Neap:

Trial Examination 2018

VCE Chemistry Unit 1

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

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

Question 1 D

By the time Bohr conducted his experiments, it had been established that the atom had a nucleus containing the positively charged particles and that electrons move around the nucleus. The model in the diagram was proposed before Bohr's work.

Question 2 C

If the metal reacts with cold water to produce hydrogen gas then it is a reactive metal, and so should react quite quickly in air to produce an oxide layer. **A** is not correct. **B** is also incorrect as both gold and silver are unreactive metals. Reactive metals react with oxygen and steam quickly. Thus **D** is not correct and **C** is the required answer.

Question 3 A

Any isotope could have been chosen as the standard and given an arbitrary whole number on the relative scale. Therefore **D** is not correct. The comparative percentage abundance is not relevant to the selection. **C** is also not correct. Carbon-12 was chosen because it is readily available, stable and convenient to use in measurements. **A** is the required answer.

Question 4 C

Two non-metallic elements comprising silicon dioxide indicates that covalent bonds are present, but the hardness of sand grains shows that discrete molecules held to each other by dispersion forces are not present. **A**, **B** and **D** are incorrect. The giant network covalent lattice structure is consistent with the observed properties of silicon dioxide and so **C** is correct.

Question 5 B

Larger crystals form in solutions which cool more slowly and so the smaller crystals will be produced in the filtrate dried in the oven.

Question 6 A

The atomic number of antimony is 51 and so there will be 51 electrons in a neutral atom. The mass number of 121 shows that the number of neutrons is 121 – 51 = 70. A charge of 2+ indicates that an atom has lost 2 electrons and so the number of electrons in the ion is 49.

Question 7 C

Electronegativity decreases down the group and so an element with a lower atomic number than Sb has a higher electronegativity value. **A** is not correct. Atomic radius decreases across a period and so the first element in the period (Rb) will have a larger atomic radius. **B** is not correct. Metallic character increases down the group and so elements above Sb would be less metallic in character. **C** is the required answer. The first ionisation energy generally increases across the period, which means that Sb would have a lower value than the noble gas xenon. Thus **D** is not correct.

Question 8 B

Plasticisers are small molecules which hold the polymer chains further apart and thus decrease the intensity of the dispersion forces between the chains. This results in less energy being required to enable the chains to move over each other and so the softening temperature is decreased.

Question 9 A

Sulfur dioxide gas produced in the process would need to be captured and treated so that the surrounding vegetation is not damaged or destroyed. This adds to the costs of the proposed smelter and thus I would have a negative impact. High local unemployment implies a ready workforce for the proposed smelter. II is likely to have a positive impact. The higher the copper concentration in the ore, the more viable the proposal to mine and extract the metal would be. III would also have a positive impact.

Question 10 C

Polymers are modified in a vast number of ways, resulting in great variation in their properties. **A** is incorrect. Making items from metal, wood or natural fibres is generally more costly than from polymer materials, due in part to the economies of scale of the plastics industry and cost of the raw materials. **B** is also incorrect. The main source of raw materials for polymers is crude oil, which is in finite supply and thus is a significant disadvantage. **C** is the required answer. Most substances will decompose at high temperatures and so this could not be seen as a major disadvantage of polymers. **D** is incorrect.

Question 11 D

The shapes of the molecules are as follows:

linear – HF, CO_2, N_2

V-shaped – H_2S

triangular pyramid – NH_3

tetrahedral – SiH_4, CCl_4

octahedral – SF_6

Question 12 D

The model of the lattice of ions held together by strong electrostatic forces of attraction explains why ionic substances will not conduct electricity as a solid, but will conduct as a liquid or aqueous solution due to the ions moving. Similarly, the strong forces of attraction explain the hardness and high melting temperature. Thus **A**, **B** and **C** are not limitations. The solubility of ionic substances varies widely and this phenomenon is not simply explained using the model. **D** is a limitation and so is the required answer.

Question 13 B

As water at 75°C is less dense than water at 25°C, it will float on the colder water. Statement I is correct. Increasing the temperature of water requires energy to be put in. Statement II is incorrect. Water molecules in ice are held together in an open configuration by hydrogen bonding and so water molecules in cold water are closer together than they are in ice. Statement III is incorrect.

Question 14 B

Hydrogen bonding and dispersion forces are the intermolecular forces between water molecules, and covalent bonding is the intramolecular force. Changing temperature up to 50°C would not disrupt the very strong bonds holding the atoms in water molecules to each other. Only the weaker intermolecular forces are being disrupted.

