b. $m(C) = 0.800$ g

$$m(H) = n \times M = \frac{N}{N_A} \times M = \frac{8.03 \times 10^{22}}{6.02 \times 10^{23}} \times 1.0 = 0.133 \text{ g}$$

$m(O) = n \times M = 0.0666 \times 16.0 = 1.066$ g 1 mark

$$n(C) : n(H) : n(O) = \frac{0.800}{12.0} : \frac{0.133}{1.0} : \frac{1.066}{16.0}$$ 1 mark

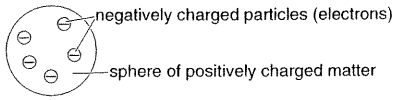
$$= 0.0667 : 0.133 : 0.0666 = 1 : 2 : 1$$

The empirical formula is CH_2O. 1 mark

Total 7 marks

Question 6

a.



1 mark

b. *Any one of:*

- They both contained small, negatively charged particles (electrons).
- They both contained positive charge that varied from one element to another.
- The total positive charge equalled the total negative charge.
- Any other suitable answer.

1 mark

c. *Any one of:*

- The current model includes neutrons. These were absent from Bohr's model.
- The current model includes sub-shells in addition to the shells found in Bohr's model.
- The current model includes orbitals, rather than the orbits found in Bohr's model.
- Any other suitable answer.

1 mark

Total 3 marks

Question 7

a. i. The energy required to create a new unit of surface area. 1 mark

ii. Platinum has strong metallic bonding. Breaking these bonds to create a new surface requires large amounts of energy. 1 mark

b. i. ion–dipole bonds (and dispersion forces) 1 mark

ii. hydrogen bonds (and dispersion forces) 1 mark

iii. yes 1 mark

The ion–dipole bonds are stronger than the hydrogen bonds in the methanol. Adhesive forces are greater than the cohesive forces, and so wetting occurs. 1 mark

Total 6 marks

Neap:

Trial Examination 2008

VCE Chemistry Unit 1

Written Examination

Suggested Solutions

SECTION A: MULTIPLE-CHOICE QUESTIONS

1	A	B	**C**	D	11	A	**B**	C	D
2	**A**	B	C	D	12	**A**	B	C	D
3	A	B	**C**	D	13	A	B	C	**D**
4	A	B	C	**D**	14	A	B	C	**D**
5	A	**B**	C	D	15	A	**B**	C	D
6	**A**	B	C	D	16	A	B	C	**D**
7	A	B	**C**	D	17	**A**	B	C	D
8	A	B	**C**	D	18	A	B	C	**D**
9	A	B	**C**	D	19	A	**B**	C	D
10	A	**B**	C	D	20	**A**	B	C	D

Question 1 **C**

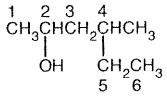
Element X will form a positive ion with a +1 charge, while element Z will form a negative ion with a –2 charge. The most likely compound they would form is therefore the ionically bonded compound X_2Z.

Question 2 **A**

The balanced equation is $CH_3CH_2OH(aq) + O_2(g) \rightarrow CH_3COOH\ (aq) + H_2O(l)$.

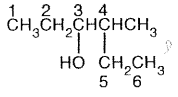
Question 3 **C**

A.



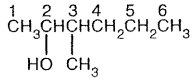
4-methyl-2-hexanol

B.



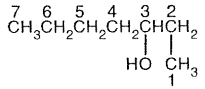
4-methyl-3-hexanol

C.



3-methyl-2-hexanol

D.



3-heptanol

Question 4 **D**

$^{25}_{12}Mg$ has 12 protons, 13 neutrons and 12 electrons.

$^{25}_{13}Al$ has 13 protons, 12 neutrons and 13 electrons.

Question 5 **B**

Metallic elements have a small number (1, 2 or 3) of electrons in their outer shell.

Question 6 **A**

The relevant calculations are shown below.

A. $N(O) = 2 \times N(CO_2) = 2 \times 1.3 \times 10^{24} = 2.6 \times 10^{24}$

B. $N(O) = 4.0 \times 10^{23}$

C. $N(O) = 2 \times N(O_2) = 2 \times n(O_2) \times N_A = 2 \times 0.25 \times 6.0 \times 10^{23} = 3.0 \times 10^{23}$

D. $N(O) = N(H_2O) = n \times N_A = \frac{m}{M} \times N_A = \frac{22}{18} \times 6.0 \times 10^{23} = 7.3 \times 10^{23}$

Question 7 **C**

Atoms of element Z have high electronegativity. This is characteristic of the non-metals (so **A** is incorrect – Group 2 elements are metals). Z bonds to two chlorine atoms. This suggests an atom that shares two electrons to achieve a stable state. This is characteristic of a Group 16 element which has six electrons in its outer shell.

