VCE CHEMISTRY 2008

YEAR 11 TRIAL EXAM UNIT 1

Time allowed: 90 minutes
Total marks: 72

SECTION A
Contains 24 Multiple Choice Questions
30 minutes, 24 marks

SECTION B
Contains 6 Extended Response Questions
60 minutes, 48 marks

To download the Chemistry Data Book please visit the VCAA website:
http://www.vcaa.vic.edu.au/vce/studies/chemistry/chem1_sample_2008.pdf *Page 20*

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Student Name...…….....…….....

VCE Chemistry 2008 Year 11 Trial Exam Unit 1

Student Answer Sheet

Instructions for completing test. Use only an HB 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 24 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

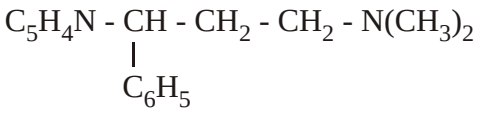
VCE Chemistry 2008 Year 11 Trial Exam Unit 1

Multiple Choice Section

Section A – (24 marks, 30 minutes)

This section contains 24 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.)*

Question 1
The semi-structural formula for the medicinal drug pheniramine, a decongestant, is shown below.

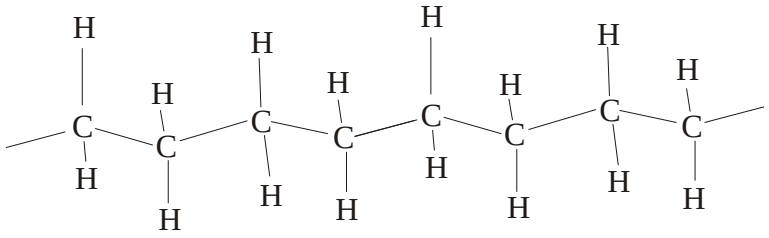


The percentage composition by mass of nitrogen in this compound is
A. 5.8 %.
B. 12.2 %.
C. 11.7 %.
D. 10.8 %.

Question 2
In the solid state magnesium oxide, MgO, will
A. conduct an electric current because the valence electrons from the magnesium and oxygen atoms are free to move through the lattice.
B. not conduct an electric current because the magnesium and oxide ions are not free to move in the lattice.
C. not conduct an electric current because the magnesium is covalently bonded to the oxygen and there are no charged particles free to move in the lattice.
D. conduct an electric current because the lattice contains the charged magnesium and oxide ions.

Question 3
The structure of solid silicon dioxide, SiO_2, consists of
A. silicon atoms bonded to two oxygen atoms in discrete molecules by double covalent bonds.
B. silicon atoms bonded by single covalent bonds to four oxygen atoms in a network lattice.
C. silicon atoms bonded by double covalent bonds to four oxygen atoms in a network lattice.
D. silicon atoms bonded to oxygen atoms in discrete molecules by single covalent bonds.

Question 4
Part of the structure of a polymer is shown below.



The empirical formula for the monomer used to prepare this polymer would be
A. C_3H_6.
B. CH_3.
C. C_2H_4.
D. CH_2.

Question 5
The ground-sate electronic configuration for a phosphide ion, P^{3-}, is
A. $1s^2 2s^2 2p^6 3s^2 3p^4 4s^2$.
B. $1s^2 2s^2 2p^6 3s^2 3p^3$.
C. $1s^2 2s^2 2p^6 3s^2$.
D. $1s^2 2s^2 2p^6 3s^2 3p^6$.

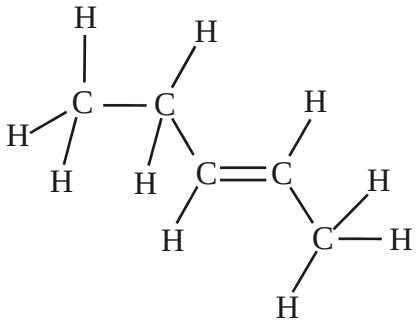
Question 6
When element-119, ununennium Uue, is discovered it will most likely
A. have an electronegativity lower than that for sodium and will form a covalently bonded oxide with the formula, Uue_2O.
B. have a first ionisation energy lower than that of potassium and will react violently when it reacts with water.
C. have an atomic radius smaller than that of francium and will react violently when it reacts with water.
D. form an oxide with the formula, Uue_2O that displays ionic bonding and the element will have an electronegativity greater than that for potassium.

Question 7
Moving left to right across a period in the Periodic Table the
A. atomic radius of the atoms increases.
B. metallic characteristics of the elements increases.
C. metallic characteristics of the elements decreases.
D. electronegativity of the elements decrease.

Question 8
Which one of the following statements best describes the model used to explain the electrical conductivity of metals in the solid state?

A. The valence electrons are delocalised and free to move within a lattice of positive ions.
B. All of the electrons are delocalised and free to move within a lattice of positive ions.
C. The valence electrons are delocalised and this forms positive ions that are free to move carrying the electrical current.
D. The electrons from the electric current are free to pass through the lattice of metal atoms.

