VCE CHEMISTRY 2013

YEAR 11 **PRACTICE** EXAM UNIT 1

Time allowed: 150 minutes
Total marks: 120 marks

Section A
Contains 30 Multiple Choice Questions
30 marks, 39 minutes

Section B
Contains 13 Short Answer Questions
90 marks, 111 minutes

To download the Chemistry Data Book please visit the VCAA website:
http://www.vcaa.vic.edu.au/Documents/exams/chemistry/2012/2012chem1-w.pdf *Page 28*

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Student Name....……..... .....

VCE Chemistry 2013 Year 11 Practice Exam Unit 1

Student Answer Sheet

Instructions for completing test. Use only a 2B pencil. If you make a mistake erase and enter the correct answer. Marks will not be deducted for incorrect answers.

Write your answers to the Short Answer Section in the space provided directly below the question. There are 30 Multiple Choice questions to be answered by circling the correct letter in the table below.

Question 1	A	B	C	D	*Question 2*	A	B	C	D
Question 3	A	B	C	D	*Question 4*	A	B	C	D
Question 5	A	B	C	D	*Question 6*	A	B	C	D
Question 7	A	B	C	D	*Question 8*	A	B	C	D
Question 9	A	B	C	D	*Question 10*	A	B	C	D
Question 11	A	B	C	D	*Question 12*	A	B	C	D
Question 13	A	B	C	D	*Question 14*	A	B	C	D
Question 15	A	B	C	D	*Question 16*	A	B	C	D
Question 17	A	B	C	D	*Question 18*	A	B	C	D
Question 19	A	B	C	D	*Question 20*	A	B	C	D
Question 21	A	B	C	D	*Question 22*	A	B	C	D
Question 23	A	B	C	D	*Question 24*	A	B	C	D
Question 25	A	B	C	D	*Question 26*	A	B	C	D
Question 27	A	B	C	D	*Question 28*	A	B	C	D
Question 29	A	B	C	D	*Question 30*	A	B	C	D

VCE Chemistry 2013 Year 11 Practice Exam Unit 1

SECTION A - Multiple Choice Questions

(30 marks, 39 minutes)

This section contains 30 multiple choice questions.
For each question choose the response that is correct or best answers the question.
Indicate your answer on the answer sheet provided.
*(Choose only **one** answer for each question.)*

Questions 1 & 2 refer to the following information.
An atom of an element has the following ground state electronic configuration:

$$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$$

Question 1
To what period and group of the Periodic Table does this element belong?
A. Period 4 and Group 4.
B. Period 2 and Group 2.
C. Period 2 and Group 4.
D. Period 4 and Group 2.

Question 2
Which one of the following statements would describe the properties of this element?
A. The element would not conduct electricity in the solid state, be moderately reactive and would have a low electronegativity.
B. The element would conduct electricity in the solid state, be moderately reactive and would have a low electronegativity.
C. The element would not conduct electricity in the solid state, be unreactive and would have a low electronegativity.
D. The element would conduct electricity in the solid state, be moderately reactive and would have a high electronegativity.

Question 3
An atom of an element contains 16 electrons. What would be the ground state electronic configuration for an ion of this atom that had a -2 charge?
A. $1s^2 2s^2 2p^4 3s^2 3p^6 4s^2$.
B. $1s^2 2s^2 2p^6 3s^2 3p^2$.
C. $1s^2 2s^2 2p^6 3s^2 3p^4$.
D. $1s^2 2s^2 2p^6 3s^2 3p^6$.

Question 4

Element X forms an X^{2+} ion that contains 18 electrons. Which one of the following would represent an isotope for element X?

A. $^{40}_{18}X$

B. $^{42}_{20}X$

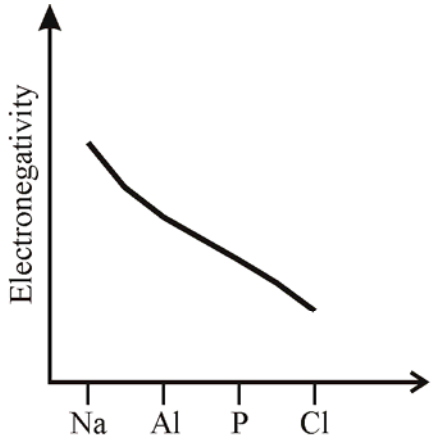
C. $^{38}_{16}X$

D. $^{20}_{20}X$

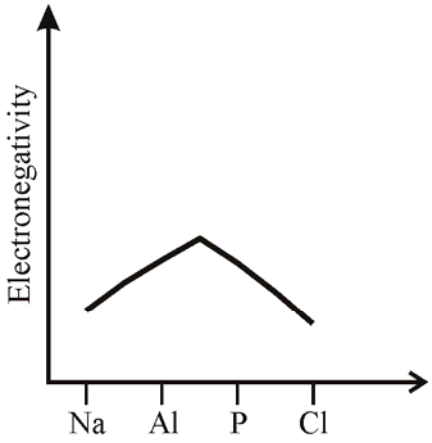
Question 5

The graph that would best describe how the electronegativity changes moving across period 3 of the Periodic Table would be

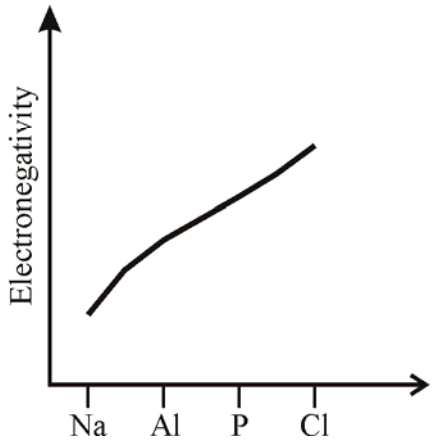
A.



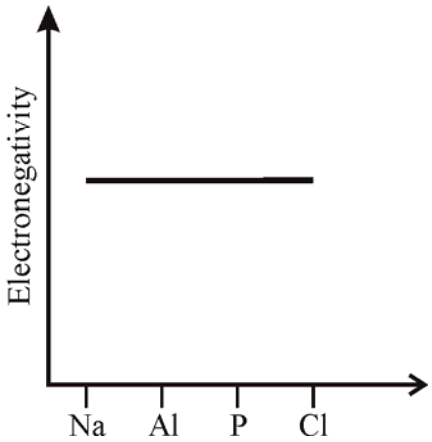
B.



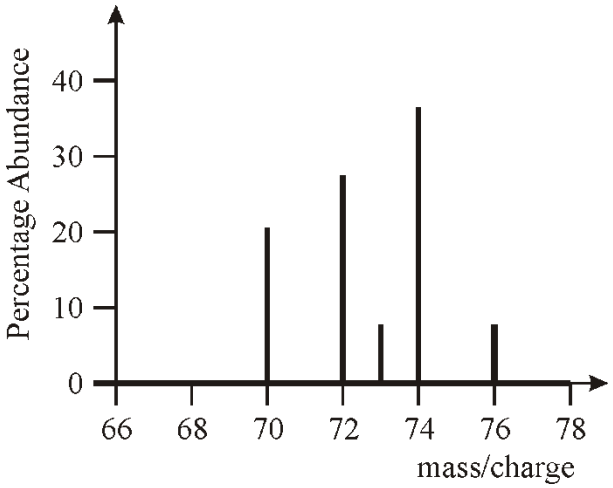
C.



D.



Question 6
The mass spectrum for a naturally occurring sample of germanium is shown.



In this sample of germanium
A. the most abundant of the five isotopes corresponds to ^{72}Ge.
B. the ^{76}Ge isotope is more abundant than the ^{70}Ge isotope.
C. the ^{74}Ge isotope will be deflected more by the magnetic field than the ^{76}Ge isotope.
D. the ^{72}Ge isotope is the second most abundant of the five isotopes.

Question 7
J. J. Thompson's 1897 model of the atom was based on the latest experimental evidence that
A. atoms contained positively and negatively charged particles.
B. atoms contained negatively charged particles orbiting the nucleus of the atom.
C. atoms contained positively charged particles concentrated in the core or nucleus of the atom.
D. most of the mass of the atom is located in the nucleus.

