Neap:

Trial Examination 2017

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

The uncharged argon isotopes would all have the same atomic number, number of protons, number of electrons, ground state electron configuration and nuclear charge. They would differ in the mass number, number of neutrons and number of nuclear particles. Only **D** has two characteristics which are the same for these isotopes of argon.

Question 2 C

The compound has a carbon-to-carbon double bond and so can be used as a monomer in addition polymerisation reactions. The compound can also be used in an addition reaction with bromine and the product will be colourless. As the compound also contains the acidic carboxyl functional group, it will react with reactive metals. Thus **C** is the required answer.

Question 3 B

The formula of the molecular structure shown is $C_3H_4O_2$, so the empirical formula is the same as the molecular formula. **A** is incorrect. In 3.6 g of the compound there is $\frac{3.6}{72}$ = 0.05 mole. Each molecule has 9 atoms and so 0.05 mole of the compound has 0.45 mole of atoms. **B** is the correct answer. As the carboxyl group is highly polar, hydrogen bonding could be expected between the molecules. **C** is incorrect. In 2 mole of the compound there is 4 mole of oxygen atoms and so there are $4 \times 6.02 \times 10^{23}$ oxygen atoms. **D** is also incorrect.

Question 4 A

Both types of metals have the common properties of malleability, ductility, lustre and electrical conductivity. Therefore, **B** and **D** apply to both metal types and **C** applies to neither type as electrical conductivity occurs in the solid and molten states. Most transition metal compounds are coloured (Zn being an exception), whereas the compounds of the main group metals are white and give a colourless solution when dissolved. **A** is the required answer.

Question 5 B

Emission spectra provided evidence which led Bohr to his model of electron shells and orbits. Subshells were a later refinement of Bohr's model, so **C** is not the correct response.

Question 6 C

Carboxylic acids are isomers of esters and so the compound $C_7H_{14}O_2$ is possibly heptanoic acid ($C_6H_{13}COOH$), ethyl pentanoate ($C_4H_9COOC_2H_5$) or butyl propanoate ($C_2H_5COOC_4H_9$). Thus **A**, **B** and **D** are correct. The compound cannot be methyl heptanoate ($C_6H_{13}COOCH_3$) with 8 carbon atoms, and so **C** is the required response.

Question 7 A

Isomers have the same molecular formula, different physical properties, different structural formulas and similar chemical properties.

Question 8 B

The number of orbitals in each of the s, p, d and f subshells is mathematically set in the quantum mechanical model at 1, 3, 5 and 7 respectively. The shell number is not relevant to the number of orbitals in a particular subshell.

Question 9 **A**

In 100 g of the compound, m(C) : m(H) : m(O) = 60.0 : 13.3 : 26.7

$$n(C) : n(O) : n(H) = \frac{60.0}{12} : \frac{13.3}{1} : \frac{26.7}{16}$$

$$= 5 : 13.3 : 1.67$$

$$= 3 : 8 : 1$$

Therefore the empirical formula is C_3H_8O.

Even though the molecular formula cannot be determined, the ratio of atoms in the empirical formula is the same for the molecular formula. **A** is the only correct statement and so is the required response.

Question 10 **D**

The relative atomic mass is the weighted mean of the relative isotopic masses of all isotopes of the element. **A** uses the simple average of the mass numbers, whereas **B** uses the weighted mean of the mass numbers. Both are incorrect. **C** uses the simple average of the relative isotopic masses which is also not correct. Only **D** uses the correct method.

Question 11 **A**

$$m(O) = 7.53 - 6.01$$

$$= 1.52 \text{ g}$$

$$n(Cu) : n(O) = \frac{6.01}{63.5} : \frac{1.52}{16.0}$$

$$= 0.09464 : 0.0950$$

$$= 1 : 1$$

Therefore the empirical formula is CuO.

Question 12 **C**

Water vapour and nitrogen gas are produced in the reaction of ammonia with the copper oxide. Using insufficient ammonia will prevent the reaction from going to completion. Thus the mass of water vapour will be less and not all of the oxygen will be removed from the copper oxide. **A** and **B** are not correct. The determination of the empirical formula relies on the calculation of the mass of oxygen in the oxide by subtracting the final mass of copper from the total mass of the copper oxide. If some of the copper oxide remains, this calculation will not be accurate and result in an incorrect empirical formula. **D** is also incorrect. The number of copper ions in the copper oxide/copper in the tube is unaffected by how much ammonia is used in the experiment and so **C** is the correct answer.

Question 13 **D**

All of the compounds in **D** are linear molecules. The other compounds are as follows:

A: NH_3 (triangular pyramid); BF_3(triangular planar); CH_3Cl (tetrahedral)

B: PF_5 (trigonal bipyramid); $SiCl_4$ (tetrahedral); C_2F_4(planar)

C: C_2H_4 (planar); CCl_4 (tetrahedral); SF_6 (octahedral)

Question 14 D

Electrons are transferred in ionic bonding and so the electronegativity has no relevance. **A** is incorrect. Ionic bonding is holding the ions together in each of the lattices and so **B** is also not correct. All of the ions present are singly charged and so this cannot be used to explain the difference in melting temperature. **C** is not correct. The electrostatic attraction is dependent on the distance between the ions and so the size of the ions is relevant. **D** is the required response.