Question 9
The systematic name for the hydrocarbon with the structure shown below is



A. pent-3-ene.
B. methylbut-2-ene.
C. pent-1-ene.
D. pent-2-ene.

Questions 10 and 11 refer to the following information.
When a sample of a hydrocarbon was decomposed into its elements it was found to contain 0.843 g and 0.176 g of carbon and hydrogen respectively. Another experiment determined the molar mass of the hydrocarbon to be 57.7 g mol^{-1}.

Question 10
The empirical formula for this hydrocarbon is

A. CH_2.
B. CH_3.
C. C_2H_5.
D. C_4H_5.

Question 11
The molecular formula for this hydrocarbon is

A. C_4H_{10}.
B. C_4H_5.
C. C_2H_5.
D. C_4H_8.

Question 12
The number of isomers possible for a hydrocarbon with the molecular formula C_4H_{10} is
A. 1.
B. 2.
C. 3.
D. 4.

Question 13
Cross-linking in a polymer is the result of the formation of
A. covalent bonds between the polymer chains and these produce a material that is less rigid than one without cross-linking.
B. hydrogen bonds between the polymer chains and these produce a material that is less rigid than one without cross-linking.
C. hydrogen bonds between the polymer chains and these produce a material that is more rigid than one without cross-linking.
D. covalent bonds between the polymer chains and these produce a material that is more rigid than one without cross-linking.

Question 14
When Mendeleev drew up his Periodic Table, what did he use to determine the order of the elements?
A. The number of electrons in atoms of the element.
B. The number of protons in the atoms of the element.
C. The atomic number of the element.
D. The relative atomic weight of the element.

Question 15
The number of atoms present in 2.132 g of magnesium sulfate heptahydrate, $MgSO_4.7H_2O$, is closest to
A. 1.4×10^{23} atoms.
B. 5.2×10^{21} atoms.
C. 3.1×10^{22} atoms.
D. 6.8×10^{22} atoms.

Question 16
Which one of the following properties of a substance cannot be adequately explained by the ionic bonding model?
A. The electrical conductivity of solid ionic compounds.
B. The relatively high melting temperatures of ionic compounds.
C. The electrical conductivity of aqueous solutions of ionic compounds.
D. The insolubility of some ionic compounds in water.

Question 17
Our current atomic model is the result of the contributions of many scientists in the past. What contribution to the atomic model did James Chadwick make?
A. He discovered the neutron.
B. He discovered the electron.
C. He proposed that electrons are arranged in shells and sub-shells around the nucleus of the atom.
D. He developed the quantum mechanical model for the atom.

Question 18
Chloroform (trichloromethane), $CHCl_3$, has a boiling temperature of 63 ºC. What are all of the bonding interactions present between the chloroform molecules in a sample of this liquid?
A. Hydrogen bonding, dipole-dipole interactions and dispersion forces.
B. Dipole-dipole interactions and dispersion forces.
C. Hydrogen bonding and dispersion forces.
D. Covalent bonding and dipole-dipole interactions.

Question 19
The amount of hydrogen atoms present in 19.36 g of methanol, CH_3OH, is
A. 0.605 mol.
B. 1.82 mol.
C. 2.42 mol.
D. 3.63 mol.

Question 20
Ethene, C_2H_4, will react with steam in the presence of an acid catalyst to produce ethanol, C_2H_5OH. This reaction is an example of
A. an oxidation reaction.
B. a substitution reaction.
C. an addition reaction.
D. a reduction reaction.

Question 21
A particle containing 54 electrons, 74 neutrons and 53 protons can be symbolically represented by
A. $^{127}_{53}I^-$.
B. $^{74}_{53}I^-$.
C. $^{74}_{54}Xe^-$.
D. $^{127}_{54}Xe^-$.

Question 22
The mass spectrum of an element shows
A. the relative isotopic masses of all of the isotopes that an element can have.
B. how much of each isotope is present in a sample of the element.
C. if the sample of an element is pure.
D. the relative isotopic masses and abundances of the isotopes present in a sample of the element.

Question 23
Which one of the following lists the surface energies for the materials in order from lowest to highest?
A. Water, diamond, mercury, hexane.
B. Hexane, mercury, water, diamond.
C. Hexane, water, mercury, diamond.
D. Diamond, hexane, water, mercury.

Question 24

The reason why gold nanoparticles show some different characteristics to a bulk sample of gold is due to

A. the gold atoms in the nanoparticles bonding in a more covalent manner.
B. the nanoparticles having a larger surface area to volume ratio than a bulk sample of gold.
C. the nanoparticles having a smaller surface area to volume ratio than a bulk sample of gold.
D. the surface energy of the gold nanoparticles being higher than the surface energy of gold.

