Neap

Trial Examination 2021

# 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 B**

**B** is correct. Only transition metals show variable charges; for example, $Cu^{2+}$ and $Cu^{+}$. **A**, **C** and **D** are incorrect. A small number of outer-shell electrons, being malleable and conducting electricity are features of all metals.

**Question 2 C**

**C** is correct. Due to the delocalised electrons in the metallic lattice of cations, metals can be beaten into sheets; that is, they are malleable. **A** and **D** are incorrect. These are not generally properties of metals. **B** is incorrect. Iron, cobalt and nickel are magnetic elements, but gold is not.

**Question 3 D**

**D** is correct. Due to the extremely small size of gold nanoparticles, changed surface effects lead to different properties to those expected of macro-sized gold. For example, gold nanoparticles have a catalytic capacity, whereas ordinary gold does not. **A** is incorrect. Nanoparticles have very large surface area-to-volume ratios. **B** is incorrect. Gold is a relatively unreactive metal, although nanoparticles of gold are much more reactive. **C** is incorrect. Even though the typical metallic structure is not present in nanoparticles, neutrons are still located within the nucleus of metals atoms.

**Question 4 C**

**C** is correct. Metal atoms have few electrons in the outer shell and tend to lose these easily to become ions with a positive charge. The electron configuration of the ion will be identical to that of the previous noble gas. **A** is incorrect. An uncharged atom of an element in the first transition series will have the 3d subshell filled or partly filled but will not have electrons in the 4p subshell. **B** is incorrect. The electron configuration is of a noble gas in the fourth period. **D** is incorrect. Atoms of non-metallic elements usually have almost complete outer shells and so losing electrons is highly unlikely.

**Question 5 B**

**B** is correct. Fullerenes consist of pentagonal and hexagonal arrangements of carbon atoms that fit together like the patches on a soccer ball. **A** and **D** are incorrect. In graphite and graphene, each carbon atom is bonded to three other carbon atoms in a hexagonal arrangement. The structure in the diagram has a hexagonal and pentagonal arrangement. **C** is incorrect. Diamond is a three-dimensional covalent network lattice in which each carbon atom is bonded to four other carbon atoms.

**Question 6 A**

**A** is correct and **B** and **C** are incorrect. As there are only three other carbon atoms bonded to each carbon atom, one electron in the outer shell is not confined in a covalent bond. These delocalised electrons can move through the molecule and will conduct electricity. **D** is incorrect. There are no ions in the structure, but the delocalised electrons can also transfer charge.

**Question 7 D**

**D** is correct. The modern periodic table orders elements by atomic number. Vertical groups contain elements with the same outer-shell electron configuration.

**Question 8 A**

**A** is correct. The valence shell electron-pair repulsion (VSEPR) model predicts molecular shapes using the principle that bonding and non-bonding electron pairs repel one another as far as possible.

**Question 9 B**

**B** is correct. Bohr used spectral evidence to propose a model of electron arrangement for atoms.

**Question 10 B**

**B** is correct. Shell $n$: $n$ subshells, $n^2$ orbitals. Shell 4 has a d subshell. Each d subshell has five orbitals.

**Question 11 D**

**D** is correct. Isotopes have the same atomic number, number of electrons, electron configuration and number of outer-shell electrons. **A**, **B** and **C** are incorrect. Isotopes differ in the number of neutrons, nuclear mass and mass number.

**Question 12 A**

**A** is correct. $CO_2$ and HCl: linear

**B** is incorrect. $CH_4$: tetrahedral, and $SF_6$: octahedral

**C** is incorrect. $NH_3$: triangular pyramidal, and $H_2O$: v-shaped

**D** is incorrect. $N_2$: linear, and $H_2S$: v-shaped

**Question 13 D**

**D** is correct. The first observation indicates that metal R is the most reactive. The second observation indicates that metal Y is more reactive than metal Q. The third observation indicates that metal X is the least reactive. So the order of increasing reactivity is X < Q < Y < R.

**Question 14 C**

**C** is correct. The polymer will soften when heated to moderate temperatures as the dispersion forces between the chains are disrupted progressively with increasing heat. **A** and **B** are incorrect. Thermosetting plastics do not soften when heated to moderate temperatures but will char at high temperatures when covalent bonds within a chain are broken. The structure is a linear polymer with no crosslinking possible between the chains. **D** is incorrect. Both types of plastic may char when heated to high temperatures.

**Question 15 A**

**A** is correct. The structure is polyethene and so the monomer is ethene ($C_2H_4$), with a relative molecular mass of 28.

**Question 16 B**

**B** is correct. The strength of the covalent bonds within the polymer chain is unaffected by the presence of a plasticiser molecule. **A** is incorrect. A plasticiser will hold the chains a little further apart, resulting in lower intensity of attractive force between the chains. So **A** is not correct because the intensity will change. **C** and **D** are incorrect. The use of a plasticiser will similarly cause both the percentage crystalline areas and temperature required to start melting the polymer to decrease.