Question 8
The elemental analysis of a solid found that it contained carbon, hydrogen and oxygen in the percentages by mass of 40.7 %, 5.12 % and 54.2 % respectively. The empirical formula for this compound is
A. $C_3H_5O_3$.
B. CHO.
C. $C_4H_3O_4$.
D. $C_2H_3O_2$.

Question 9
0.0130 mol of an alkane had a mass of 2.21 g. The molecular formula for this alkane is
A. $C_{14}H_{28}$.
B. $C_{12}H_{26}$.
C. $C_{12}H_{28}$.
D. $C_{10}H_{22}$.

Question 10
2.0 mol of ethane, C_2H_6, contains
A. 1.2×10^{24} carbon atoms.
B. 3.6×10^{24} hydrogen atoms.
C. 7.2×10^{24} hydrogen atoms.
D. 9.6×10^{24} carbon atoms.

Question 11
When 3.156 g of cerium, Ce, reacts with excess oxygen, an oxide with a mass of 3.697 g is formed. The empirical formula for the oxide formed is
A. Ce_2O_3.
B. CeO.
C. Ce_3O_2.
D. CeO_2.

Question 12
The ionic bonding model has difficulty in explaining why
A. solid aluminium oxide will not conduct an electric current.
B. concentrated aqueous solutions of potassium chloride will be moderate conductors of an electric current.
C. the melting temperature for magnesium oxide is higher than that for sodium chloride.
D. sodium chloride is soluble and silver chloride is insoluble.

Question 13
In the anaesthetic halothane, which contains the molecule bromochlorotrifluoroethane, $C_2HBrClF_3$, the least polar bond, after the carbon-carbon bond, would be
A. the carbon-chlorine bond.
B. the carbon-bromine bond.
C. the carbon-hydrogen bond.
D. the carbon-fluorine bond.

Question 14
The structure for graphite is
A. a layer lattice with covalent bonding between the carbon atoms in the layer and weak interactions between the layers.
B. a network lattice where there is covalent bonding between all adjacent carbon atoms in the lattice.
C. a network lattice where there is covalent bonding between the carbon atoms in two directions and weak interactions in the third direction.
D. a layer lattice with covalent bonding between layers of atoms and weak interactions between the carbon atoms within the layers.

Question 15
The melting temperature of sodium chloride is 801 ºC whereas the melting temperature for hydrogen chloride is -114 ºC. The best explanation for this observation is that
A. sodium chloride has a higher molar mass than hydrogen chloride.
B. the electrostatic forces between the sodium and chloride ions are significantly stronger than the intermolecular forces in hydrogen chloride.
C. the electrostatic forces between the sodium and chloride ions are significantly stronger than those between the hydrogen and chloride ions.
D. the bonding between the hydrogen and chlorine in hydrogen chloride is significantly weaker compared to the bonding between the sodium and chlorine in sodium chloride.

Question 16
In an aqueous solution of copper(II) sulfate, what is the main type of bonding interaction between the sulfate ions and the water molecules ?
A. Dipole-dipole interactions.
B. Hydrogen bonding.
C. Ion-dipole interactions.
D. Ionic bonding.

Question 17
Which one of the following molecular formulae would be that for an alkane?
A. C_6H_6
B. C_6H_{10}
C. C_6H_{12}
D. C_6H_{14}

Question 18
The systematic name for the hydrocarbon represented by the semi-structural formula; CH_3-CH=CH-CH_2-CH_3, is
A. Pent-3-ene.
B. Pent-1-ene.
C. Pent-2-ene.
D. Pent-2-ane.

Question 19
Isomers are
A. molecules with the same empirical formula but different arrangements of the atoms in the molecule.
B. molecules with the same molecular formula but different arrangements of the atoms in the molecule.
C. molecules with the same empirical formula but different molecular formulae.
D. molecules that contain atoms that have the same atomic number but different mass numbers.

Question 20
A straight chain alkane will **not**
A. burn in the presence of excess oxygen to form carbon dioxide and water.
B. undergo an addition reaction with bromine to form a dibromoalkane.
C. be a member of a homologous series with the general formula C_nH_{2n+2}.
D. undergo a chemical reaction with chlorine in the presence of ultraviolet light to form a chloroalkane.

Question 21
A horticulturist intended to use a water soluble fungicide on a plant with waxy leaves. In order to achieve an effective coverage of the product on the leaves, the horticulturist needs to
A. dissolve the fungicide in water.
B. add a surfactant to a solution of the fungicide dissolved in a hydrocarbon solvent.
C. dissolve the fungicide in a hydrocarbon solvent.
D. add a surfactant to an aqueous solution of the fungicide.

Question 22
When a water droplet is placed on the surface of a clean polyethene slide it does not spread out. This is due to

A. the interactions formed between the water and the polyethene surface being stronger than the hydrogen bonds between the water molecules.
B. the hydrogen bonds formed between the water and the polyethene surface being stronger than the hydrogen bonds between the water molecules.
C. the interactions formed between the water and the polyethene surface being weaker than the hydrogen bonds between the water molecules.
D. the hydrogen bonds formed between the water and the polyethene surface being weaker than the hydrogen bonds between the water molecules.

Question 23
Compared with the surface tension of pure water, what would be the surface tension of an aqueous solution containing a small quantity of an anionic surfactant?

A. The surface tension of the solution would be the same.
B. The surface tension of the solution would be higher.
C. The surface tension of the solution would be lower
D. The surface tension of the solution could be higher or lower as it depends on the surface tension of the surfactant.

Question 24
One of the main reasons why nanoparticles are useful as catalysts is because

A. molecules readily 'stick' to their surfaces.
B. they have a high surface area to volume ratio.
C. they allow reactants to bind readily to their surfaces.
D. they have a low surface area to volume ratio.

Question 25
Compared to a polyethene sample with no branching on the polymer chain, a polyethene sample with a significant degree of chain branching would have

A. a slightly higher density and be softer.
B. a slightly lower density and be less flexible.
C. a slightly lower density and be softer.
D. a slightly higher density and be less flexible.

Question 26
What structural characteristics do the monomers used to produce addition polymers require?

A. The must be a hydrocarbon.
B. They must contain oxygen and hydrogen atoms that can form water which is released when the polymer forms.
C. They must have a low molecular mass.
D. They must contain a carbon-carbon double bond.

Question 27
When a polymeric material undergoes cross-linking it will

A. become more rigid and brittle.
B. be easier to soften and mould.
C. be more easily reshaped when moderate heat is applied.
D. be more flexible and elastic.

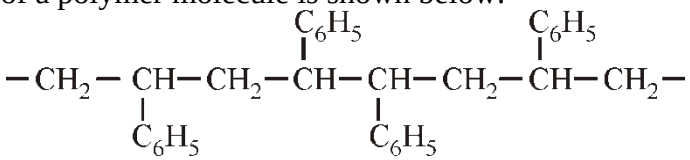
Question 28
The shape of a molecular species is determined mainly by
A. all of the electrons in the atoms present in the molecule.
B. the non-bonding electrons in the atoms present in the molecule.
C. both the bonding and non-bonding electrons in the atoms present in the molecule.
D. the bonding electrons in the atoms present in the molecule.

Question 29
The surface energies for some liquids are shown in the table below.

Liquid	**Surface Energy at 25 ºC (mJ m^{-2})**
Methanol	23
Heptane	20
Benzene	29

In which material is the strength of the forces between the particles at the surface the weakest?
A. Heptane, because it has the lowest value for the surface energy, and this is a measure of how much energy is released when the surface area of the material is increased.
B. Benzene, because it has the highest value for the surface energy, and this is a measure of how much energy is released when the surface area of the material is increased.
C. Benzene, because it has the highest value for the surface energy, and this is a measure of how much energy is required to increase the surface area of the material.
D. Heptane, because it has the lowest value for the surface energy, and this is a measure of how much energy is required to increase the surface area of the material.

