

Trial Examination 2007

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	30
B Short-answer	6	6	50	60
			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 13 pages, including a Periodic Table of the Elements.

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.

PERIODIC TABLE OF THE ELEMENTS

1 H 1.0																	2 He 4.0
3 Li 6.9	4 Be 9.0															9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3															17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.1	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (271)	111 Rg (272)							

<i>Lanthanides</i>										67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.3	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9					

<i>Actinides</i>										99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.1	94 Pu (244)	95 Am (243)	96 Cm (251)	97 Bk (247)	98 Cf (251)	99 Es (252)					

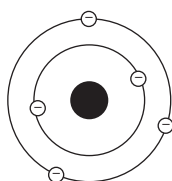
SECTION A: MULTIPLE-CHOICE QUESTIONS**Instructions for Section A**

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

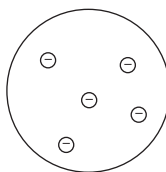
The sketches below depict four models of the atom proposed at various times in the development of atomic theory.



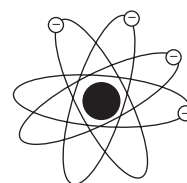
I



II



III



IV

In which order did these models appear historically?

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

Question 2

If a $^{12}_6\text{C}$ atom is assigned a mass of 40 units exactly, the mass of a $^{16}_8\text{O}$ atom would be closest to

- A. 30 units.
- B. 53 units.
- C. 58 units.
- D. 67 units.

Question 3

Which of the following properties of substances is **not** explained by the nature of the **intermolecular** bonding within the substance?

- A. Hydrogen has a very low boiling point.
- B. Ammonia readily dissolves in water.
- C. A high temperature is required to decompose methane into its constituent elements.
- D. Hydrogen fluoride has a higher boiling point than other Group 17 hydrides.

Question 4

The particle represented by the symbol $^{89}_{39}\text{Y}^{2+}$ contains

- A. 39 protons, 50 neutrons and 41 electrons.
- B. 39 protons, 89 neutrons and 37 electrons.
- C. 39 protons, 50 neutrons and 37 electrons.
- D. 41 protons, 50 neutrons and 39 electrons.

Question 5

A neutral atom of element X has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$.

Given this information, it would be **incorrect** to say that element X

- A. has an atomic number of 30.
- B. would be located in Period 4, Group 2 of the Periodic Table.
- C. would be likely to form a compound of formula XCl_2 .
- D. is metallic.

Question 6

A sample of $Al_2(SO_4)_3$ contains 0.50 mol of aluminium ions.

The total mass of oxygen in the sample is

- A. 8.0 g
- B. 32 g
- C. 48 g
- D. 96 g

Question 7

Which of the following statements concerning atoms and the ions they form is **incorrect**?

- A. Metals form ions which have smaller radii than the parent atoms.
- B. Non-metals form ions when they accept one or more electrons.
- C. Metals form ions with approximately the same mass as the parent atoms.
- D. Non-metal atoms always form ions which are less stable than the parent atoms.

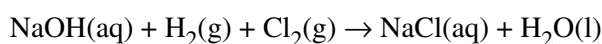
Question 8

Which of the following has the smallest number of mole of nitrogen atoms?

- A. 1.4 mol of sodium nitrate ($NaNO_3$)
- B. 5.0×10^{23} molecules of laughing gas (N_2O)
- C. 1.2×10^{24} atoms of nitrogen (N)
- D. 22 g of nitrogen gas (N_2)

Question 9

Which set of coefficients would balance the following equation?



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

Question 10

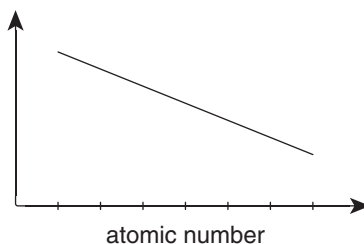
Eicosane is an alkane containing 20 carbon atoms.

Which of the following statements concerning eicosane is **incorrect**?

- A. Eicosane molecules are non-polar and saturated.
- B. The intermolecular bonding in eicosane is due to dispersion forces.
- C. Eicosane would have a higher boiling point than octane.
- D. Eicosane would form an electrically conducting aqueous solution.

Question 11

The graph below shows the trend in one property of elements moving from left to right across the Periodic Table from Group 1 to Group 17 for Period 3.



Which property is represented?

