Neap

Trial Examination 2022

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 C

C is correct. Electrons moving in defined orbits was proposed by Bohr and was modified considerably in Schrödinger's quantum mechanical model. This statement as written is not part of the model proposed by Schrödinger.

A, **B** and **D** are incorrect. These options are features of Schrödinger's quantum mechanical model.

Question 2 D

D is correct. In the structures of graphene (I), graphite (III) and fullerenes (IV), there are only three other carbon atoms bonded to each carbon atom. Thus, one electron in the outer shell of each carbon atom is not confined by a covalent bond. These delocalised electrons can move through the structures and conduct electricity.

A, **B** and **C** are incorrect. Diamond (II) is a three-dimensional covalent network lattice in which each carbon atom is bonded to four other carbon atoms. There are no delocalised electrons that would allow electrical conduction.

Question 3 A

A is correct. Delocalised electrons carry charge and can move through the various elemental carbon structures.

B and **C** are incorrect. There are no ions present in elemental carbon structures.

D is incorrect. Electrical conduction generally only occurs in solids by electron movement or in liquids by ion movement. Other charged particles are not involved in electrical conduction.

Question 4 C

C is correct. Alkenes have a C=C double bond that allows addition polymerisation to occur.

A, **B** and **D** are incorrect. These groups of compounds do not have the C=C double bond structure, which is a requisite for addition polymerisation.

Question 5 A

A is correct. The outer shell of $3s^2 3p^4$ gains two electrons to produce an ion with a double-negative charge and results in the electron configuration shown in option **A**. An almost-filled or just-filled third shell indicates that the element is non-metallic and is in period 3.

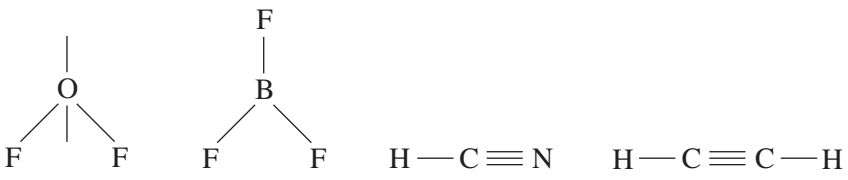
B is incorrect. This option is the transition metal chromium.

C is incorrect. Gain of electrons to form an ion usually involves the completion of the outer shell. The third shell in this option is still incomplete. In addition, if this was the configuration of a double-negatively charged ion, the parent atom would be magnesium, a metallic element.

D is incorrect. This option is the transition metal zinc.

Question 6 A

A is correct. OF_2 is V-shaped. The structures of each molecule are shown below.



V-shaped trigonal planar linear linear

B, **C** and **D** are incorrect. These options do not give the correct shapes of the molecules.

Question 7 C

C is correct. The structure is similar to the structure of diamond, a giant, three-dimensional covalent network lattice. The compound is hard because of the covalent bonds in three dimensions, so it would be useful as an abrasive to clean metal surfaces and remove rust.

A is incorrect. A plasticiser is a small molecule that fits between polymer chains. The compound is not a small molecule.

B is incorrect. The raw material for polymer production is crude oil, which is a mixture of mainly hydrocarbons of various chain lengths.

D is incorrect. Fuel usually contains carbon and hydrogen with or without oxygen.

Question 8 D

$n(\text{O}) = 9 \times n(\text{CuSO}_4.5\text{H}_2\text{O}) = 9 \times 2.0 = 18 \text{ mol}$

$\text{N(O atoms)} = n \times N_\text{A} = 18 \times 6.02 \times 10^{23} = 1.1 \times 10^{25} \text{ atoms}$

Question 9 A

A is correct. Phosphorus is a group 15 element, so it has five outer-shell electrons. Fluorine is in group 17, so it has seven outer-shell electrons. Each fluorine atom will share one electron to obtain a share of an outer-shell octet of electrons. Each phosphorus atom will share three electrons to obtain this outer-shell octet of electrons.