End of Section A

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Section B – (48 marks, 60 minutes)

This section contains six questions, numbered 1 to 6.
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 – (8 marks, 10 minutes)

a. Draw the structures for the following molecules showing all bonding and non-bonding electrons.

i. CH_2Cl_2

ii. NF_3

iii. CS_2

iv. HCHO

(4 marks)

b. Which of the molecules in a. above would have a permanent dipole?

(2 marks)

c. Between which of the molecules in a. above would hydrogen bonding occur?

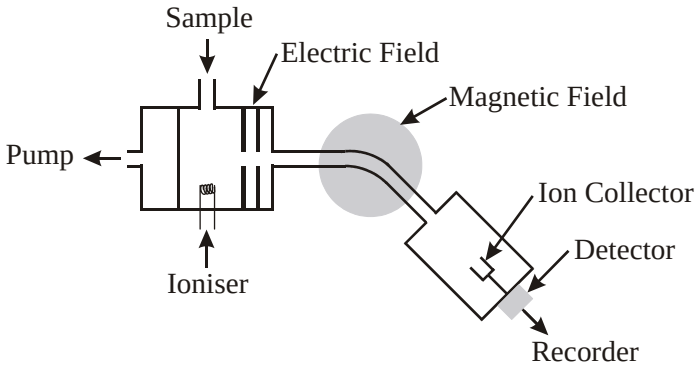
(1 mark)

d. How does the presence of hydrogen bonding between molecules affect the boiling temperature of a substance?

(1 mark)

Question 2 – (7 marks, 9 minutes)

a. A schematic diagram for a mass spectrometer is shown below.



i. What does the ioniser do to the sample in the ionisation chamber?

(1 mark)

ii. What role does electric field play in the mass spectrometer?

(1 mark)

iii. What role does magnetic field play in the mass spectrometer?

(1 mark)

b. The mass spectral data for magnesium is given in the table below.

Relative Isotopic Mass	% Abundance
23.9850	78.7
24.9858	10.1
25.9826	11.2

i. How many neutrons are present in the atoms of least abundant isotope of magnesium?

(1 mark)

ii. What is the standard that all relative isotopic and atomic mass are relative to?

(1 mark)

iii. Calculate the relative atomic mass for magnesium?

(2 marks)

Question 3 – (6 marks, 7 minutes)

a. A sample of water contains 9.51×10^{24} hydrogen atoms.

i. How many mole of water are present in the sample?

(1 mark)

ii. What is the mass of the water sample?

(1 mark)

b. The chemical analysis of an antitumour drug found that it contained carbon, hydrogen and nitrogen with percentages by mass of 51.4 %, 8.6 % and 40.0 % respectively.

i. Determine the empirical formula for this compound.

(2 marks)

ii. 1.2×10^{-3} mol of this antitumour drug compound had a mass of 0.252 g. Determine the molecular formula for the compound.

(2 marks)

Question 4 – (6 marks, 7 minutes)

a. In 1805 John Dalton published his atomic theory which became the basis that the current theory has developed from. One of Dalton's proposals stated:
All the atoms of a particular element are identical in weight and have identical chemical properties.

i. What later experimental evidence has shown that part of this proposal is incorrect?

(1 mark)

ii. What part of this proposal is correct and why is that the case?

(1 mark)

b. What experimental data did Niels Bohr use to develop his electronic configuration model?

(1 mark)

c. Write the ground-state electronic configurations for the following particles and state the number of electrons in the outer shell.

i. A cobalt atom.

ii. A sodium ion.

(2 marks)

d. Explain how a carbon atom could have an electronic configuration of $1s^2 2s^2 2p^3 3p^1$.

(1 mark)

Question 5 – (12 marks, 15 minutes)

a. Two groups of hydrocarbons are the alkanes and the alkenes.

i. What is the key difference between these two groups of hydrocarbons?

(1 mark)

ii. What is the general formula for the homologous series that includes ethane?

(1 mark)

b. Write an appropriate chemical equation for the combustion of propane, the main component of liquefied petroleum gas, LPG.

(1 mark)

c. Draw the structures for the following hydrocarbon compounds.

i. hex-2-ene ii. 2-methylbutane iii. 2,2-dimethylpropane

(3 marks)

d. Explain why 2-ethylpropane is **not** the correct systematic name for a hydrocarbon with the semi-structural formula that was written down as $CH_3\,CH(CH_2CH_3)CH_3$.

(1 mark)

e. i. Write an appropriate chemical equation to describe the reaction between ethene and hydrogen in the presence of a suitable catalyst.

(1 mark)

ii. What type of chemical reaction is occurring in this process?

(1 mark)

f. i. Draw part of the structure for the polymer that could be produced from propene.

(1 mark)

ii. Two forms of unbranched polypropene can be produced. Atactic polypropene is very soft whereas isotactic polypropene does not soften in boiling water. What structural differences between the two polymers could explain this marked difference?

(1 mark)

g. What is a copolymer?