Question 30
Part of the structure of a polymer molecule is shown below:



The semi-structural formula for the monomer used to produce this polymer would be
A. CH_3-CH_2-C_6H_5.
B. CH_2=CH-C_6H_5.
C. CH_3-CH=C_6H_5.
D. CH_2=CH(C_6H_5)-CH(C_6H_5)=CH_2.

End of Section A

VCE Chemistry 2013 Year 11 Practice Exam Unit 1

SECTION B - Short Answer Questions

(90 marks, 111 minutes)

This section contains thirteen questions, numbered 1 to 13.
All questions should be answered in the spaces provided.
The mark allocation and approximate time that should be spent on each question are given.

Question 1 (10 marks, 13 minutes)

a. Magnesium and chlorine are both located in the third period of the Periodic Table.

i. Write the ground-state electronic configurations for both of these elements.

Magnesium:

Chlorine:

(1 mark)

ii. How would the atomic radius for chlorine compare with that for magnesium?

(1 mark)

iii. The electronegativity for chlorine is 3.2. How would the electronegativity for magnesium compare with this value?

(1 mark)

iv. What would be the empirical formula for the compound that forms when chlorine and magnesium react?

(1 mark)

v. What type of bonding would be present in the compound that forms when magnesium reacts with chlorine?

(1 mark)

b. When Mendeleev drew up his Periodic Table, gallium had not yet been discovered, however he was able to predict the chemical and physical properties for this element. Use your knowledge about the trends in the Periodic Table to complete the following table for element 120, which would be given the symbol Ubn when it is made.

Element	**Element-120 Ubn**
Group	
Period	
Ground-state valence shell electronic configuration	
Formula for oxide	
Reactivity with water compared to earlier elements in the Group.	

(5 marks)

Question 2 (6 marks, 7 minutes)
For each of the following molecules:
Draw their structures showing **all** bonding and non-bonding electron pairs.
Mark on the polarity of the bonds.
State the strongest form of intermolecular forces between the molecules.

a. Carbon dioxide, CO_2.

(2 marks)

b. Ammonia, NH_3.

(2 marks)

c. Chloromethane, CH_3Cl.

(2 marks)

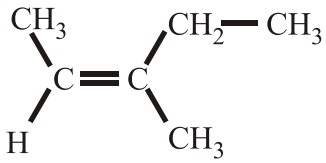
Question 3 (10 marks, 13 minutes)

a. Draw two possible structures for a compound with the molecular formula C_4H_{10} and give the systematic name for each structure.

(4 marks)

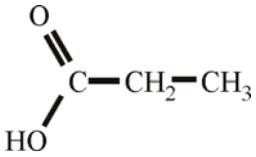
b. Give the systematic names for the following compounds

i.



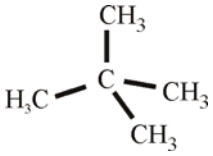
(1 mark)

ii.



(1 mark)

iii.



(1 mark)

c. What are the molecular formulae and names for the first two members of the alkene homologous series?

(2 marks)

d. The boiling points for three hydrocarbon compounds are shown in the table below.

Compound		**Boiling Point (ºC)**
Methane	CH_4	-162
Octane	C_8H_{18}	126
Dodecane	$C_{12}H_{26}$	216

What is the main type of bonding interaction between the molecules of each of these three hydrocarbons?

(1 mark)

Question 4 (5 marks, 6 minutes)

Metals have played a significant role in society for millennia.

a. Using the bonding model for metals explain the following properties that are characteristic of metals.

i. Metals will conduct an electric current.

(1 mark)

ii. Metals are ductile.

(1 mark)

iii. Metals are generally dense.

(1 mark)

b. What is one of the properties of a metallic substance that the bonding model for metals has difficulty in explaining?

(1 mark)

c. Most of the metals that are used extensively in society are alloys. What is the requirement of the material added to a metal to form an interstitial alloy?

(1 mark)

Question 5 (9 marks, 11 minutes)

a. When metal oxides are treated with hydrogen they can be converted to the metal and water. 5.622 g of water was formed when a 17.85 g sample of a manganese oxide was treated with hydrogen.

i. What mass of oxygen is present in the water formed?

(2 marks)

ii. Determine the empirical formula for the manganese oxide.

(3 marks)

b. Ammonium iron(II) sulfate is a crystalline solid with the formula $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$.

i. Determine the percentage by mass of water in this compound.

(2 marks)

ii. A group of VCE chemistry students heated a 4.674 g sample of this compound to constant mass in a crucible. Their results showed that the mass of solid remaining at the end of this process was 1.812 g. Did the heating process completely dehydrate the sample or did other decomposition reactions occur?

(2 marks)

Question 6 (10 marks, 13 minutes)

a. Draw structures for the following molecules showing **all** bonding and non-bonding electron pairs.

i. Ammonia, NH_3.

(1 mark)

ii. Methanal, H_2CO.

(1 mark)

b. Silicon carbide, SiC, is a very hard solid that has a melting temperature of 2200 ºC and sublimes at temperatures above this under normal pressures.

i. What type of bonding would be present in solid silicon carbide that could explain these properties?

(1 mark)

ii. Predict the electrical conductivity of solid silicon carbide giving the reasoning for the choice.

(1 mark)

c. Complete the table below for the two particles given.

	$^{41}_{19}X$	$^{27}_{13}Z^{3+}$
Number of protons in the nucleus		
Number of neutrons in the nucleus		
Ground state electronic configuration of the particle		
Group that the element belongs to		
Period that the element belongs to		

(6 marks)

Question 7 (5 marks, 6 minutes)

a. An ice cream container has a recycling symbol that identifies that it is made from polypropene.

i. Write the semi-structural formula for the monomer that would be used to produce this polymer.

(1 mark)

ii. What type of chemical reaction occurs during the production of polypropene from its monomer?

(1 mark)

iii. Draw the part of the structure for a polypropene molecule.

(1 mark)

b. Polymeric materials can be grouped into one of two classes, thermoplastics or thermosetting plastics.

i. What is the important structural difference between these two types of polymeric materials?

(1 mark)

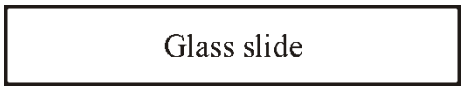
ii. What is the difference in the behaviour of these two classes of polymeric materials when they are heated?

(1 mark)

Question 8 (7 marks, 9 minutes)

a. A water droplet is placed on the surface of a clean glass slide.

i. Draw a diagram to show how this water droplet would behave.



(1 mark)

ii. Briefly explain why this behaviour occurs.

(1 mark)

iii. What is the single word term that can be used to describe the properties of the glass surface with regards to how it interacts with water?

(1 mark)

b. i. Place the following four liquids, at room temperature, in order of **increasing** surface energy.

Ethanol Mercury Hexane Water

(1 mark)

ii. What is the key factor that has to be considered when determining the relative surface energies of these liquids?

(1 mark)

c. i. A suspension of silver nanoparticles in water had a bright yellow colour compared to the silver colouration of a piece of silver metal. Give a reason why there is this difference in colour for the same element.

(1 mark)

ii. Silver metal is an active catalyst for certain chemical reaction. When the suspension of the silver nanoparticles was used, the rate at which the product formed was greatly increased over that obtained using pieces of silver wire. Give one reason why this would occur.

(1 mark)

Question 9 (6 marks, 7 minutes)

a. The data from the mass spectrum of an element are shown below.

Relative Isotopic Mass	Relative Abundance (%)
23.99	78.70
24.99	10.13
25.98	11.17

Calculate the relative atomic mass for this element.

(2 marks)

b. A 38.59 g sample of lithium sulfate, Li_2SO_4, was placed in a container.

i. What amount of lithium sulfate is present in the container?

(2 marks)

ii. What is the total number of ions that would be present in this sample?

(2 marks)

Question 10 (6 marks, 7 minutes)

Two hydrocarbon gases of significant importance in society are propane and propene.

a. Write an appropriate chemical equation for the complete combustion of propane at SLC.

(1 mark)

b. When propene is bubbled through a solution of bromine, it reacts changing the colour of the solution, however when propane is bubbled through the bromine solution, no reaction occurs.

i. Write an appropriate chemical equation for the reaction between bromine and propene.