B, **C** and **D** are incorrect. Structure II does not show the five outer-shell electrons of phosphorus, and structure III incorrectly shows six outer-shell electrons for phosphorus.

Question 10 C

C is correct. Cross-linking uses covalent bonds, which require a large amount of heat to disrupt. Therefore, high temperatures can be tolerated without change to the structure of a polymer.

A is incorrect. All polymers will burn at high temperatures.

B is incorrect. As thermosetting polymers have cross-linking with covalent bonds, it is difficult to recycle them, unlike thermoplastics, which will melt at low temperatures.

D is incorrect. Thermoplastics have dispersion forces between the chains, whereas thermosetting polymers have covalent bonds between the chains.

Question 11 B

B is correct. The more electronegative atom will develop a small negative charge. As the molecule can be depicted as a dipole with distinct positive and negative ends, nitrogen is the negative end of the molecule.

A is incorrect. Ammonia is a highly polar molecule because there is a large difference between the electronegativity values of the atoms in the molecule and the molecule can be depicted as a dipole.

C is incorrect. The arrangement of the electron pairs is tetrahedral, but the bonding pairs give the shape of the molecule and are arranged in a pyramidal shape.

D is incorrect. The molecule has three bonding electron pairs and one non-bonding electron pair.

Question 12 B

B is correct. Statement I is correct as evidence is presented in the graph that the density of ice is lower than the density of liquid water, so ice will float on water. Statement III is correct as the density of water at 95°C is lower than the density of water at 25°C, so the warmer water will float on the colder water.

A, **C** and **D** are incorrect. Statement II is incorrect as heating ice to 0°C results in a sudden increase in density, which then decreases with further heating. This is not typical of the outcomes of heating other solids.

Question 13 B

B is correct. The water molecules in ice are held apart in an open structure by hydrogen bonding, so the density of ice is lower than the density of liquid water.

A, **C** and **D** are incorrect. These bonding types are not responsible for the open structure of ice.

Question 14 D

D is correct. Oxygen is more electronegative than carbon, so it develops a small negative charge while carbon develops a small positive charge. Even though the covalent bonds in a carbon dioxide (CO_2) molecule are polar, the molecule has no overall polarity because it cannot be represented as a dipole since it has no distinct positive and negative ends.

A and **B** are incorrect. Both molecules are non-polar.

C is incorrect. Many linear molecules are polar, such as hydrogen fluoride (HF) and hydrogen choride (HCl).

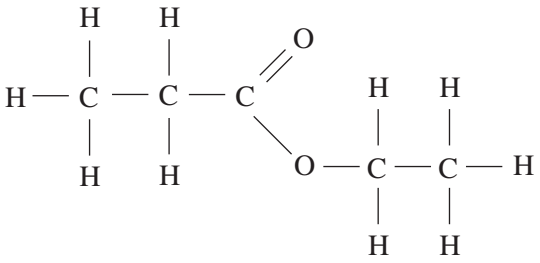
Question 15 B

B is correct. More reactive metals require greater application of energy or chemical means to isolate them from their ores than less reactive metals. Metal Q requires no intervention, so it is the least reactive metal. Metal Z requires the application of heat only, whereas metal X requires chemical reaction with carbon or its derivatives as well as strong heat. Metal Z is, therefore, less reactive than metal X. Metal Y is the most reactive metal as it can only be isolated from its ore by melting and using electrical means.

A, **C** and **D** are incorrect. These options do not give the correct order of increasing reactivity of the metals.

Question 16 A

A is correct. In naming an ester, the alcohol component is named first with the ‘yl’ ending. The acid part is named second with the ‘oate’ ending. The named ester therefore has a 2-carbon alcohol chain (ethyl) and a 3-carbon acid chain (propan). The correct structure of the ester is shown below.



B and **C** are incorrect. These options show the wrong carbon chains.

D is incorrect. This option does not show the required two oxygen atoms.

Question 17 C

C is correct. As the red-hot copper was allowed to cool slowly, larger crystals would form in piece 2.