(1 mark)

Question 6 – (9 marks, 12 minutes)

a. Two of the structural forms of carbon, diamond and graphite, have significant differences in their characteristics such as colour, hardness and electrical conductivity, yet both forms have high melting and boiling temperatures.
Use the appropriate bonding model to explain the following.

i. Graphite is so much softer than diamond.

(1 mark)

ii. Diamond is an insulator while graphite is a weak electrical conductor.

(1 mark)

iii. The melting and boiling temperatures of the two substances are both high.

(1 mark)

b. Nanoparticles have properties often markedly different from the bulk properties displayed by their materials.

i. How would the electrical conductivity of a metal nanoparticle most likely compare with that of the parent metal?

(1 mark)

ii. Besides electrical conductivity what is one other physical property where nanoparticles can show a marked difference from their parent materials?

(1 mark)

iii. Some observers believe that nanoparticles have the potential to cause adverse effects on health. Why could nanoparticles pose a potential health hazard?

(1 mark)

c. When a drop of water is placed on a clean glass surface it spreads out and wets the surface. A similar drop of water placed on a clean polyethene surface, beads and does not wet the surface. Explain why the water drops behave in such different ways on the two surfaces.

(3 marks)

End of Trial Exam

Suggested Answers VCE Chemistry 2008 Year 11 Trial Exam Unit 1

Multiple Choice Section

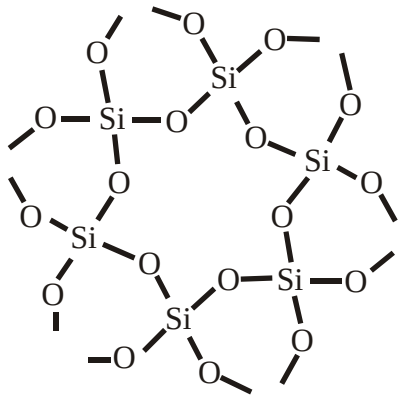
Section A (1 mark per question)

Q1 **C** The molecular formula for pheniramine is $C_{16}H_{20}N_2$.
$M(C_{16}H_{20}N_2) = 16\times12.0 + 20\times1.0 + 2\times14.0 = 240.0$ g mol^{-1}.

$$\%(N) = \frac{2\times14.0}{240.0}\times\frac{100}{1} = \mathbf{11.7\ \%}$$

Q2 **B** Magnesium oxide, MgO, will exhibit ionic bonding between the magnesium ions, Mg^{2+}, and the oxide ions, O^{2-}. In the solid state these ions are fixed in the lattice, therefore there are no charged particles free to move and carry an electric current. **Solid magnesium oxide will not conduct an electric current.**

Q3 **B** Silicon dioxide, SiO_2, has a covalent network lattice structure. Silicon (Z = 14) therefore has four valence (outer shell; $\mathbf{3}s^2\mathbf{3}p^2$) electrons and will share all four of these when forming covalent bonds. Oxygen (Z = 8) has six valence electrons ($\mathbf{2}s^2\mathbf{2}p^4$) and will share two of these when forming covalent bonds. In the lattice each silicon atom will form single covalent bonds with four oxygen atoms, while each oxygen atom will form single covalent bonds with two silicon atoms. The diagram shows part of the silicon dioxide network lattice structure.



Q4 **D** The polymer is polyethene which is produced by an addition polymerisation reaction from ethene, C_2H_4. The empirical formula is the lowest whole number ratio of the atoms present in the material, therefore $\mathbf{CH_2}$.

Q5 **D** Phosphorous, P, Z = 15. The phosphide ion, P^{3-}, will therefore have three additional electrons giving a total of 18 electrons. The ground-state electronic configuration fills the sub-shells in the following order;

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, …,

Each s, p and d sub-shell can contain a maximum of 2, 6 and 10 electrons respectively.
Therefore for P^{3-}, $\mathbf{1s^2 2s^2 2p^6 3s^2 3p^6}$

Q6 **B** Element 119 will be located in group 1 of the Periodic Table. The trends in the properties of the elements with a group of elements are:
The atomic radius increases moving down the group as the increasing number of electrons occupy more shells.
The first ionisation energy decreases because the valence electrons are further from the nucleus and therefore experience a lower force of attraction.
The electronegativity decreases as any electrons attracted by the atom are further from the nucleus and experience a weaker attraction.
For group 1 elements this means that moving down the group the valence electron is more readily removed and since potassium reacts violently with water the reaction of this element would be expected to be more violent.

Q7 **C** **Moving left to right across a period in the Periodic Table the metallic characteristics of the elements decreases**. In general metals will be located on the left-hand side and non-metals on the right-hand side of the Period Table. For example in the third period, sodium, magnesium and aluminium are all metals, while phosphorous, sulfur, chlorine and argon are all non-metals. Silicon displays some metal and non-metal characteristics therefore is known as a metalloid.