(1 mark)

ii. Draw the structure for the compound produced in this reaction.

(1 mark)

iii. Why does the propene react while the propane does not react?

(1 mark)

iv. What type of chemical reaction process occurs when the propene reacts with the bromine?

(1 mark)

v. State another substance that propene will react with in a similar manner.

(1 mark)

Question 11 (5 marks, 6 minutes)

a. Draw an electron transfer diagram to show what occurs at the electronic level when magnesium reacts with chlorine to form magnesium chloride.

(2 marks)

b. State the chemical formulae for the following ionic compounds.

i. Barium oxide.

(1 mark)

ii. Ammonium carbonate.

(1 mark)

iii. Chromium(III) sulfate.

(1 mark)

Question 12 (5 marks, 6 minutes)
One of the early contributors to atomic theory was John Dalton. The following are some of the concepts that Dalton proposed. For each of these write a comment stating how they are either supported or refuted by our current understanding of atomic theory.

a. All matter consists of indivisible atoms.

(1 mark)

b. Atoms of a particular element are identical in weight and have identical properties.

(2 marks)

c. Atoms are neither created nor destroyed in reactions.

(2 marks)

Question 13 (6 marks, 7 minutes)

a. Using the ionic bonding model, explain the following observations regarding the physical properties of ionic compounds.

i. Ionic compounds tend to have moderate to high melting temperatures.

(1 mark)

ii. Solid ionic compounds tend to be hard but brittle.

(1 mark)

b. Complete the following table with regards to the properties of substances which exhibit covalent bonding.

Property	Discrete Covalent Molecules	Covalent Network Lattices
Melting Temperature		
Hardness		

(4 marks)

End of Section B

End of Practice Exam

Suggested Answers

VCE Chemistry 2013 Year 11 Practice Exam Unit 1

SECTION A - Multiple Choice Questions

(1 mark per question)

Q1 **D** The element has the ground state electronic configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$. Since four shells are occupied then this is a **Period 4** element. The number of electrons in the outer (valence) shell is 2, therefore this element is in **Group 2**. The element is calcium, which can be located in the Periodic Table.

Q2 **B** Since the element is in Group 2 it will be a metal, therefore it **will conduct an electric current in the solid state**. Group 2 elements are reactive as they can readily loose two electrons to form ionic compounds. Elements on the left-hand side of the Periodic Table have **low electronegativities**, as the electronegativity is a measure of an atom's ability to attract electrons, and as these atoms readily lose electrons therefore they will have a low electronegativity.

Q3 **D** The neutral atom of the element contains 16 electrons. A –2 ion means that an additional two electrons have been gained, therefore the ion contains 18 electrons.
The first shell can hold a maximum of 2 electrons.
The second shell can hold a maximum of 8 electrons.
The third shell can hold a maximum of 18 electrons.
When assigning electrons to shells, a shell is filled or has eight electrons placed in it before electrons are placed in the next shell.
Therefore: **$1s^2 2s^2 2p^6 3s^2 3p^6$.**

Q4 **B** The X^{2+} ion has 18 electrons, therefore the neutral atom X has 20 electrons. In neutral atoms the number of electrons is equal to the number of protons therefore the atomic number of X is 20 therefore $_{20}\mathbf{X}$. Only responses B and D fulfil this criterion. Response D, $^{20}_{20}X$, has a mass number of 20, therefore the nucleus will only contain 20 protons. This would be unstable due to the electrostatic repulsion between the protons, hence this response is not viable. Response B, $^{42}_{20}X$, has a mass number of 42 indicating 22 neutrons in addition to the 20 protons in the nucleus. (The only stable atom containing only protons in the nucleus is $^{1}_{1}H$.)

Q5 **C** The electronegativity is a measure of an element's ability to attract electrons. Moving across the period, the electronegativity increases because the effective nuclear charge experienced by electrons being attracted into the outer or valence shell increases.

Q6 **D** The mass spectrum shows that germanium has five isotopes, the most abundant being ^{74}Ge and the least abundant either ^{73}Ge or ^{76}Ge. The ^{72}Ge isotope is the second most abundant. In a mass spectrometer the ion with the highest mass to charge ratio will be deflected the most by the magnetic field.

Q7 **A** The Thompson model, commonly referred to as the 'plum pudding' model had the atom consisting of positive and negative particles.
Later work by Rutherford showed that the nucleus had a positive charge and that most of the mass of the atom was located in this nucleus.

Q8 **D** The empirical formula for a compound is the lowest whole number mole ratio of the atoms of the elements present in the compound. Assuming 100 g then the mass of each element is numerically equivalent to the percentage.
$n(X) = m(X)/M(X)$

$$n(C) : n(H) : n(O) = \frac{m(C)}{M(C)} : \frac{m(H)}{M(H)} : \frac{m(O)}{M(O)} = \frac{40.7}{12.0} : \frac{5.12}{1.0} : \frac{54.2}{16.0}$$

$= 3.39 : 5.12 : 3.39$ divide all values by smaller value.
$= 1.0 : 1.5 : 1.0$ multiply by 2 to remove 1.5 value
$= 2 : 3 : 2$ $C_2H_3O_2$

Q9 **B** Alkanes have the general formulae C_nH_{2n+2}.

$$M(C_nH_{2n+2}) = \frac{m}{n} = \frac{2.21}{0.0130} = 170 \text{ g mol}^{-1}$$

$M(C_nH_{2n+2}) = n\times12.0 + (2n + 2)\times1.0 = 14n + 2$
$14n + 2 = 170 \Rightarrow 14n = 168 \Rightarrow n = 12$
$C_{12}H_{26}$ ($M(C_{12}H_{26}) = 12\times12.0 + 26\times1.0 = 170.0$ g mol^{-1})

Q10 **C** Each ethane molecule, C_2H_6, contains two carbon atoms and six hydrogen atoms.
Therefore for 2.0 mol of C_2H_6
$n(C) = 2 \times n(C_2H_6) = 2 \times 2.0 = 4.0$ mol
$N(C) = 4.0 \times 6.02\times10^{23} = 2.4\times10^{24}$ atoms (2 significant figures)
$n(H) = 6 \times n(C_2H_6) = 6 \times 2.0 = 12.0$ mol
N(H) $= n(H) \times N_A = 12.0 \times 6.02\times10^{23} =$ **7.2×10^{24} atoms**

Q11 **A** $m(Ce) = 3.156$ g
$m(O) = 3.697 - 3.156 = 0.541$ g
The empirical formula can be determined from the mole ratio of the elements present.
$n = m / M$ with the molar masses being the relative atomic masses for the elements.

$$n(Ce) : n(O) = \frac{3.156}{140.1} : \frac{0.541}{16.0}$$

$= 0.0225 : 0.338$ divide through by the smaller

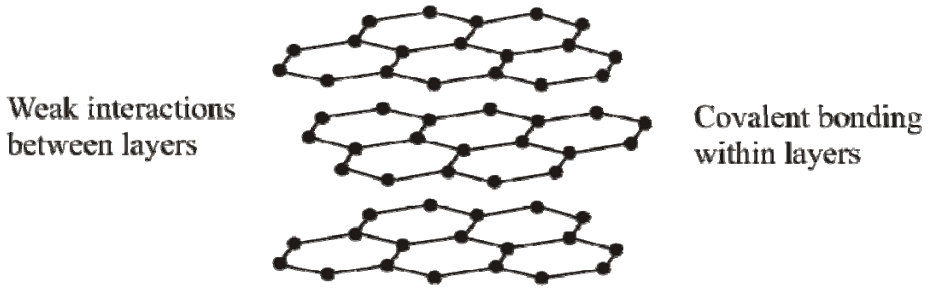
$$= \frac{0.0225}{0.0225} : \frac{0.0338}{0.0225} = 1 : 1.5$$

Empirical formulae are whole number ratios therefore;
$= 2 : 3$ **Ce_2O_3**

Q12 **D** One of the main limits to the ionic bonding model is that it cannot predict the solubilities of the various compounds. Since both sodium chloride and silver chloride contain singly charged positive and negative ions, one should expect both to have similar solubilities, because the interactions of these ions with each other and the water molecules of the solvent should be the same.