Question 15 B

In MgO, $n(\text{Mg}) = n(\text{O}) = \dfrac{3.29}{24.3} = 0.1353 \text{ mol}$

$m(\text{O}) = n \times M = 0.1353 \times 16 = 2.166 = 2.17 \text{ g}$

Question 16 D

If the mass of magnesium used was accurate, then a larger amount of magnesium oxide should have been produced. **A** is thus plausible and not the answer. If the mass of magnesium was recorded incorrectly as higher than the actual mass, then less magnesium oxide than expected would be produced. **B** is also plausible. Incomplete combustion would produce a lower mass of product as some of the magnesium has not combined with oxygen. **C** is also plausible. An excess of oxygen must be used in the reaction to ensure complete combustion and conversion of the magnesium to magnesium oxide. This would have no impact on the mass of magnesium oxide produced. **D** is thus not a plausible explanation and is the required answer.

Question 17 D

The group number is found by considering the number of electrons in the outer shell; that is, 2 + 3 = 5. Thus the element is in group 15. The period number is the number of occupied electron shells; that is, 5.

Question 18 C

The polymer softens when heated and so it is a thermosoftening polymer. Thermosoftening polymers do not have extensive cross-links, only weaker intermolecular bonding, so they can be melted and recycled.

Question 19 A

Element M has three electrons in its outer shell and is in period 4. It is a metal. Element Q has seven electrons in its outer shell and so is a non-metal. When M and Q combine, electron transfer occurs and an ionic compound is formed from the ions M^{3+} and Q^{-}. The compound will be MQ_3.

Question 20 A

W and X have the same atomic number, 26, and so are the same element.

SECTION B

Question 1 (5 marks)

a. $C_5H_8O_2\,(g) + \mathbf{6}O_2(g) \rightarrow \mathbf{5}CO_2(g) + \mathbf{4}H_2O(g)$ 1 mark

b.

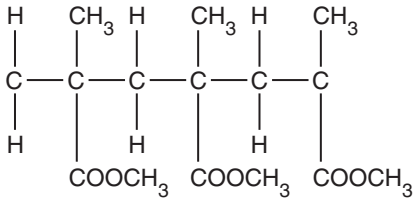
	All bonds are polar	Not all bonds are polar
Molecule is polar		✓
Molecule is not polar		

1 mark

c. **i.** COOH 1 mark

ii. The molecule contains a chain of five carbon atoms. 1 mark

d.



1 mark

Question 2 (11 marks)

a. **i.** $m(C) : m(H) : m(O) = 48.7 : 8.1 : 43.2$

$$n(C) : n(H) : n(O) = \frac{48.7}{12} : \frac{8.1}{1} : \frac{43.2}{16}$$ 1 mark

$$= 4.06 : 8.1 : 2.7$$

$$= 1.5 : 3.0 : 1.0$$

$$= 3 : 6 : 2$$

The empirical formula is $C_3H_6O_2$. 1 mark

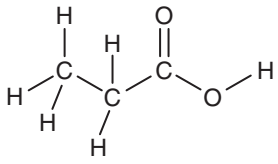
ii. The relative mass of $C_3H_6O_2$ is $3 \times 12 + 6 \times 1 + 2 \times 16 = 74$, the same as the RMM, and so the empirical formula must also be the molecular formula – that is, $C_3H_6O_2$. 1 mark

b. **i.** Esters are used as fragrances or flavourings. 1 mark

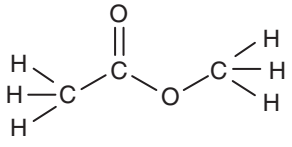
ii. ethyl methanoate 1 mark

iii. $HCOOCH_2CH_3$ 1 mark

c.



OR



1 mark

d. **i.** CH_2CH_2 1 mark

ii. Ethanol has a higher molecular mass than ethene and so has stronger dispersion forces between the molecules. 1 mark

Ethanol contains the OH group and so has hydrogen bonding between the molecules. This gives stronger bonding than dispersion forces alone. 1 mark

Stronger bonding leads to the higher boiling point for ethanol. 1 mark

Question 3 (18 marks)

a. **i.** A*ny one of:*

- conduct electricity well
- conduct heat well
- malleable
- lustrous

1 mark

ii. Metals are composed of a lattice of cations in a 'sea' of delocalised electrons. 1 mark

Thus the array of cations can be pulled into the shape of a wire because the delocalised electrons are strongly attracted to all cations in the vicinity, preventing any cations breaking away easily. 1 mark

b. *Any one of:*

- Some are magnetic.
- Compounds of transition metals are usually coloured.
- Ions of these metals can have variable oxidation states.