Question 15 A

Metal Y is unreactive with dilute acid, meaning it could be gold, silver, platinum or copper. Metal X is more reactive than metal Z, so the combination could be Mg and Fe respectively, but not the combinations Cu/Pb, Fe/Na or Pb/Mg. **A** shows the only possible combination.

Question 16 C

Red blood cell is 7×10^{-6} m, hydrogen molecule is 0.15×10^{-9} m.

$$\text{Ratio is } \frac{7 \times 10^{-6}}{0.15 \times 10^{-9}} = 47 \times 10^{3}$$

$$= 50\,000 \text{ (approximately)}$$

Question 17 D

As the size of nanoparticles is so small, light interacts differently compared to the macroscale particles, and often changes in colour and/or opacity occur. The changes in **A** and **C** are likely. Due to the vast increase in surface area of nanoparticles, catalytic activity may increase or even develop, although the bulk material may not show this property. The change in **B** is possible. The bonding between nanoparticles is usually by dispersion forces, and not by the stronger bonding type shown in the bulk material. Thus melting point is likely to be lowered at the nanoscale, not increased. The change in **D** is unlikely, and so this is the required response.

Question 18 B

Generally, first ionisation energy for elements increases across the period and so element S appears to be the last element in the row containing elements Q, R and S. The significant fall in the first ionisation energy for the next row (beginning with elements T, U, V and W) occurs because the shell is further from the nucleus and there is less attraction for the outermost electron. **B** is the required answer.

Question 19 B

U represents a group 2 element, T a group 1 element, so **D** is incorrect. The number of neutrons does not affect ionisation energy, so **A** is not the required response. Atomic radius decreases across a period, so **C** is incorrect. The greater core charge of U (+2 compared to +1 for T) means that the electron is more tightly held, and so requires greater energy for its removal.

Question 20 C

An uncharged atom with 16 protons will have 16 electrons distributed as shown in **A**. In the ground state, electrons will fill the 2p subshell before the 3s subshell starts to fill. In **B**, the electron configuration is for an excited atom as there only four electrons in the 2p subshell. The electron configuration in **C** should have 16 electrons (15 + 1), but has only 14 electrons, and so this is the configuration for a positive ion. **C** is incorrect and so is the required answer. Chromium has an unusual electron configuration and this is shown correctly in **D**.

SECTION B – SHORT ANSWER QUESTIONS

Question 1 (14 marks)

a. **i.** Solid magnesium chloride consists of Mg^{2+} and Cl^- ions — 1 mark
arranged in a regular array or lattice held together by electrostatic forces/ionic bonding — 1 mark
with two chloride ions for every one magnesium ion. — 1 mark

ii. The magnesium ions gain electrons. — 1 mark

iii. Less energy is needed for the process, which lowers the cost of producing magnesium. — 1 mark

b. $$\% \text{ Cu by mass in } Cu_2S = \frac{2 \times 63.5}{2 \times 63.5 + 32.1} \times 100$$

$$= 79.8\%$$ — 1 mark

In 1.00 tonne of ore, there is $0.798 \times 10^6 = 7.98 \times 10^5$ g of Cu. — 1 mark

c. **i.** *Any one of:*

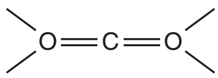
Fe_2O_3(s) will not conduct electricity as the ions which are present in the structure are held together by strong ionic bonding, — 1 mark
and so are unable to move. — 1 mark

OR

CO(g) will not conduct electricity as it is a molecular compound with no ions in the structure — 1 mark
or electrons which are free to move, as they are involved in covalent bonds. — 1 mark

OR

CO_2(g) will not conduct electricity as it is a molecular compound with no ions in the structure — 1 mark
or electrons which are free to move, as they are involved in covalent bonds. — 1 mark

ii.  — 1 mark

iii. Each oxygen atom has greater electronegativity than the carbon atom and so will have a partial negative charge (δ–), while the carbon atom will have a partial positive charge (δ+). — 1 mark

However, as there are no distinct positive and negative ends of the molecule, carbon dioxide is non-polar; that is, the dipoles cancel out. — 1 mark

d. *For example:*

copper

Large amounts of sulfur dioxide are released in the smelting process. 1 mark

Sulfur dioxide is toxic to some animal and plant life. It also dissolves in rain water to produce acidic conditions which can impair the normal functioning of living things. 1 mark

OR

iron

Carbon dioxide gas is released from the blast furnace. 1 mark

This is a greenhouse gas which is one cause of the temperature of the Earth rising over time, degrading habitats and ecosystems. 1 mark

OR

magnesium

Most electricity generation uses fossil fuels and produces greenhouse gases. 1 mark

Greenhouse gases cause the temperature of the Earth to rise over time, degrading habitats and ecosystems. 1 mark