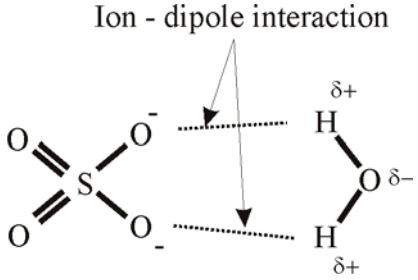
Q13 **C** The polarity of a bond in a compound is determined by the difference in electronegativities of the two elements that form the bond. Bromine, chlorine and fluorine are members of Group 17 in the periodic table and are highly electronegative, 2.8, 3.0 and 4.0 respectively. Therefore the carbon-hydrogen bond would be the least polar because hydrogen has the lowest electronegativity, 2.1, of the four elements.

Q14 A The structure for graphite is a layer lattice where each carbon atom in the layers is covalently bonded to three other carbon atoms and the fourth valence electron on each carbon atom is delocalised throughout the entire layer. Between the layers there are weak interactions, which allow the layers to readily slip over each other.

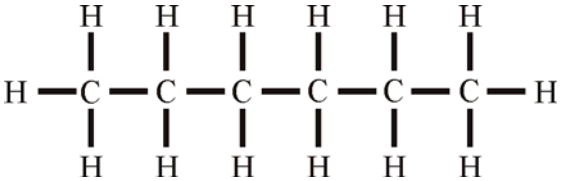


Q15 B Sodium chloride is an ionic compound, therefore its melting temperature reflects the energy required to break the ions free of their lattice. Hydrogen chloride is a covalent compound, and here the melting temperature reflects the energy required to overcome intermolecular forces between the molecules. In the case of hydrogen chloride these weak bonding interactions are dispersion forces and dipole-dipole interactions.

Q16 C The interaction between the sulfate and water molecules in solution will be ion-dipole interactions. Water molecules have a permanent dipole due to the difference in electronegativity between hydrogen and oxygen atoms. Sulfate ions are negatively charged and these will interact with the positive end of the dipole, which are the hydrogen atoms on the water molecule, as shown in the diagram below.



Q17 D Alkanes have only single carbon-carbon bonds in their structures and the homologous series has the general formula; C_nH_{2n+2}, thus C_6H_{14}.
The formula can be worked out from the structure based on a C_6 carbon atom chain as shown in the diagram below, where each carbon atom must form four bonds with other atoms.



Q18 C This is a hydrocarbon containing five carbon atoms.

1. Locate the longest carbon-carbon atom backbone chain in the structure; 5 carbon atoms in this case therefore **pent-**
2. Determine if there are any carbon-carbon atom multiple (double or triple) bonds in this backbone; in this case there is a carbon-carbon double bond, therefore **pentene.**
3. Locate the position of this double bond in the backbone. In this case it is between the second and third carbon atoms, therefore **pent-2-ene (**or 2-pentene).
4. There are no groups attached to the chain, therefore **pent-2-ene**

Q19 **B** Isomers are molecules with the **same molecular formulae** but **different structures**.
Two possible semi-structural formulae for C_2H_6O are CH_3CH_2OH and CH_3OCH_3.

Q20 **B** A straight chain alkane will have the general formula, C_nH_{2n+2} since there are no multiple carbon-carbon bonds. Alkenes will burn in excess oxygen to form carbon dioxide and water, as all hydrocarbon compounds do. Alkanes can undergo substitution reactions with chlorine in the presence of ultraviolet light, where one or more hydrogen atoms are replaced by chlorine atoms.
Alkanes do not undergo addition reactions as this type of reaction process requires a double or triple carbon-carbon bond. The molecule that reacts is added across the multiple carbon-carbon bond. This is a particular reaction for alkenes which readily react with bromine, Br_2. The bromine is added across the double carbon-carbon bond to form a dibromoalkane.

Q21 **D** The fungicide is water soluble therefore an aqueous solution of this will be used to treat the plant. Because the plant has waxy leaves an aqueous solution on its own will not effectively wet the surface of the leaves and the water will form droplets and run off. To counter this problem a surfactant can be added to the aqueous solution of the fungicide and this mixture will wet the leaves.

Q22 **C** Polyethene is non-polar and as a result the surface will display this property. Therefore there will only be weak interactions between the water molecules and the surface of the slide. This will result in the water forming droplets and not spreading out over the surface, as the water-polyethene interactions will be weaker than the hydrogen bonding between the water molecules.

Q23 **C** When a surfactant is added to water the surface tension of the resultant solution will be lower.

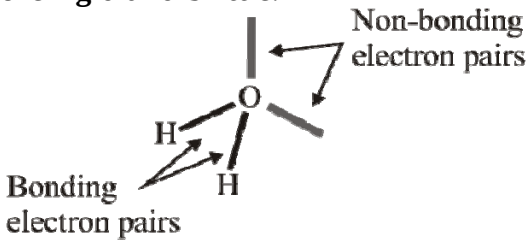
Q24 **B** Solid catalysts function by having the reactant molecules attach and react on their surfaces. The **larger the surface area of a catalyst the more sites that are available for reactions to occur at**, and hence the more efficient the catalyst. **Nanoparticles have a high surface area to volume ratio making them ideal as catalysts**.

Q25 **C** The greater the degree of branching on a polymer chain results in the polymer strands not being able to pack so closely together. Therefore a polymer with significantly branched chains would have a **lower density** compared to a polymer derived from the same monomer with little chain branching. Also this polymer would be softer and more flexible.
Low density polyethene, LDPE, is a polymer with significant chain branching and is soft and flexible, making it suitable for use in cling films and squeeze bottles. High density polyethene, HDPE, is stronger and less flexible, making it suitable for use in making buckets, containers and pipes.

Q26 **D** All monomers that form addition polymers must have a carbon-carbon double bond.
For example ethene polymerises to form polyethene
$nCH_2=CH_2 \rightarrow -(CH_2-CH_2)_n-$

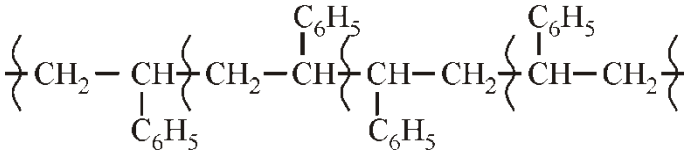
Q27 **A** **Crosslinking in polymers restricts the movement of the polymer molecules**, therefore the material will become **more rigid and brittle**.

Q28 **C** The shape of a molecule is determined by both the bonding and non-bonding electron pairs as these zones of negative charge repel each other. The water molecule has a bent shape due to the two bonding and two non-bonding electron pairs around the oxygen atom.



Q29 D The surface energy for a material is a measure of the amount of energy required to increase the surface area for that material. To increase the surface area of a material, bonds must be broken between the particles at the surface. Consequently the lower the surface energy for the material the weaker the bonding between the particles at the surface. Since heptane has the lowest value in the table, then the forces between the particles at this surface is the smallest.