**Question 17 C**

**C** is correct. Crude oil is in finite supply as it takes a very long time for the dead marine animals that were covered with sediments to break down to produce deposits of the oil. As a result, reserves of the raw materials required to produce man-made polymers are limited, and alternatives will need to be found when these are exhausted. **A**, **B** and **D** are incorrect. The great benefits of artificial polymers are their relative cheapness, the vast range of items that can be produced from them and the ease of recycling of thermoplastics.

**Question 18 A**

**A** is correct. Crystals of NaCl are formed when ions come out of solution and are deposited in a regular array. The size of the crystals will increase if this happens over a long period of time with many ions available for their formation. In the experiment, a short time for the evaporation process and a low number of ions available will produce crystals of the smallest size.

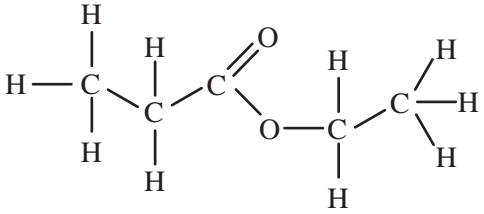
**Question 19 D**

**D** is correct. With simple microscopy it is quite easy to identify the size of crystals, which are seen as small, regular-shaped objects. **A**, **B** and **C** are incorrect. An electron microscope can barely reveal individual atoms or ions in some materials. Individual subatomic particles cannot be seen even by an electron microscope, and ions will not be seen by a simple binocular microscope.

**Question 20 C**

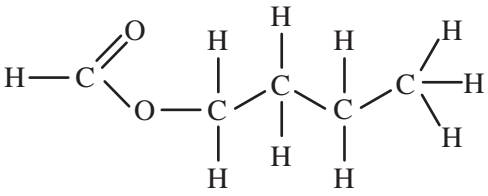
**C** is correct. Relevant structures and molecular formulas are as follows.

**A.**



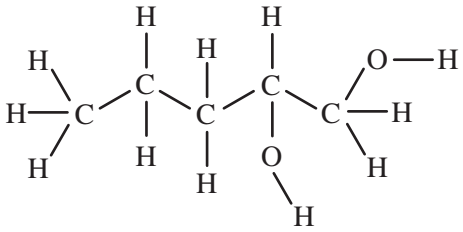
$C_5H_{10}O_2$

**B.**



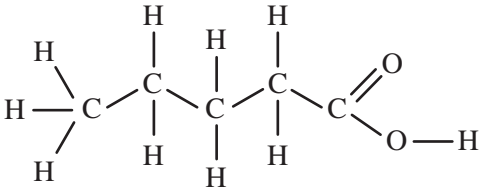
$C_5H_{10}O_2$

**C.**



$C_5H_{12}O_2$

**D.**

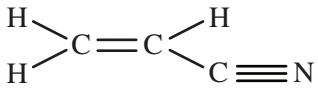


$C_5H_{10}O_2$

## SECTION B

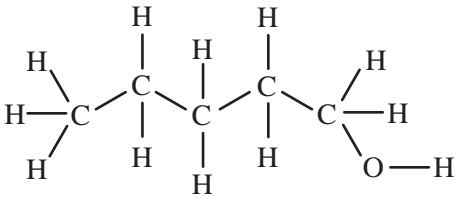
**Question 1** (5 marks)

**a.**



1 mark

**b.** **i.** *For example:*



1 mark

**ii.** pentan-1-ol 1 mark

**c.** The name of the compound is vanadium(II) chloride. 1 mark

The relevant ions are $V^{2+}$ and $Cl^-$, hence the formula is $VCl_2$. 1 mark

**Question 2** (12 marks)

**a.** A simple mean would produce a value of about 2.0 but the RAM is a weighted mean of the RIM values, taking into account the abundance of each isotope. 1 mark

As the weighted mean produces a RAM value of 1.0, which is close to the RIM of protium, this would indicate that the abundances of both deuterium and tritium are extremely low. 1 mark

**b.** **i.** *For example:*

The electron configuration of hydrogen is $1s^1$, which is the same as the outer-shell $s^1$ electron configuration of the elements in group 1. 1 mark

**ii.** *For example:*

The group 1 elements are reactive metals and hydrogen does not fit into this category. 1 mark

**c.** **i.** Two hydrogen atoms are joined by a covalent bond so that each atom completes the outer shell by sharing a pair of electrons. 1 mark

A helium atom has a complete outer shell and so there is no requirement to share electrons with another atom. 1 mark

**ii.** dispersion forces 1 mark

**d.** **i.** In 1 mole or 18.0 g of water, there are 2.0 g of hydrogen.

$$\%\ \text{H by mass} = \frac{2.0}{18.0} \times 100 = 11.1 = 11\%\ \text{(to two significant figures)}$$ 1 mark