Q8 **A** The model for metallic bonding involves the delocalisation of the valence electrons from the atoms resulting in a three dimensional lattice of positive ions. The **delocalised electrons are free to move within this lattice**, so that an electric current can flow through the solid.

Q9 **D** The structure has a carbon-carbon double bond, therefore this is an alkene and the systematic name will end with the suffix **–ene**.
The longest carbon-carbon chain in the structure contains five carbon atoms, therefore **pent-**.
There are no groups attached to the carbon-carbon backbone.
The location of the double bond is determined by numbering the carbon atoms along the chain to obtain the smaller of the two possible numbers, **2** numbering from the right.
Therefore; **pent-2-ene**.

Q10 **C** The empirical formula is the lowest whole number ratio of the elements present in the compound. This is the same as the lowest whole number molar ratio of the elements.

$$n(C) : n(H) = \frac{m(C)}{M(C)} : \frac{m(H)}{M(H)} = \frac{0.842}{12.0} : \frac{0.176}{1.0}$$

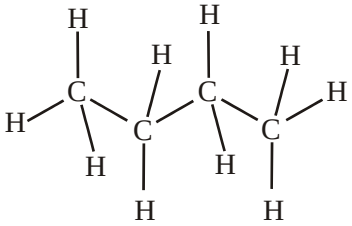
$n(C) : n(H) = 0.0703 : 0.176$
Divide both values by the smaller of the two.
$n(C) : n(H) = 1 : 2.51 = 2 : 5$ therefore $\mathbf{C_2H_5}$.

Q11 **A** The molecular formula is a whole number multiple of the empirical formula, therefore $(C_2H_5)_n$.
Formula mass for $C_2H_5 = 2\times12.0 + 5\times1.0 = 29.0$ g mol^{-1}

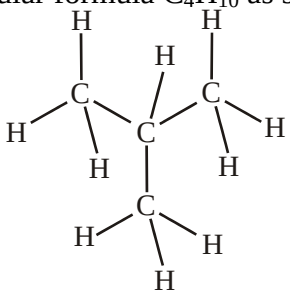
$$n = \frac{57.7}{29} = 1.99 = 2$$

Therefore $(C_2H_5)_2$ or $\mathbf{C_4H_{10}}$.

Q12 **B** There are two structural isomers, different arrangements of the carbon atoms, possible for the hydrocarbon with the molecular formula C_4H_{10} as shown below.



butane



2-methylpropane

Q13 **D** **Crosslinking occurs when strong covalent bonds form between the polymer chains** and this will make it more difficult for the chains to move over each other resulting in a **more rigid material**.

Q14 **D** When Mendeleev proposed his Periodic Table in 1869 the subatomic particles were yet to be discovered. **Mendeleev used the relative atomic weights** (now more correctly referred to as relative atomic masses) to order the known elements. Many of these were determined by Jöns Berzelius.

Q15 **A** $M(MgSO_4.7H_2O) = 24.3 + 32.1 + 4\times16.0 + 7\times(2\times1.0 + 16.0) = 246.4$ g mol^{-1}

$$n(MgSO_4.7H_2O) = \frac{m(MgSO_4 .7H_2O)}{n(MgSO_4 .7H_2O)} = \frac{2.132}{246.4} = 8.65\times10^{-3} \text{ mol}$$

Each $MgSO_4.7H_2O$ contains 27 atoms

$N(\text{atoms}) = 27 \times 8.65\times10^{-3} \times 6.02\times10^{23} =$ **1.41×10^{23} atoms**

Q16 **D** The insolubility in water of some ionic compounds cannot be adequately explained by the bonding model. For example magnesium sulfate, $MgSO_4$, is soluble whereas barium sulfate, $BaSO_4$, is insoluble. Both compounds involve the electrostatic attraction between 2+ and 2- ions yet one is soluble and the other is not.

Q17 **A** James Chadwick discovered the neutron in 1932 and was therefore able to explain the existence of isotopes that had been suggested by Frederick Soddy.

Q18 **B** **Dispersion forces** are the weakest of the intermolecular interactions and are **present between all molecules**. Chloroform, $CHCl_3$, is a **polar molecule** due to the electronegativity differences between chlorine, carbon and hydrogen. This results in one end of the molecule, where the more electronegative chlorine atoms are located, developing a small negative charge while a small positive charge develops on the hydrogen atom. **Dipole-dipole interactions** will therefore occur between the chloroform molecules.