Q30 B The repeat unit in this polymer, which is polystyrene, can be identified



Therefore the monomer from which this polymer is produced will contain a carbon-carbon double bond between the two carbon atoms, one of which will have a benzene, C_6H_5, ring attached to it. **CH_2=CH-C_6H_5.**

SECTION B - Short Answer (Answers)

Question 1 (10 marks, 13 minutes)

a. i. The ground-state filling order for the sub-shells is;
1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, ...
Magnesium (Z=12) **$1s^2 2s^2 2p^6 3s^2$ (½ mark)**
Chlorine (Z=17) **$1s^2 2s^2 2p^6 3s^2 3p^5$ (½ mark)**

ii. The atomic radius for chlorine would be **smaller** than that for magnesium. **(1 mark)** The trend within a period is that the atomic radii for the elements decrease moving across the period. The effective nuclear charge for an element is the number of protons in the nucleus minus the number of electrons occupying the inner shells. The effective nuclear charges for magnesium and chlorine are +2 and +7 respectively. The trend in properties occurs because while the valence shell being populated is the same, the effective nuclear charge that these electrons are experiencing is increasing, thereby exerting a stronger force of the electrons and bringing them closer to the nucleus.

iii. The electronegativity for magnesium would be **less than** that for chlorine. **(1 mark)** The trend within a period of the Periodic Table is for the electronegativity to increase moving left to right across the period. The electronegativity of an element is a measure of the element's ability to attract electrons into its valence shell. The observed trend occurs because the electrons are being attracted into the same valence shell, but the effective nuclear charge increases moving across the period.

iv. Magnesium has two valence electrons and chlorine has seven electrons. Since magnesium is a Group 2 metal and chlorine is a Group 17 non-metal, then each chlorine can accept one electron to get eight electrons in its valence shell, while each magnesium can lose two electrons to achieve eight electrons in its outer shell. The formula for the compound, magnesium chloride, will be **$MgCl_2$. (1 mark)**

v. The reaction between a metal and a non-metal will produce a compound with **ionic bonding**. **(1 mark)**

b. Using the Periodic Table, element 120 will be in the next period, Period 8, and in the same group as magnesium, Group 2. All elements in Group 2 have two electrons in their outer shells therefore an s^2 ground state electronic configuration. For Ubn the outer shell will be the eighth shell therefore $8s^2$. This group is to the left-hand side of the Periodic Table therefore Ubn will be a metal and will lose its two outer shell electrons to form the Ubn^{2+} ion when it reacts with oxygen to form its oxide. Since each oxygen atom can accept two electrons to form the O^{2-} ion, the formula for the oxide will be UbnO. Since the reaction involves the atoms losing electrons, the reactivity of the elements increases, moving down a group as the electrons involved are further from the nucleus.

Element	**Element-120 Ubn**
Group	**2 (1 mark)**
Period	**8 (1 mark)**
Ground-state valence shell electronic configuration	**$8s^2$ (1 mark)**
Formula for oxide	**UbnO (1 mark)**
Reactivity with water compared to earlier elements in the Group.	**It will be more reactive than earlier members of the same Group. (1 mark)**

Question 2 (6 marks, 7 minutes)

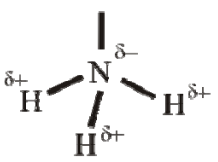
The structures for the three molecules are shown below.

a. Carbon dioxide has a linear molecular structure with two carbon-oxygen double bonds. Due to the electronegativity difference between the carbon and oxygen, the carbon-oxygen bonds are polarised, so that the oxygen atom has a small negative charge and the carbon atom a small positive charge. **(1 mark)**
Because the polar bonds are symmetrically opposite to each other, the whole molecule is non-polar, so the strongest interaction between carbon dioxide molecules will be **dispersion forces**. **(1 mark)**

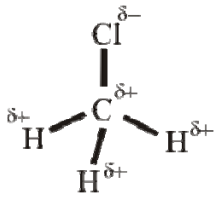
b. The structure of the ammonia molecule has a **triangular pyramidal shape** due to the non-bonding electron pair on the nitrogen atom. Each nitrogen-hydrogen single bond is polarised, with the hydrogen atoms having a slight positive charge and the nitrogen atom a slight negative charge. **(1 mark)**
The molecule has a permanent dipole and because the intermolecular interaction involves hydrogen and nitrogen atoms, the strongest intermolecular force will be **hydrogen bonding**. **(1 mark)**

c. Chloromethane has a tetrahedral structure involving four single bonds. The electronegativity differences between the carbon, hydrogen and chlorine atoms will result in the chlorine having a slight negative charge and the carbon atom and hydrogen atoms a slight positive charge. **(1 mark)**
The molecule has a permanent dipole therefore the strongest intermolecular interaction will involve **dipole-dipole interactions**. **(1 mark)**

carbon dioxide



ammonia

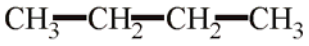


chloromethane

Question 3 (10 marks, 13 minutes)

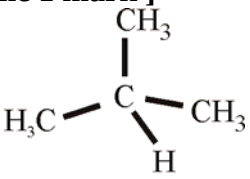
a. C_4H_{10} is butane, and there are only two possible structural isomers for this compound as shown below.

[Mark allocation: Structure 1 mark and name 1 mark]



I

I: butane



II

II: 2-methylpropane

b. i.

Locate the longest carbon atom backbone:	5	**pent-**
Bonding between carbon atoms:	one double	**-en(e)**
Location:	carbon 2	**2-**
Location of methyl group, -CH_3:	carbon 2	**2-methyl**
Systematic name:		**2-methylpent-2-ene (1 mark)**

ii.

Locate the longest carbon atom backbone:	3	**prop-**
Bonding between carbon atoms:	all single	**-an(e)**
Functional group:	–COOH	**oic acid**
Systematic name:		**propanoic acid (1 mark)**

iii.

Locate the longest carbon atom backbone:	3	**prop-**
Bonding between carbon atoms:	all single	**-an(e)**
Attached groups:	$–CH_3$ ×2	**dimethyl-**
Location of first group:	carbon 2	**2-**
Location of second group:	carbon 2	**2-**
Systematic name:		**2,2-dimethylpropane (1 mark)**

c. **Ethene, C_2H_4, (1 mark)** and **Propene, C_3H_6 (1 mark)**

The alkenes have a carbon-carbon double bond, therefore the can be no C_1 member of the series. In the homologous series the difference between sequential members is CH_2.

d. These are all alkanes and therefore the compounds are non-polar. The main type of interaction between these molecules would be **dispersion forces. (1 mark)** The boiling points increase as a result of the increasing mass of the individual molecules.

Question 4 (5 marks, 6 minutes)

a. The bonding model for a metallic substance is a relatively closely packed three-dimensional lattice of positive metal ions with the valence electrons delocalised, spread, throughout the lattice. The lattice is held together by electrostatic attraction between the positive ions and their delocalised electrons.

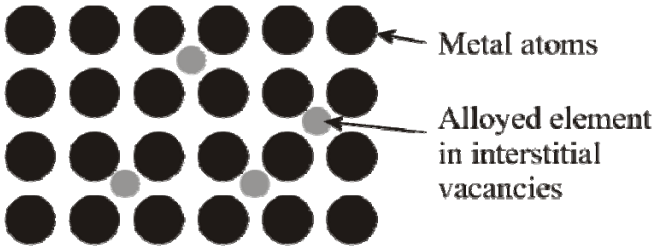
i. Because the **electrons** are very small they can move easily within the lattice while the positive metal ions remain in fixed positions. When an electric current is applied to a metal, electrons will be forced in at one end and an equal number of electrons will exit at the other thus **the current will easily pass through the metal**. **(1 mark)**

ii. Ductile means that metals can be drawn out into wires, therefore layers of metal ions must slide easily over each other. As the lattice is made up of positive ions there are no strong forces of attraction between adjacent metal ions, therefore one layer can easily slide over another. The delocalised electrons, which can move about freely, can be easily rearranged to hold the lattice together in the new position. **(1 mark)**

iii. The high density is due to the atoms being closely packed in the lattice. **(1 mark)** The density will depend on the mass of the metal atoms, their size and how they are packed in the lattice.

b. Possible alternatives include: **(1 mark)**
Magnetic properties exhibited by some metals such as iron, nickel and cobalt.
The wide range in the melting temperatures of metallic elements from mercury (-39 °) to tungsten (3410 °C)

c. For an added element to form an interstitial alloy with a metal, its **atomic radius must be smaller than that of the metal** so that it can occupy the spaces between the metal atoms in the metallic lattice. **(1 mark)**



Question 5 (9 marks, 11 minutes)

a. i. $M(H_2O) = 2\times1.0 + 16.0 = 18.0$ g mol^{-1}

$n(H_2O) = m/M = \dfrac{5.622}{18.0} = 3.12\times10^{-1}$ mole

$n(O) = n(H_2O) = 3.12\times10^{-1}$ mole **(1 mark)**

$m(O) = n\times M = 3.12\times10^{-1} \times 16.0 =$ **4.99 g (1 mark)**

ii. Let the oxide have the formula Mn_xO_y.