Question 8 **C**

An empirical formula of C_2H_4O has a mass of 44. The relative molecular mass of 88 (= 2 × 44) shows that the molecular formula is $C_4H_8O_2$. $(CH_3)_2CHCOOH$ (II) and $CH_3CH_2COOCH_3$ (III) both have this molecular formula.

Question 9 **C**

When moving across Period 3 from sodium to chlorine, there is an increase in core charge from +1 to + 7. This increased core charge means that electrons are more strongly attracted to the nucleus, and so electronegativity increases. The increased attraction also leads to a decrease in atomic radius. Therefore the properties in II and III increase.

Question 10 **B**

When a sample of methanol is vapourised, it is the intermolecular bonds (hydrogen bonds and dispersion forces) that are affected. The covalent bonds within the molecules are not broken

Question 11 **B**

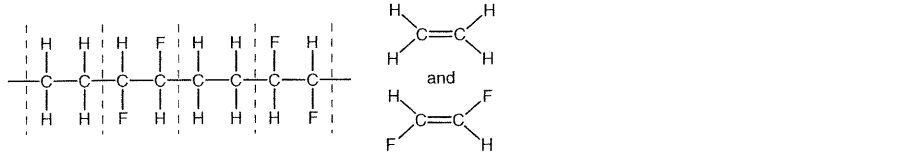
Q and X are isotopes as they have the same atomic number but different mass numbers. Similarly, R and Z are isotopes. Q and X each have an electron shell configuration of 2, 8, 6, and R and Z have the configuration 2, 8, 18, 3. Non-metals typically have 4, 5, 6 or 7 electrons in the outer shell. Therefore, Q and X are the required non-metallic isotopes.

Question 12 **A**

The molecules C_2H_2, C_2H_4 and C_2H_6 contain a carbon–carbon triple bond, a carbon–carbon double bond and a carbon–carbon single bond respectively. The bond strength is therefore decreasing, and the bond length is therefore increasing. Bond polarity does not alter, as all the carbon–carbon bonds are non-polar.

Question 13 **D**

The monomers used must contain a double bond (so **A** is incorrect). Look for the repeating units.



Question 14 **D**

X and Z have the same number of protons, and are therefore the same element. X and Z are the same element with different numbers of neutrons. They are therefore isotopes. X has more electrons than protons. It is therefore a negatively charged ion. Thus the statements in **A**, **B** and **C** are all correct. While Y and Z have the same number of neutrons, their numbers of nucleons (i.e. their mass numbers) are different. The statement in **D** is therefore incorrect and so is the required response.

Question 15 **B**

Deflection of positively charged ions in the magnetic field of a mass spectrometer is directly proportional to the charge on the ion, and inversely proportional to the mass of the ion. Thus the ion with the smallest mass and greatest charge will be deflected most strongly.

Question 16 **D**

The bond between two chlorine atoms is non-polar (so **A** is incorrect). The bond between a chlorine atom and a hydrogen atom is polar (so **B** is incorrect). The Cl_2 molecule is non-polar (so **C** is incorrect). The HCl molecule is polar.

Question 17 **A**

The metallic lattice consists of an array of cation immersed in a sea of electrons. Electrostatic attractions between the cations and electrons hold the lattice together. This is metallic bonding.

Question 18 **D**

Li (2, 1) is in Group 1 and Period 2.
Mg (2, 8, 2) is in Group 2 and Period 3.
Al (2, 8, 3) is in Group 13 and Period 3.
Be (2, 2) is in Group 2 and Period 2.

Question 19 **B**

When moving down a group of the Periodic Table, the radii increase as there are more electron shells for each period. The Group 17 elements show little if any electrical conductivity (so **C** is incorrect). Melting point for the Group 14 elements varies from very high for carbon (diamond and graphite), to relatively high for lead. It does not increase steadily as it does for the Group 17 elements (so **A** is incorrect). Electronegativity generally decreases down a group (so **D** is incorrect).

Question 20 **A**

Nanotechnology deals with investigation of particles in the size range 1–100 nm, where 1 nm = 10^{-9} m. A mitochondrion, with a length of 0.5 μm (= 500 nm) is outside the size range for nanotechnology. A buckyball (with a diameter of 10 Å = 1 nm), a virus (with a length of 3×10^{-8} m = 30 nm) and DNA (with a width of 2 nm) all fall within the size range for nanotechnology.