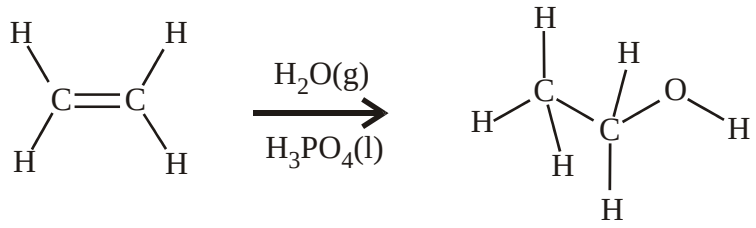
Q19 **C** $M(CH_3OH) = 12.0 + 4\times1.0 + 16.0 = 32.0$ g mol^{-1}

$$n(CH_3OH) = \frac{m(CH_3OH)}{M(CH_3OH)} = \frac{19.36}{32.0} = 0.605 \text{ mol}$$

Each methanol molecule contains four hydrogen atoms

$n(H) = 4 \times n(CH_3OH) = 4 \times 0.605 =$ **2.42 mol**

Q20 **C** When ethene reacts with water to form ethanol, the H_2O is added across the carbon-carbon double bond, therefore **an addition reaction** occurs.



ethene ethanol

Q21 **A** The atomic number (Z) is determined by the number of protons in the nucleus and this determines which element the particle is. Z = 53 therefore **I**.

The mass number (A) is determined by the number of protons plus neutrons in the nucleus of the particle. A = 53 + 74 = **127**.

The electronic charge is determined by the difference between the number of protons and the number of electrons, 53 – 54 = -1

Therefore: $^{127}_{53}I^-$

Q22 **D** The mass spectrum of an element shows the **abundances** and the **relative atomic masses of the isotopes present in the sample**. Response D is the most correct.

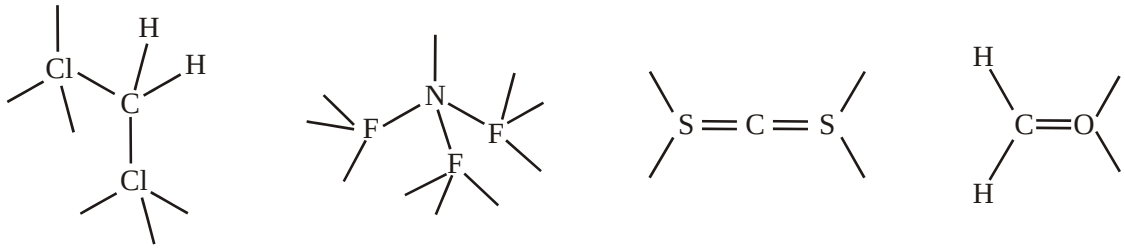
Q23 C The **surface energy is a measure of the energy required to increase the surface area of a substance**, therefore its value **reflects the forces between the particles** present in the substance. The weaker the intermolecular forces the lower the surface energy. Hexane will have the lowest surface energy because the molecules are held together by weak dispersion forces. Water will be next due to the hydrogen bonding between the water molecules. Mercury will be next due to the metallic bonding and diamond will have the largest surface energy because the atoms in the lattice are held together with covalent bonds.

Q24 B **Nanoparticles have a high surface area to volume ratio** and this has a major impact on the characteristics of the particles.

SECTION B

Question 1 – (8 marks, 10 minutes)

a. **(1 mark for each correct structure. Total mark allocation 4 marks.)**



i. ii. iii. iv.

b. Three of the molecules in a. above will have a permanent dipole, CH_2Cl_2, NF_3 and H_2CO. **(Mark allocation: 1 mark for two correct responses, two marks for three correct responses.)**

c. **Hydrogen bonding occurs** between molecules with a permanent dipole that have **polar hydrogen and oxygen atoms**. In a. above only in **H_2CO** would hydrogen bonding occur. **(1 mark)**

d. The presence of hydrogen bonding will **increase the boiling temperature of a substance** compared to molecules with a similar relative molecular mass. **(1 mark)** For example the boiling temperatures for methane, CH_4, and water, H_2O, are -162 ºC and 100 ºC respectively.

Question 2 - (7 marks, 9 minutes)

a. i. The ioniser bombards the sample with electrons and **creates a positively charged ion** in the ionisation chamber. **(1 mark)**

ii. The electric field **accelerates the ion to high speed** and into the analyser section of the mass spectrometer. **(1 mark)**

iii. The magnetic field **separates the ions according to their mass to charge ratio by bending the ion beam**. **(1 mark)**

b. i. The least abundant isotope has a relative isotopic mass of 24.9858, therefore a mass number (which is a whole number) of 25. The mass number is the sum of the number of protons and neutrons in the nucleus. Since the element is magnesium with an atomic number of 12 the nucleus will contain 12 protons. Therefore the number of neutrons will be the difference **13 neutrons**. **(1 mark)**

ii. The standard used for relative atomic and isotopic masses is that the **mass of the ^{12}C isotope is 12 exactly**. **(1 mark)**

iii. The relative atomic mass is the weighted average of the isotopic masses.

$$A_r = \frac{23.9850 \times 78.7 + 24.9858 \times 10.1 + 25.9826 \times 11.2}{100} = \mathbf{24.3}$$ **(2 marks)**

Question 3 - (6 marks, 7 minutes)

a. i. $n(H) = \frac{N(H)}{N_A} = \frac{9.51\times10^{24}}{6.02\times10^{23}} = 15.8$ mol