Question 2 (10 marks)

a. **i.** $^{297}_{117}Ts$ 1 mark

ii. Carbon-12 is stable and abundant and so can be accurately measured. 1 mark

b. **i.** $7s^2 7p^5$ 1 mark

ii. less than (*electronegativity decreases moving down the group*) 1 mark

iii. Atomic radius decreases moving across the period from the left due to the increasing nuclear charge drawing electrons more tightly. 1 mark

Ts would therefore have a smaller atomic radius than the element before it in Period 7, element 116. 1 mark

c. **i.** Nuclei are positively charged and so will repel each other electrostatically as they approach. 1 mark

To overcome this repulsion, the calcium nuclei were given high energy so that the nuclei could collide and form a new nucleus. 1 mark

ii. The RAM of Ca is 40.1 which indicates that the isotope with mass number 40 is by far the most abundant. 1 mark

The RAM is calculated from the weighted mean of all of the isotopes and so, if the heavier isotopes had high abundance, the RAM would be skewed away from near 40 to a higher value. 1 mark

Question 3 (13 marks)

a. crude oil (or petroleum) 1 mark

b. C_7H_{16} 1 mark

c. **i.** There is covalent bonding holding the atoms within the molecule. 1 mark

Between the molecules, dispersion forces are the only intermolecular bonding. 1 mark

ii. type 2 — 1 mark

The polymer chains in type 2 can be packed closely together because of their regular structure and thus the intensity of the dispersion forces will be greater, causing the higher melting temperature. — 1 mark

(The polymer chains of type 1 are arranged irregularly and so will not pack together as closely, resulting in weaker dispersion forces and a lower melting temperature than type 2.)

iii. Heat the sample gently and determine whether it softens as it heats. — 1 mark

If it softens on heating and then hardens on cooling, it is a thermoplastic. — 1 mark

(This is because the bonds between the polymer chains are only dispersion forces which are disrupted at low temperatures.)

d. i. *For example:*

Less polypropene will enter landfill or be discarded to spoil the environment. — 1 mark

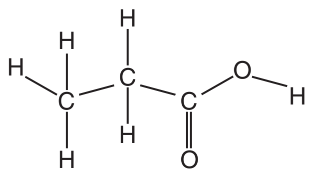
ii. *For example*:

The source material for the polymer is derived from fossil fuels which are in finite supply. — 1 mark

e. i. $CH_3CH_2CH_2OH$ — 1 mark

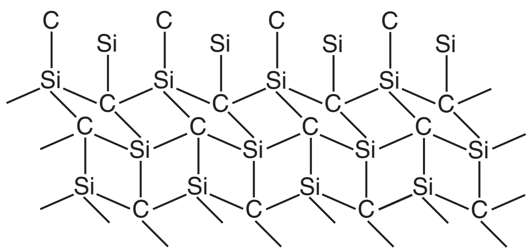
$CH_3CHOHCH_3$ — 1 mark

ii. — 1 mark



Question 4 (13 marks)

a. i.



2 marks
1 mark for alternating Si and C atoms.
1 mark for correct three-dimensional structure.
Note: Students may draw less of this.

ii. To grind metal or stone requires the material to be very hard. — 1 mark

Due to the strong covalent bonds throughout the lattice, SiC is very hard and so is suitable for these applications. — 1 mark

b. i. This oil is a relatively large non-polar hydrocarbon compound which has dispersion forces between the molecules. — 1 mark

The large molecules will slide over each other easily as the intermolecular bonding is very weak. — 1 mark

ii. Graphite is a two-dimensional layer covalent lattice with dispersion forces between the layers. 1 mark

Thus the layers will slide over each other easily because of the very weak interlayer bonding. 1 mark

iii. *For example*:

At high temperatures, the hydrocarbon will ignite and burn. 1 mark

c. *Any one of:*

Number	Property	Modification process
1.	hardness	Introduction of different metal atoms into the metallic lattice prevents the layer of cations rolling over each other easily.
2.	hardness	The crystals formed in quenching are small and so pack together tightly, producing a hard edge which can be sharpened.
3.	will not corrode	Zinc is a more reactive metal than iron and also provides a physical barrier which prevents iron rusting.
4.	strength	Placing smaller atoms within the metallic lattice increases the interparticle attractive forces and produces a stronger alloy.
5.	will not corrode	Cadmium is a less reactive metal than steel and provides a physical barrier against agents which cause corrosion.
6.	flexibility	Heating the piping causes annealing in which large metal crystals are formed but are not packed together tightly.

2 marks

1 mark for the correct property of the selected application.

1 mark for the correct description of how the modification achieves the desired property.

d. As water cools, the molecules move slower and the hydrogen bonding between the molecules becomes stronger. 1 mark

When water freezes, the water molecules are held in an open crystal structure in which each molecule is directly bonded to four other molecules at a distance greater than the intermolecular distance in liquid water; that is, the water expands to fill a larger volume, potentially bursting pipes. 1 mark