- A. atomic radius
- B. electronegativity
- C. melting point
- D. first ionisation energy

Question 12

The order of increasing energy of subshells within an atom is

- A. 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s.
- B. 1s, 2s, 3s, 4s, 2p, 3p, 4p, 3d, 4d, 4f.
- C. 1s, 2s, 2p, 3s, 3p, 3d, 4s, 4p, 4d, 4f.
- D. 1s, 1p, 1d, 1f, 2s, 2p, 2d, 2f, 3s, 3p, 3d, 3f.

Question 13

Which of the following statements concerning the major sub-atomic particles is correct?

- A. The number of neutrons in an atom equals the number of protons.
- B. The number of electrons in an atom equals the number of neutrons.
- C. The masses of protons and neutrons are almost the same.
- D. The total mass of electrons equals the total mass of protons.

Question 14

Which of the following elements has uncharged atoms containing five occupied electron shells?

- A. strontium (Sr)
- B. caesium (Cs)
- C. phosphorus (P)
- D. chromium (Cr)

Question 15

A substance is known to have a high melting point.

Which of the following properties is it also likely to exhibit?

- A. malleability
- B. electrical conductivity when solid
- C. hardness
- D. high chemical reactivity

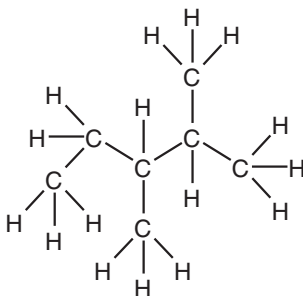
Question 16

Evidence from which of the following experiments led to the model of the atom in which electrons occupy discrete energy levels?

- A. observation of the scattering patterns of α -particles
- B. analysis of the emission spectrum of hydrogen
- C. study of the deflection of positively charged ions in a magnetic field
- D. experimentation with rays produced in gas discharge tubes

Question 17

The systematic name for the molecule shown below is



- A. 2,3-dimethylpentane.
- B. 3,4-dimethylpentane.
- C. heptane.
- D. 1,2,3-trimethylpentane.

Question 18

The bond angle in a pure tetrahedral structure is $109^{\circ}28'$.

Which of the following molecules contains a bond angle of less than $109^{\circ}28'$?

- A. CO_2
- B. NF_3
- C. CH_4
- D. HBr

Question 19

The total number of non-bonding outer-shell electron pairs in a molecule of PCl_3 is

- A. 0
- B. 1
- C. 4
- D. 10

Question 20

Which of the following is **not** an empirical formula?

- A. K_2SO_4
- B. $\text{C}_2\text{H}_5\text{Br}$
- C. $\text{Na}_2\text{Cr}_2\text{O}_7$
- D. N_2O_4

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 compound found in vinegar has the following composition by mass.

40.0% carbon, 6.7% hydrogen, 53.3% oxygen

A 2.84 g sample of the compound was known to contain 0.047 mol of the compound.

- a. Determine the empirical formula of the compound.

2 marks

- b. Calculate the molar mass of the compound.

1 mark

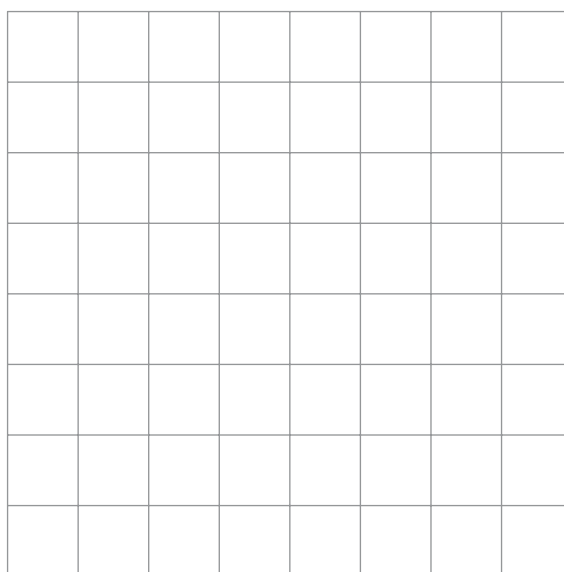
- c. Hence determine the molecular formula of the compound.

1 mark

Total 4 marks

- c. Bromine consists of two isotopes: ^{79}Br and ^{81}Br . The relative atomic mass of bromine is 79.9.

On the axes below, sketch the expected mass spectrum for a sample of bromine atoms. Include any calculations performed to obtain data for the spectrum drawn.



3 marks
Total 12 marks

Question 3

- a. Statements I to VI can be used to describe features of certain substances.