$n(H_2O) = ½\ n(H) = ½ \times 15.8 =$ **7.90 mol (1 mark)**

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

$m(H_2O) = n \times M = 7.90 \times 18.0 =$ **142 g (1 mark)**

b. i. The empirical formula is the lowest whole number ratio of the number of mole of the elements present. Assuming 100 g:

$n(C) : n(H) : n(N) = \frac{51.4}{12.0} : \frac{8.6}{1.0} : \frac{40.0}{14.0}$

$= 4.28 : 8.6 : 2.86$ **(1 mark)**

Divide through by the smallest value

$= 1.5 : 3.0 : 1.0$

Multiply all values by 2 to get whole number ratio

$= 3 : 6 : 2$ $\mathbf{C_3H_6N_2}$ **(1 mark)**

ii. $M = \frac{m}{n} = \frac{0.252}{1.2\times10^{-3}} = 210$ g mol^{-1} **(1 mark)**

Formula mass$(C_3H_6N_2) = 3\times12.0 + 6\times1.0 + 2\times14.0 = 70.0$ g mol^{-1}

Molecular formula is whole number multiple of the empirical formula.

$(C_3H_6N_2)_n$

$n = \frac{210}{70.0} = 3$

$(C_3H_6N_2)_3$ or $\mathbf{C_9H_{18}N_6}$ **(1 mark)**

Question 4 - (6 marks, 7 minutes)

a. i. The **mass spectra of the elements have shown that not all the atoms of an element have the same mass**. This is due to the presence of **isotopes** that result from different numbers of neutrons in the nucleus of the atom. **(1 mark)**

ii. The **chemical properties of the atoms of an element are the same** because the **chemical properties depend on the ground-state electronic configuration** of the element and this remains the same for all isotopes. **(1 mark)**

b. Niels Bohr used **emission spectra**, particularly that of hydrogen, to develop his electronic configuration model. **(1 mark)**

c. i. Co (Z = 27) : $\mathbf{1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2}$ **2 outer shell electrons (1 mark)**

ii. Na^+ (Z = 11) 1+ ion so 10 electrons $\mathbf{1s^2 2s^2 2p^6}$ **8 outer shell electrons (1 mark)**

d. The ground-state electronic configuration for carbon is $1s^2 2s^2 2p^4$. For a carbon atom to have a $1s^2 2s^2 2p^3 3p^1$ electronic configuration it must have **absorbed energy** (heat or light) **to raise it to an excited state**. **(1 mark)**

Question 5 - (12 marks, 15 minutes)

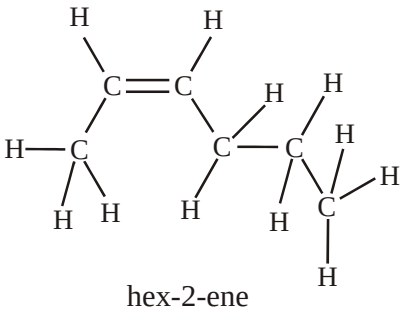
a. i. The key difference between the alkanes and the alkenes is that the **alkenes have at least one carbon-carbon double bond** in their structure whereas the **alkanes only have single carbon-carbon bonds**. **(1 mark)**

ii. Ethane is an alkane and has the molecular formula C_2H_6, the general formula for this homologous series is $\mathbf{C_nH_{2n+2}}$. **(1 mark)** The difference between any two successive members in any homologous series is CH_2.

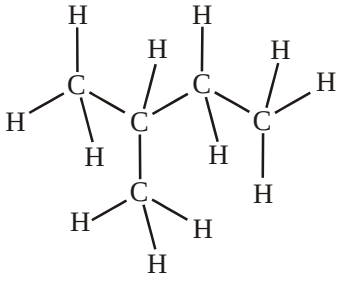
b. The products of the complete combustion of a hydrocarbon are carbon dioxide and water. Propane is C_3H_8.

1. Write down the reactants and products.
   $C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$
2. Balance the number of carbon atoms with carbon dioxide molecules.
   $C_3H_8(g) + O_2(g) \rightarrow 3CO_2(g) + H_2O(l)$
3. Balance the number of hydrogen atoms with water molecules.
   $C_3H_8(g) + O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
4. Balance the number of oxygen atoms in the products with oxygen molecules.
   $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ **(1 mark)**