$m(Mn_xO_y) = 17.85$ g

$m(Mn) = m(Mn_xO_y) - m(O) = 17.85 - 4.99 = 12.9$ g **(1 mark)**

The empirical formula for a compound is the lowest whole number mole ratio of the atoms of the elements present in the compound.

$n(Mn) : n(O) = \dfrac{m(Mn)}{M(Mn)} : \dfrac{m(O)}{M(O)} = \dfrac{12.9}{54.9} : \dfrac{4.99}{16}$ **(1 mark)**

$= 0.235 : 0.312$ divide both by the smaller value

$= 1.00 : 1.33$ multiply both by 3 to remove 1.33

$= 3 : 4$ **Mn_3O_4 (1 mark)**

b. i. The percentage by mass of water in $(NH_4)_2Fe(SO_4)_2\cdot6H_2O$.

In this calculation it is better to treat water separately from the other hydrogen and oxygen atoms in the formula.

$M(H_2O) = 2\times1.0 + 16.0 = 18.0$ g mol^{-1}.

N:	2×14.0	28.0
H:	8×1.0	8.0
Fe:	1×55.9	55.9
S:	2×32.1	64.2
O:	8×16.0	128.0
H_2O:	6×18.0	108.0
M		**392.1 g mol^{-1} (1 mark)**

$\%(H_2O) = \dfrac{108.0}{392.1} \times \dfrac{100}{1}$

= **27.5 % (1 mark)**

ii. Dehydration would remove the water of crystallization from the solid. If this was the only process that occurred, then the percentage mass change would be equivalent to the percentage by mass of water in the compound. The percentage mass loss for this sample is determined as follows:

mass(loss) = mass(original sample) – mass(after heating)

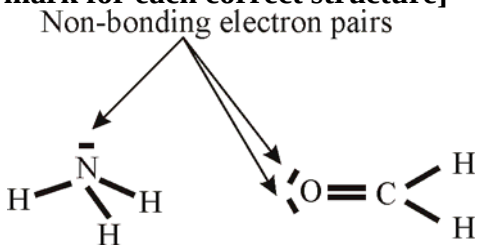
mass(loss) = 4.674 – 1.812 = 2.862 g

$\%(\text{loss}) = \dfrac{2.862}{4.674} \times \dfrac{100}{1}$ = **61.2 % (1 mark)**

Since the percentage mass loss is significantly greater than the percentage by mass of water then **processes other than just dehydration occurred.**
(1 mark)

Question 6 (10 marks, 13 minutes)

a. Structures as shown in the diagram below must show one non-bonding pair of electrons on the nitrogen atom in the ammonia structure and two non-bonding pairs of electrons on the oxygen atom in the methanal structure.
[Mark allocation: 1 mark for each correct structure]



b. i. **Covalent network lattice. (1 mark)**
Carbon and silicon are both non-metals therefore would be expected to form covalent bonds between their atoms in the compound. Because the material is hard and has a very high melting temperature the structure must be of a lattice, rather than discrete molecules. The structure of silicon carbide is similar to that for diamond, with each silicon atom bonded to four adjacent carbon atoms by single bonds, and each carbon atom is bonded to four adjacent silicon atoms.

ii. Silicon carbide would **not conduct an electric current**, because the electrons are localised in bonds between the silicon and carbon atoms and not free to move. **(1 mark)**

c. **[Mark allocation: Correct number of protons and neutrons. (1 mark)**
Correct electron configuration. (1 mark)
Correct group and period. (1 mark)
[Total 6 marks]

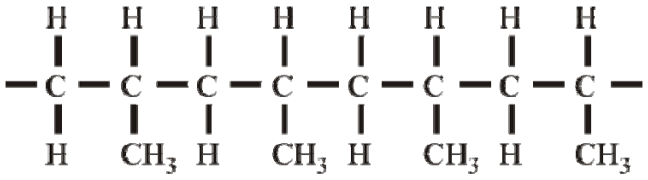
	$^{41}_{19}X$	$^{27}_{13}Z^{3+}$
Number of protons in the nucleus	Atomic number = 19 **19 protons**	Atomic number =13 **13 protons**
Number of neutrons in the nucleus	Mass number = 41 41-19 = **22 neutrons**	Mass number = 27 27-13 = **14 neutrons**
Ground state electronic configuration of the particle	Neutral particle 19 electrons **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$**	+3 particle 13-3 = 10 electrons **$1s^2 2s^2 2p^6$**
Group that the element belongs to	Element has 1 electron in outer shell **Group 1**	Element will have 3 electrons in outer shell (2, 8, 3) **Group 3**
Period that the element belongs to	The outer shell of the element is the fourth. **Period 4**	Outer shell for element is the third. **Period 3**
Element	***Potassium***	***Aluminium***

Question 7 (5 marks, 6 minutes)

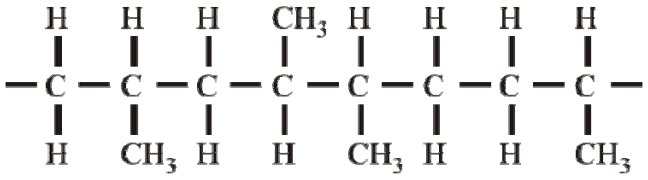
a. i. The monomer required to produce polypropene is **propene**, **$CH_3CH=CH_2$**. **(1 mark)**

ii. When propene reacts to form polypropene **an addition reaction occurs**. **(1 mark)** During this process the electrons from one of the pairs of electrons that form the carbon-carbon double bond are rearranged to form bonds between the monomer units.

iii. The structure for part of a polypropene molecule is shown below. **(1 mark)** The key points in the structure are single carbon-carbon bonds and methyl groups attached to one of the carbon atoms in every two. The structure shows both the isotactic form where all of the methyl groups, the side groups, are on the same side of the carbon-carbon backbone. This form of polymer allows for closer packing of the polymer strands and as a result there are increased forces of attraction between the polymer chains making the polymer stronger. The atactic structure has the methyl groups randomly attached to the backbone. This will result in a much softer polymer and in the case of polypropene a material that is only useful as a lubricant.



isotactic polypropene



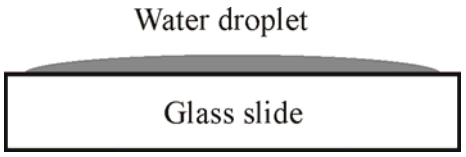
atactic polypropene

b. i. The important structural difference between thermoplastics and thermosetting plastics is that in a **thermosetting plastic there are covalent bonds between the polymer chains**. **(1 mark)** These bonds increase the rigidity of the structure.

ii. When heated, a **thermoplastic will soften** whereas a **thermosetting plastic will remain rigid**. **(1 mark)** This is due to the covalent bonds between the polymer chains not being readily broken. Thermosetting plastics will not soften and will decompose if sufficient heat is applied.

Question 8 (7 marks, 9 minutes)

a. i. A water droplet will spread out and wet the surface of a clean glass slide. **(1 mark)**



ii. A clean glass surface has **ionic sites** on its surface, therefore there will be **ion-dipole interactions between the surface and the water molecules**. **The strength of these interactions will be greater than those between the water molecules in the droplet and as a result the water will spread out and wet the surface**. **(1 mark)**

iii. Because the surface attracts water, it is described as being **hydrophilic.** **(1 mark)**

b. i. The order is from least to highest surface energy:
Hexane – Ethanol – Water – Mercury (1 mark)

ii. The key factor that has to be considered in determining the relative surface energies of the liquids is the **interactions between the particles that make up the liquid**. **(1 mark)** The stronger the interactions between these particles the higher the surface energy, since the surface energy is the amount of energy required to increase the surface area.
Ethanol, hexane and water contain covalently bonded molecules, therefore the interaction between these is determined by the weak intermolecular forces. Hexane is a non-polar liquid, therefore only dispersion forces act between the molecules and these are the weakest of the intermolecular forces and hence hexane would have the lowest surface energy. Ethanol and water are both polar molecules and exhibit dipole-dipole and hydrogen bonding interactions in addition to the weaker dispersion forces. The hydrogen bonding and dipole-dipole interactions will be greater in water because the water molecules are smaller and can pack closer together.
Mercury is a metal therefore the interaction between the particles will involve strong metallic bonding, therefore mercury would have the highest surface energy.