1 mark

c. **i.** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2$ 1 mark

ii. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$ 1 mark

d. **i.** Atomic number is the number of protons. Atoms of Ni have 28 protons in the nucleus whereas atoms of Co have 27 protons in the nucleus. 1 mark

ii. The RAM is the weighted mean of all the isotopes of the element. 1 mark

Ni must have an isotope (or isotopes) which has a low relative isotopic mass (RIM) with a high abundance, and so the weighted mean is skewed towards a lower value. 1 mark

iii. Elements in the transition series are filling the d-subshell. 1 mark

The d-subshell can have a maximum of ten electrons and so there are ten elements in this series. 1 mark

e. The abundances of ^{63}Cu and ^{65}Cu are y and $(100 - y)$.

$$\text{RAM(Cu)} = 63.5 = \frac{(62.93 \times y + 64.93 \times (100 - y))}{100}$$ 1 mark

$$y = 69.5$$

Therefore the percentage abundance of the heavier isotope is 30.5%. 1 mark

f. *Any one of the following:*

Possible methods of modifying iron prior to its use		
Coating the iron	**Heat treatment of iron**	**Making an alloy from iron**
• protects from corrosion • gives an attractive appearance	• makes the iron more flexible • makes the iron harder	• makes the iron stronger • protects from corrosion • gives an attractive appearance

1 mark

g. **i.** 1 mol of Cr_2O_3 has a mass of 152 g and contains 2 mol (104 g) of Cr. 1 mark

$$\% \text{ Cr in } Cr_2O_3 = \frac{104}{152} \times 100 = 68.4\% \quad \text{1 mark}$$

ii. $100 \text{ kg} = 100 \times 10^3 \text{ g}$

$$n(\text{Al}) = \frac{m}{M} = \frac{100 \times 10^3}{27.0} = 3703 \text{ mol} \quad \text{1 mark}$$

number of Al atoms = n x $N_A = 3703 \times 6.02 \times 10^{23} = 2.23 \text{ x } 10^{27}$ atoms 1 mark

Question 4 (10 marks)

a. **i.** Solid lithium chloride is an ionic compound with ions held strongly in a lattice and, because the ions cannot move, no electrical conduction can occur. 1 mark

Solid diamond is a giant covalent lattice with outer shell electrons held in covalent bonds and so no electrical conduction is possible, as the electrons are not free to move. 1 mark

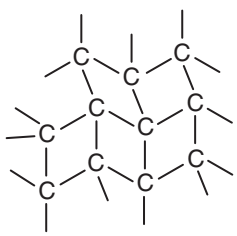
Solid glucose is composed of discrete molecules held strongly together in an array with electrons held in covalent bonds – no electrical conduction occurs as the electrons are not free to move. 1 mark

ii. Liquid lithium chloride will conduct electricity because the bonds between the ions have been disrupted and the ions are free to move, resulting in a transfer of charge. 1 mark

Liquid diamond will not conduct electricity as no electrons are delocalised and so no charge can be transferred. *(Diamond usually undergoes sublimation and does not readily form a liquid.)* 1 mark

Liquid glucose will not conduct electricity even though the intermolecular bonds are broken because outer shell electrons remain in covalent bonds and so no charge can be transferred. 1 mark

b.



2 marks

1 mark for three-dimensional lattice structure.
1 mark for tetrahedral arrangement of bonds.

c. **i.** hardness 1 mark

ii. Carbon atoms are held by very strong bonds in a giant three-dimensional lattice and thus it can withstand extreme force without breaking. 1 mark

Question 5 (6 marks)

a. *Any two of:*

Incorrect statement	Reason for statement being incorrect
I	Nanoparticles are in the range of 1 to 100 nanometres.
II	The surface area-to-volume ratio is extremely large compared to bulk material.
V	Nanoparticles tend to clump together because of dispersion forces, as their very small size allows very tight packing of the particles and intense interaction.

4 marks

1 mark for each incorrect statement identified (maximum of 2 marks).
1 mark for explanation of why each identified statement is incorrect (maximum of 2 marks).

b. **i.** Both nanomaterials are composed of covalently bonded carbon atoms. 1 mark

ii. *For example, any one of:*

- Graphene is a sheet structure, whereas fullerenes have a geodesic dome or soccer-ball shape.
- Graphene has a very large number of carbon atoms in its structure, whereas fullerenes have a discrete number; for example, C_{60} or C_{70}.

1 mark