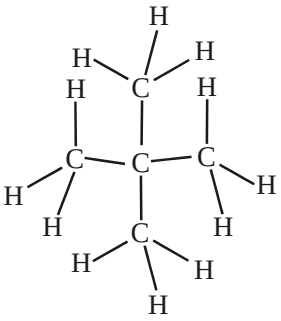
c. **(1 mark for each correct structure. Total marks allocated 3 marks)**



hex-2-ene

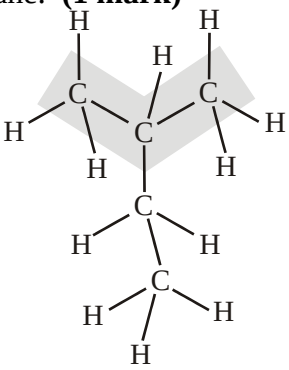


2-methylbutane

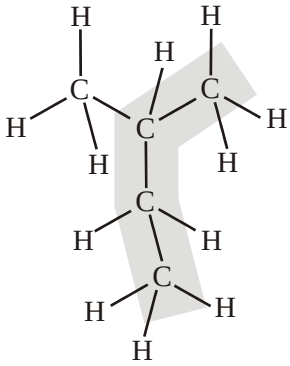


2,2-dimethylpropane

d. 2-ethylpropane is not the systematic name for a hydrocarbon with the molecular formula C_5H_{12} because as can be seen from the diagram below the longest carbon chain in the molecule is a C_4 chain therefore the systematic name is 2-methylbutane. **(1 mark)**



2-ethylpropane

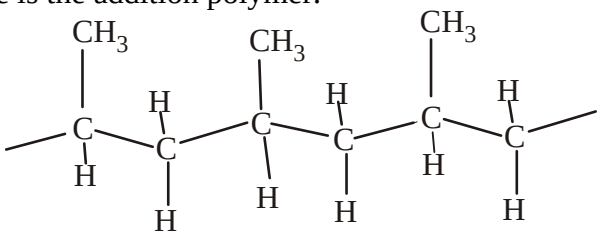


2-methylbutane

e. i. Ethene, C_2H_4.
   $C_2H_4(g) + H_2(g) \xrightarrow{\text{catalyst}} C_2H_6(g)$ **(1 mark)**

ii. The hydrogen has been added to the ethene to form ethane, therefore this is **an addition reaction**. **(1 mark)**

f. i. Propene: $CH_3CH=CH_2$
Polypropene is the addition polymer.



(1 mark)

ii. The main difference between the atactic and isotactic polymers is the **location of the methyl, CH_3, side group**. In the isotactic polymer the methyl groups are all on one side producing more uniform chains that stack together more closely therefore a more rigid structure results that does not soften as readily when heated. In the atactic structure the methyl groups are randomly arranged and this produces chains that do not stack together well and the polymer softens easily. **(1 mark)**

g. A copolymer is a polymer made **from two or more monomers**. **(1 mark)**

Question 6 - (9 marks, 12 minutes)

a. Both diamond and graphite have covalent network lattice structures with covalent bonds between the carbon atoms.

i. In **graphite the carbon atoms are arranged in 2 dimensional sheets which can freely move over each other** whereas in **diamond the carbon atoms are arranged in a rigid 3 dimensional lattice**. Therefore graphite will be much softer than diamond. **(1 mark)**

ii. In **diamond each of the carbon atoms is covalently bonded to four other carbon atoms** whereas in graphite each **carbon atom is bonded to three other carbon atoms and the fourth valence electron on each carbon atom is delocalised across the 2 dimensional sheets of atoms**. The **delocalised electrons in graphite make it a weak electrical conductor** whereas in diamond there are no free electrons making it an insulator. **(1 mark)**

iii. Both structures are **network lattices** therefore would be expected to have **high melting and boiling temperatures**. **(1 mark)**

b. i. Since there are **fewer valence electrons** in the nanoparticles the nanoparticles would be expected to be a much **poorer electrical conductor** than the parent metal. **(1 mark)**

ii. Possible answers include: **(1 mark for a correct answer)**
Chemical Reactivity – bulk samples of gold are highly unreactive and tend not to corrode yet gold nanoparticles will readily oxidise in oxygen.
Colour – gold nanoparticles have been observed to have a variety of colours other than the "gold" colour associated with a bulk sample of the material.
Thermal Conductivity – the delocalised electrons are limited to movement within the nanoparticle lattice itself and this limits the movement.
Transparency – zinc oxide nanoparticles are transparent whereas larger particles are opaque.

iii. Because of **their size there is a potential for nanoparticles to be able to enter cells** and possibly cause damage at this level by interfering with the chemical reactions that occur in the cell. **(1 mark)**

c. For a liquid **to wet a surface the force of attraction between the particles in the liquid and the surface must be greater than the force of attraction between the particles in the liquid**. **(1 mark)**
The glass surface contains ionic sites, hydrophilic, and the water molecules in the drop can form ion-dipole interactions with the glass surface. These interactions will be stronger than the hydrogen bonds between the water molecules in the drop and so the water then spreads out and wets the surface. **(1 mark)**
The polyethene surface is hydrophobic since it contains no polar or ionic sites and as a result the force of attraction between these sites and the water molecules is less than the hydrogen bonding between the water molecules in the drop. Therefore the drop of water will not spread out and the surface will not be wet. **(1 mark)**

End of Suggested Answers