I – exhibits hydrogen bonding between molecules

II – is brittle

III – has a high melting point

IV – does not conduct electricity in either the solid or molten states

V – forms an electrically conducting aqueous solution

VI – exhibits ionic bonding

Circle the numeral or numerals which can be applied to each of the substances named in the table below.

ethanol ($\text{CH}_3\text{CH}_2\text{OH}$)	I	II	III	IV	V	VI
sodium hydroxide (NaOH)	I	II	III	IV	V	VI
graphite (C)	I	II	III	IV	V	VI
methane (CH_4)	I	II	III	IV	V	VI

4 marks

- b.** Choose from the list below a substance to match each description in **i.** to **iv.** A substance in the list may be used more than once.

mercury (Hg)
silicon dioxide (SiO₂)
phosphine (PH₃)
hydrogen bromide (HBr)
carbon dioxide (CO₂)
potassium (K)
boron trifluoride (BF₃)

- i.** This substance is composed of atoms covalently bonded into a three-dimensional network lattice.

- ii.** Molecules of this substance are pyramidal in shape.

- iii.** Molecules of this substance are linear and non-polar.

- iv.** This substance melts at 64°C. It conducts electricity in both the solid and molten states.

1 + 1 + 1 + 1 = 4 marks

Total 8 marks

Question 4

- a. i.** Alkenes are an homologous series of hydrocarbons. Write the general formula for an alkene in terms of the symbols C, H and *n*.

- ii.** Using this general formula, calculate the percentage by mass of carbon in any alkene.

1 + 1 = 2 marks

- b.** The hydrocarbon pentane, CH₃(CH₂)₃CH₃, is referred to as a straight-chain hydrocarbon.

Do the five carbon atoms in pentane actually have a straight, linear arrangement? Explain your answer with the aid of a diagram.

2 marks

- c. Draw a structural formula for
- a saturated hydrocarbon containing ten hydrogen atoms.
 - an unsaturated hydrocarbon containing three carbon atoms.
 - the carbon-containing product of the complete combustion of ethane with oxygen.
 - a section of the addition polymer formed when propene is polymerised.

1 + 1 + 1 + 1 = 4 marks

- d. The properties of polymers depend on their structure and bonding.
Complete the table below which relates structural features to their effect on polymer properties (indicate your responses by placing ticks in the appropriate columns).

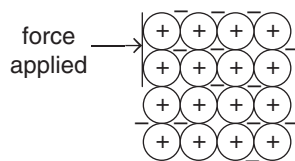
Structural feature	Polymer becomes harder	Polymer becomes elastic	Polymer has a lower melting temperature
highly branched monomers			
very long polymers			
the presence of occasional cross-links between polymer chains			

3 marks
Total 11 marks

Question 5

The diagrams in this question show models of experimental set-ups which may be used to explain or to test various properties of substances.

a.



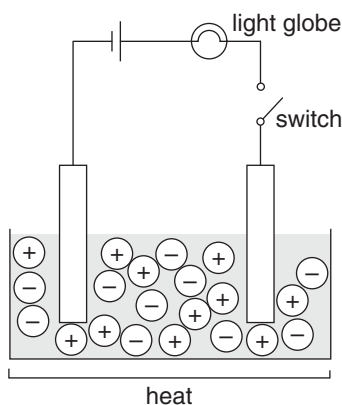
- i.** State the property being explained or tested in the above diagram.

- ii.** State the type of substance (ionic, metallic, covalent network or molecular) being tested.

- iii.** Explain the property in terms of the bonding in the substance being tested.

1 + 1 + 2 = 4 marks

b.



- i.** State the property being explained or tested in the above diagram.

- ii.** State the type of substance (ionic, metallic, covalent network or molecular) being tested.

- iii.** Explain the property in terms of the bonding in the substance being tested.

1 + 1 + 2 = 4 marks

Total 8 marks

Question 6

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

Substance	Surface energy (mJ m^{-2})
iron(III) oxide	1355
mercury	480
polyethene	32
ethanol	22

- a. Explain why the surface energy of mercury is relatively high.

1 mark

- b. A drop of ethanol is placed on the surface of a polyethene sheet.

- i. Draw the expected appearance of the ethanol on the diagram below.



- ii. Explain why the ethanol has the appearance shown in your sketch.

1 + 2 = 3 marks

- c. Catalysts are substances that increase the rate of reactions without themselves being consumed in the reaction. Solid catalysts work by adsorbing reactants on to their surface.

- i. Explain why iron(III) oxide might be used as a catalyst for a reaction between nitrogen and hydrogen gases.

- ii. Why would nano-sized particles of iron(III) oxide be a very effective catalyst?

1 + 2 = 3 marks
Total 7 marks**END OF QUESTION AND ANSWER BOOKLET**