**ii.** If 11.1% represents 0.0954 g for hydrogen, then for oxygen:

88.9% represents $\frac{88.9}{11.1} \times 0.0954$ g 1 mark

mass of oxygen = 0.764 = 0.76 g (to two significant figures) 1 mark

**iii.** mass ratio of Al : O = 0.859 g : 0.764 g

mole ratio of Al : O = $\frac{0.859}{27.0} : \frac{0.764}{16.0} = 0.0318 : 0.0478 = 1 : 1.5$ 1 mark

So the empirical formula of aluminium oxide is $Al_2O_3$. 1 mark

**Question 3** (12 marks)

**a.** **i.** H 1 mark

**ii.** *Any one of:*
D, E 1 mark

**iii.** D 1 mark

**iv.** C and E 1 mark

**v.** *Any one of:*
A, C, D, E 1 mark

**vi.** I 1 mark

**vii.** B *(A and E both exhibit hydrogen bonding, thus raising their boiling points)* 1 mark

**b.** Compound G has a branched structure and so its molecules are unable to pack as close together as the molecules of compound I. 1 mark

Thus, the intermolecular dispersion forces of compound G are not as intense and so will require less heat to disrupt; that is, compound I will have the higher boiling point. 1 mark

**c.** $n(\text{compound E}) = \frac{m}{M} = \frac{0.935}{74.0} = 0.012635 \text{ mol}$ 1 mark

number of molecules = $n \times N_A = 0.012635 \times 6.02 \times 10^{23} = 0.07606 \times 10^{23}$ 1 mark

In each molecule there are 11 atoms, therefore:

number of atoms in 0.935 g = $11 \times 0.07606 \times 10^{23} = 0.8363 \times 10^{23} = 8.37 \times 10^{22}$ 1 mark

**Question 4** (12 marks)

**a.** Magnesium is a reactive metal, whereas gold is not. 1 mark

Reactive metals lose their valence electrons easily and react readily with other elements to produce more stable compounds, which are deposited as ores. 1 mark

**b.** **i.** Solid magnesium chloride consists of magnesium ions and chloride ions held by strong electrostatic attractions in a lattice. The charged particles, ions, cannot move. This movement is necessary for the conduction of electricity. 1 mark

When molten, the strong bonds are weakened and so the ions are able to move and conduct electricity. 1 mark

**ii.** The ionic bonds holding the ions in the lattice of magnesium chloride are very strong. 1 mark

A large amount of heat is needed to disrupt the bonds. A temperature of 700°C provides sufficient heat for the ionic bonds to be disrupted and for the solid to become molten. 1 mark

**iii.** hard **OR** brittle 1 mark

**c.** **i.** aluminium 1 mark

**ii.** sodium 1 mark

**iii.** sodium 1 mark

**d.** *For example, any one of:*

1. Introduction of different metal ions into the Cu lattice produces a less corrosive, more attractive metal, which also has sound characteristics that are highly suitable for musical instruments.
2. Tin is a less reactive metal than iron and produces a physical barrier against corrosion by moist food.
3. The small atoms of C in the steel metallic lattice creates an interstitial alloy, to form a much stronger material needed for structural support.
4. The polymer Teflon produces a surface on the frying pan with weaker forces between the food and the pan, preventing or inhibiting food from sticking to the pan surface.

2 marks
*1 mark for identification of the desired property.*
*1 mark for explanation of the modification.*

**Question 5** (9 marks)

**a.** Due to the higher electronegativity of the oxygen atom in the water molecule, the electrons in the H–O bond are shared unequally, and so the oxygen atom develops a small negative charge ($\delta-$) and the hydrogen atom develops a small positive charge ($\delta+$). 1 mark

As a result, the water molecule is a dipole with oxygen at the negative end and the hydrogen atoms at the positive end. 1 mark

When a positively charged rod is brought near a thin stream of water, the negative end of the water molecule is attracted to the rod, causing the stream to bend. The positive end of the water molecule is attracted to a negatively charged rod, also causing the water stream to bend. 1 mark

**b.** When a polymer chain is unbranched, the individual chains can pack close to other chains. 1 mark

This results in the increased intensity of the dispersion forces between the chains and the development of a higher percentage of crystalline areas within the plastic item. 1 mark

Crystalline areas are denser regions that scatter light rather than allow light to penetrate, and so the item is not transparent. 1 mark

**c.** As liquid water cools towards the freezing temperature of water, each water molecule forms hydrogen bonds with four other water molecules. 1 mark

This is a very open arrangement, and the molecules are held further apart in an ice crystal than the molecules in liquid water; that is, there is less mass in a given volume. 1 mark

The density of ice is therefore lower than the density of liquid water, and so the ice will float. 1 mark