c. i. The colour and lustre of metals is due to the interaction of light with the delocalised electrons in the metallic lattice. In nanoparticles, because the number of centres over which these electrons are delocalised is much smaller, the interactions that occur are not the same as those in bulk materials and a different colour is observed. **(1 mark)**

ii. The increased rate in the product formation is the result of the catalyst being more active. **Nanoparticles have a very large surface area to volume ratio** therefore there are **more active sites for the reaction to occur at** compared to a bulk sample of the catalyst. **(1 mark)**

Question 9 (6 marks, 7 minutes)

a. The relative atomic mass is the weighted average of the isotopic masses obtained by multiplying the relative isotopic masses by their abundances.
$23.99\times (78.70/100) + 24.99 \times (10.13/100) + 25.98 \times (11.17/100) =$ **24.31 (2 marks)**

b. i. $M(Li_2SO_4) = 2\times6.9 + 32.1 + 6\times16.0 = 109.9$ g mol^{-1} **(1 mark)**
$n(Li_2SO_4) = m/M = 38.59 / 109.9 =$ **3.511×10^{-1} mol (1 mark)**

ii. Li_2SO_4 contains two lithium, Li^+, and one sulfate, SO_4^{2-}, ions, a total of three ions.
$n(ions) = 3\times n(Li_2SO_4) = 3\times 3.551\times10^{-1} = 1.053$ mol **(1 mark)**
$N(ions) = n\times N_A = 1.053 \times 6.02\times^{23} =$ **6.35×10^{23} ions (1 mark)**

Question 10 (6 marks, 7 minutes)

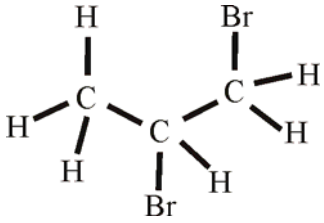
Propane and propene have the following semi-structural formulae, $CH_3CH_2CH_3$ and $CH_3CH{=}CH_3$, respectively.

a. The complete combustion of a hydrocarbon produces carbon dioxide and water.

1. Write down the reactants and products of the reaction.
   $C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$
2. Balance the number of carbon atoms in the chemical equation.
   $C_3H_8(g) + O_2(g) \rightarrow 3CO_2(g) + H_2O(l)$
3. Balance the number of hydrogen atoms in the chemical equation.
   $C_3H_8(g) + O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
4. Balance the number of oxygen atoms in the chemical equation remembering that that the reactant is O_2.
   Products: $3\times2 + 4 = 10$
   O_2 molecules required = 5
   $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ **(1 mark)**

b. i. $CH_3CH=CH_2(g) + Br_2(aq) \rightarrow CH_3CHBrCH_2Br(l)$ **(1 mark)**

or $C_3H_6(g) + Br_2(aq) \rightarrow C_3H_6Br_2(l)$

ii. 

(1 mark)

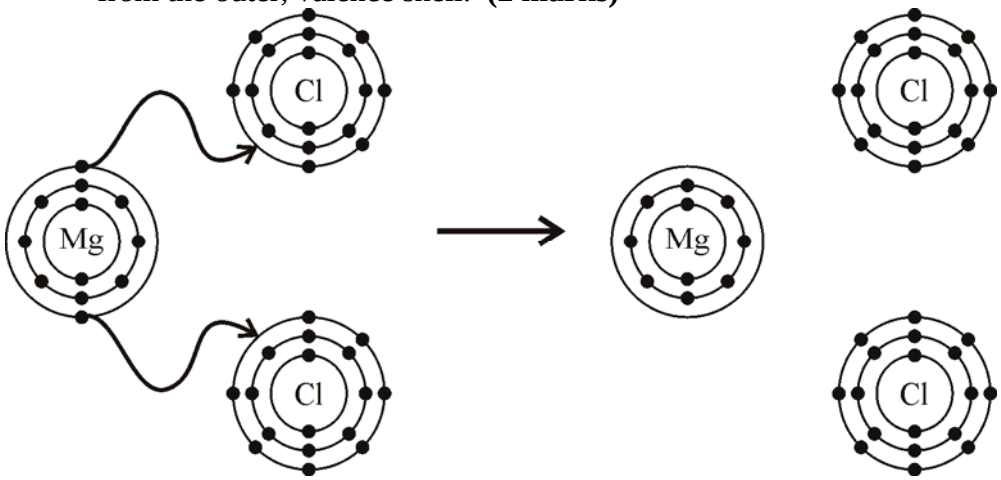
iii. Propene reacts because alkenes are more reactive than alkanes due to the **carbon-carbon double bond**. **(1 mark)**

iv. The two bromine atoms from the bromine solution are incorporated into the product, therefore this is an **addition reaction**. **(1 mark)**

v. Possible answers included: **(1 mark)**
Hydrogen, H_2.
Water, H_2O.
Hydrogen halides, such as hydrogen chloride, HCl.
Alkenes themselves to form polymers.

Question 11 (5 marks, 6 minutes)

a. Diagram must show two electrons being transferred from magnesium and one electron being accepted by each of two chlorines. The electrons being transferred must come from the outer, valence shell. **(2 marks)**



b. i. Barium oxide, Ba^{2+} and O^{2-}
BaO (1 mark)

ii. Ammonium carbonate, NH_4^+ and CO_3^{2-}.
$(NH_4)_2CO_3$ (1 mark)

iii. Chromium(III) sulfate, Cr^{3+} and SO_4^{2-}.
$Cr_2(SO_4)_3$ (1 mark)

Question 12 (5 marks, 6 minutes)

a. *All matter consists of indivisible atoms.*
The current atomic model has shown that atoms consist of sub-atomic particles, therefore atoms are divisible. **(1 mark)** At the basic level, atoms consist of three sub-atomic particles, protons, neutrons and electrons, and this suffices to explain most chemical phenomena. More detailed models have these consisting of other particles.

b. *Atoms of a particular element are identical in weight and have identical properties.*
The evidence of isotopes refutes the part of the statement relating to all atoms of a particular element having identical weight. **(1 mark)**
The chemical properties of all atoms of a particular element would be the same, as the chemical reactivity depends largely on the number and arrangement of the electrons within the atoms which would be the same. **(1 mark)** There are small differences in some of the physical properties of isotopes of an element.

c. *Atoms are neither created nor destroyed in reactions.*
The law of conservation of mass supports this in relation to chemical reactions. **(1 mark)**
The concept does not hold up however in the case of nuclear reactions, where there can be a conversion between mass and energy. **(1 mark)**

Question 13 (6 marks, 7 minutes)

a. i. Ionic compounds contain a network of alternating positive and negative ions. These ions are held together by strong electrostatic forces. When a substance melts, the particles must break these forces of attraction so that they can move about freely. Therefore ionic compounds have moderate to high melting temperatures. **(1 mark)**

ii. Because the ions are held in the lattice by strong electrostatic forces, ionic compounds tend to be hard. They are brittle because when sufficient force is applied to the solid to cause the ions to shift within the lattice, repulsive forces can develop between like charges causing the solid to shatter. **(1 mark)**

b.

Property	Discrete Covalent Molecules	Covalent Network Lattices
Melting Temperature	These compounds tend to have **low melting temperatures** because the forces between the molecules are weak intermolecular forces such as; dispersion forces, dipole-dipole and hydrogen bonding. **(1 mark)**	Since the bonding extends throughout the lattice in either two dimensions (graphite) or three dimensions (diamond), the melting temperatures of these compounds tend to be **high** because large amounts of energy are required to break the bonds. **(1 mark)**
Hardness	Solid compounds exhibiting this type of bonding display a varied hardness depending on the weak bonding interactions between the molecules when they crystallise into a lattice. **(1 mark)**	Where the bonding extends in three dimensions, compounds exhibiting this type of bonding tend to be hard. However those where the bonding extends in two dimensions are soft, as the layers of the atoms can easily slide over one another. **(1 mark)**

End of Suggested Answers