A is incorrect. Heating to red hot destroys the crystal structure but cooling regenerates crystals in certain materials such as copper.

B and **D** are incorrect. Rapid cooling generates small crystals.

Question 18 D

D is correct. Most transition elements are hard and have high melting points, whereas the main group metals typically have much lower melting points and varying degrees of softness.

A is incorrect. Transition metals have properties directly opposite to these properties.

B is incorrect. Nickel, iron and cobalt are magnetic and so this property is not typical of most transition metals.

C is incorrect. All metals are ductile (able to be drawn into wires) to some extent.

Question 19 B

B is correct. Strength of the transition metal was needed to ensure the cutlery maintained its shape, and the lustre of silver was attractive and protective.

A is incorrect. The malleability of the transition metal was used for the application, but the strength of silver was not used for cutlery.

C and **D** are incorrect. These properties were not relevant for cutlery making.

Question 20 D

D is correct. For a given volume, nanoparticles have vastly more atoms at the surface than the equivalent bulk sample of the metal. Thus, the reaction with oxygen occurs more quickly for nanoparticles than would happen otherwise.

A is incorrect. This is a correct statement but it does not explain why pure silver nanoparticles are difficult to obtain.

B is incorrect. Silver nanoparticles are more reactive than silver.

C is incorrect. Silver has low reactivity in bulk form.

SECTION B

Question 1 (13 marks)

a. **i.** Millions of years ago, marine animals and plants died and settled at the bottom of the ocean. 1 mark

Sediments covered these dead organisms over time and they broke down to simpler compounds. 1 mark

Deposits of liquid carbon compounds were trapped between layers of rock under great pressure. 1 mark

ii. $C_{16}H_{34} \rightarrow C_7H_{16} + 3C_2H_4 + C_3H_6$ 3 marks

1 mark for using the correct formula of $C_{16}H_{34}$.
1 mark for using the correct formula of C_7H_{16}.
1 mark for using the correct formula of C_3H_6.
Note: Deduct 1 mark if $3C_2H_4$ is not shown.

b. **i.** alkanols **OR** alcohols 1 mark

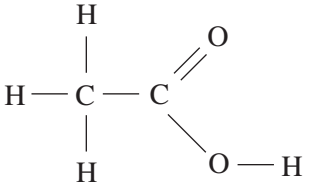
ii. $C_9H_{19}OH$ **OR** $C_9H_{20}O$ 1 mark

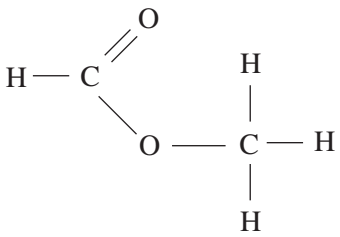
c. The hydrocarbon component of carboxylic acids is non-polar, so dispersion forces are the intermolecular bonds. 1 mark

As the number of atoms in the hydrocarbon component increases, so does the intensity of the dispersion forces. These stronger forces require a higher temperature for their disruption to allow boiling to occur. 1 mark

d. **i.** 1,1,2-trichloroethane 1 mark

ii. *For example, any one of:*





1 mark

iii. $\%O = \dfrac{m(O)}{m(\text{compound})} \times 100 = \dfrac{2 \times 16.0}{60.0} \times 100 = 53.3\%$ 1 mark

Question 2 (10 marks)

a. **i.** Mg 1 mark

ii. Ar 1 mark

b. $1s^2 2s^2 2p^6$ 1 mark

c. **i.** Argon is a noble gas with eight outer-shell electrons. 1 mark

As reactions usually occur so that the reactants obtain an octet of outer-shell electrons by transferring or sharing electrons, no reaction will occur with the unreactive gas argon. 1 mark

ii. $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$ 2 marks

1 mark for using the correct formulas of reactants and products.
1 mark for balancing and using the correct state symbols.

iii.

