timeline below shows some of the scientists who have played a role in the development of our understanding of atomic theory.



- a. Draw a labelled diagram of Thomson's model of the atom.

- b. Thomson's and Rutherford's models of the atom, although quite different, shared some common features. State **one** feature common to Thomson's and Rutherford's models of the atom.

- c. State **one** way in which the current model of the atom differs from that of Bohr's.

1 mark
Total 3 marks

1. Periodic Table of the elements

1 H 1.0 hydrogen																	2 He 4.0 helium														
3 Li 6.9 lithium	4 Be 9.0 beryllium	atomic number 79 Au 197.0 gold										symbol of element name of element					5 B 10.8 boron	6 C 12.0 carbon	7 N 14.0 nitrogen	8 O 16.0 oxygen	9 F 19.0 fluorine	10 Ne 20.2 neon									
11 Na 23.0 sodium	12 Mg 24.3 magnesium											13 Al 27.0 aluminium	14 Si 28.1 silicon	15 P 31.0 phosphorus	16 S 32.1 sulfur	17 Cl 35.5 chlorine	18 Ar 39.9 argon														
19 K 39.1 potassium	20 Ca 40.1 calcium	21 Sc 44.9 scandium	22 Ti 47.9 titanium	23 V 50.9 vanadium	24 Cr 52.0 chromium	25 Mn 54.9 manganese	26 Fe 55.8 iron	27 Co 58.9 cobalt	28 Ni 58.7 nickel	29 Cu 63.5 copper	30 Zn 65.4 zinc	31 Ga 69.7 gallium	32 Ge 72.6 germanium	33 As 74.9 arsenic	34 Se 79.0 selenium	35 Br 79.9 bromine	36 Kr 83.8 krypton														
37 Rb 85.5 rubidium	38 Sr 87.6 strontium	39 Y 88.9 yttrium	40 Zr 91.2 zirconium	41 Nb 92.9 niobium	42 Mo 95.9 molybdenum	43 Tc 98.1 technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 Sb 121.8 antimony	52 Te 127.6 tellurium	53 I 126.9 iodine	54 Xe 131.3 xenon														
55 Cs 132.9 cesium	56 Ba 137.3 barium	57 La 138.9 lanthanum	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 197.0 gold	80 Hg 200.6 mercury	81 Tl 204.4 thallium	82 Pb 207.2 lead	83 Bi 209.0 bismuth	84 Po (209) polonium	85 At (210) astatine	86 Rn (222) radon														
87 Fr (223) francium	88 Ra (226) radium	89 Ac (227) actinium	104 Rf (261) rutherfordium	105 Db (262) dubnium	106 Sg (263) seaborgium	107 Bh (264) bohrium	108 Hs (265) hassium	109 Mt (268) meitnerium	110 Ds (271) darmstadtium	111 Rg (272) roentgenium	112 Uub		114 Uuq		116 Uuh		118 Uuo														
																		58 Ce 140.1 cerium	59 Pr 140.9 praseodymium	60 Nd 144.2 neodymium	61 Pm (145) promethium	62 Sm 150.3 samarium	63 Eu 152.0 europium	64 Gd 157.2 gadolinium	65 Tb 158.9 terbium	66 Dy 162.5 dysprosium	67 Ho 164.9 holmium	68 Er 167.3 erbium	69 Tm 168.9 thulium	70 Yb 173.0 ytterbium	71 Lu 175.0 lutetium
																		90 Th 232.0 thorium	91 Pa 231.0 protactinium	92 U 238.0 uranium	93 Np 237.1 neptunium	94 Pu (244) plutonium	95 Am (243) americium	96 Cm (251) curium	97 Bk (247) berkelium	98 Cf (251) californium	99 Es (252) einsteinium	100 Fm (257) fermium	101 Md (258) mendelevium	102 No (259) nobelium	103 Lr (260) lawrencium

2. Physical constants

Avogadro's constant (N_A) = $6.02 \times 10^{23} \text{ mol}^{-1}$ Charge on one electron = $-1.60 \times 10^{-19} \text{ C}$ Faraday constant (F) = $96\,500 \text{ C mol}^{-1}$ Gas constant (R) = $8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ Ionic product for water (K_w) = $1.00 \times 10^{-14} \text{ mol}^2 \text{ L}^{-2}$ at 298 K (self ionisation constant)Molar volume (V_m) of an ideal gas at 273 K, 101.3 kPa (STP) = 22.4 L mol^{-1} Molar volume (V_m) of an ideal gas at 298 K, 101.3 kPa (SLC) = 24.5 L mol^{-1} Specific heat capacity (c) of water = $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ Density (d) of water at 25°C = 1.00 g mL^{-1}

1 atm = 101.3 kPa = 760 mmHg

0°C = 273 K

3. SI prefixes, their symbols and values

SI prefix	Symbol	Value
giga	G	10^9
mega	M	10^6
kilo	k	10^3
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

END OF DATA SHEET