SECTION B: SHORT-ANSWER QUESTIONS

Question 1

a. **i.** The mass of an atom expressed on the scale where an atom of carbon-12 has a mass of 12 exactly. 1 mark
For example, each Sb atom has approximately ten times the mass of a carbon-12 atom. 1 mark

ii. The number of nucleons (protons plus neutrons) in the nucleus of an atom. 1 mark
For example, an atom of Sb-123 has 51 protons and 72 (123 – 51) neutrons. 1 mark

b. **i.** RAM = Σ(RIM $\times$ abundance fraction)

$$= \left(120.9 \times \frac{32.7}{100}\right) + \left(122.9 \times \frac{67.3}{100}\right)$$

$$= 122.2$$

2 marks

ii. The listed relative atomic mass for antimony is 121.8. The sample used gave a relative atomic mass of 122.2. Hence the sample was not taken from a natural source. It may have been generated artificially. 1 mark

Total 7 marks

Question 2

a. **i.** Aluminium ions have a +3 charge, compared with a +1 charge for sodium ions. 1 mark
The greater charge means that cations and electrons are more strongly attracted to each other, resulting in a stronger metallic bond for aluminium. This stronger bond gives a higher melting point for aluminium. 1 mark

ii. Chlorine molecules (Cl_2) and argon atoms are both bonded together to form solids by weak, intermolecular dispersion forces. 1 mark
These forces increase in strength with increasing molecular size. Argon atoms therefore have weaker bonds between them than do chlorine molecules. The melting point of argon is therefore lower than that of chlorine. 1 mark

b. All Period 2 elements have two occupied electron shells. Core charge increases across Period 2 of the Periodic Table. Fluorine's core charge of +7 attracts outer-shell electrons more strongly than the +1 core charge of sodium. 1 mark
This greater attraction for the outer-shell electrons causes the radius of the atom to decrease across the Period 2 elements. 1 mark

c. **i.** $_9$L *(a Group 17 element in Period 2)* 1 mark

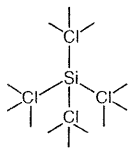
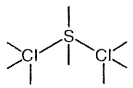
ii. $_{20}$G *(metal reactivity increases down the group)* 1 mark

iii. $_{13}$M *(a metal with three outer-shell electrons)* 1 mark

Total 9 marks

Question 3

a. i.

Molecule	Structural diagram	Name of shape
$SiCl_4$		tetrahedral
SCl_2		angular or V-shaped

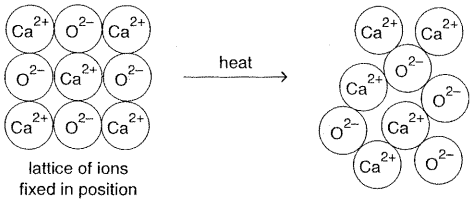
4 marks
1 mark for each diagram
1 mark for each name

ii. *Any one of:*

- H_2O
- H_2S
- OF_2
- Any other suitable answer.

1 mark

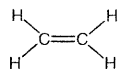
b. CaO is an ionic solid consisting of a lattice of cations and anions held together by electrostatic forces of attraction between oppositely charged ions. 1 mark
Ions are fixed in the solid and so are unable to conduct electricity. Melting frees the ions, allowing them to conduct electricity. 1 mark



1 mark
Total 8 marks

Question 4

a. i.



1 mark

ii. I. 1 mark
The branched chains in polymer II do not pack closely together. This reduces the strength of the dispersion forces between them and so lowers the melting point of the polymer. 1 mark

iii.

polymer I	*x*	(*y*)	*z*
polymer II	*x*	(*y*)	*z*
polymer III	*x*	*y*	(*z*)

3 marks
1 mark for each polymer

b. i. Boiling point increases as the size of the molecules increase. 1 mark
As size increases, the strength of the dispersion forces between the molecules increases. This leads to higher boiling points. 1 mark

ii. *Any two of:*

- members of a series have a general formula, e.g. C_nH_{2n+2} for alkanes.
- successive members of a series differ by CH_2.
- viscosity increases as molecular mass increases.
- any other suitable answer.

2 marks
1 mark for each characteristic
Total 10 marks

Question 5

a. i. $C_9H_8O_4$ 1 mark

ii. 6.02×10^{23} molecules have a mass of 180 g.
1 molecule has a mass of *x* g.

$$x = \frac{180}{6.02 \times 10^{23}} = 2.99 \times 10^{-22} \text{ g}$$ 1 mark

iii. $n(\text{acetylsalicylic acid}) = \frac{m}{M} = \frac{300 \times 10^{-3}}{180} = 1.67 \times 10^{-3}$ mol 1 mark

iv. $n(\text{C}) = 9 \times n(\text{acetylsalicylic acid})$
$N(\text{C atoms}) = n \times N_A = 9 \times 1.67 \times 10^{-3} \times 6.02 \times 10^{23} = 9.05 \times 10^{21}$ 1 mark