Result	Explanation
does not conduct electricity as a solid	**The compound is composed of cations and anions. Ions in the lattice are held so that they do not move apart, so electricity is not conducted.**
conducts electricity when dissolved in water	**Dissolving the ionic lattice allows the ions to move, so electricity is conducted.**

3 marks

1 mark for recognising the ionic structure.
1 mark for each explanation (two required).

Question 3 (9 marks)

a. Isotopes are atoms of an element that have the same number of protons but different numbers of neutrons. 1 mark

b. **i.**

	Lighter isotope	Heavier isotope
Abundance	19.9%	80.1%
Relative isotopic mass	y	$y + 0.996$

1 mark

$10.8 = 0.199y + 0.801(y + 0.996)$ 1 mark

$y = 10.0122 = 10.0$ 1 mark

ii. $^{11}_{5}B$ 1 mark

c. The elements in the periodic table are ordered according to their atomic numbers and tellurium has a lower atomic number of 52 than iodine, which has an atomic number of 53. 1 mark

Tellurium has a high abundance of heavier isotopes, which skews the weighted mean of the isotopic masses to be higher than that of iodine. 1 mark

d.

	^{58}Fe	^{58}Ni	^{59}Co	$^{60}Ni^{2+}$	$^{63}Cu^{2+}$
Atomic entity that has the largest number of electrons	26	28 ✓	27	28 – 2 = 26	29 – 2 = 27
Atomic entity that has the largest number of neutrons	32	30	32	32	34 ✓

2 marks

1 mark for each correct answer.
Note: Responses are not required to include values or calculations to obtain full marks.

Question 4 (8 marks)

a. $m(Cl) = 2.397 - 1.785 = 0.612$ g 1 mark

$$n(\text{Pb}) : n(\text{Cl}) = \frac{1.785}{207.2} : \frac{0.612}{35.5} = 0.0086 : 0.0172 = 1 : 1.99$$ 1 mark

The empirical formula of lead chloride is $PbCl_2$. 1 mark

b. This method relies on all the lead from the lead chloride being removed so that its mass can be determined accurately. Having excess aluminium powder ensures that all the lead ions have been converted to lead atoms. 1 mark

c. If the unreacted aluminium was not removed, the mass of the lead would have been apparently higher as some aluminium would be present. 1 mark

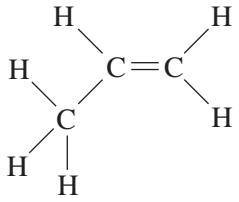
The mass of chlorine in the compound would have been calculated as being lower, so the calculated empirical formula of the compound would be incorrect. 1 mark

d. Lead chloride consists of a lattice of lead ions and chloride ions held to each other by ionic bonding. 1 mark

This strong bonding must be disrupted for the lattice to melt, and this will only occur when sufficient heat is provided for the ions to break away. 1 mark

Question 5 (10 marks)

a.



1 mark

b. $M(\text{propene}) = 42 \text{ g mol}^{-1}$

$290\,000 = 42x$ 1 mark

$x = 6905$ monomers 1 mark

c. Bonding between the non-polar polymer chains is by dispersion forces only. 1 mark

These relatively weak forces are overcome as the polymer is heated, allowing it to soften and melt. 1 mark

d. *For example, any one of:*

- High-density polypropene (HDPP) will have a higher melting point than low-density polypropene (LDPP). 1 mark

  The more open structure of LDPP, due to the branching of the molecules, 1 mark
  weakens the dispersion forces between the chains leading to a lower melting temperature. 1 mark

- HDPP will be less transparent/more opaque than LDPP. 1 mark

  The more closely packed arrangement of the linear molecules in HDPP produces crystalline regions in the polymer, 1 mark
  which prevent the transmission of light, making it opaque. 1 mark

e. **i.** *For example:*

The recycling of polymers reduces the use of fossil fuels to make propene. 1 mark

ii. *For example:*

Polypropene, like other synthetic polymers, is non-biodegradable, so it may accumulate in landfill. 1 mark

