Neap:

Trial Examination 2010

VCE Chemistry Unit 1

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A Multiple-choice	20	20	20	25
B Short-answer	6	6	50	65
			Total 70	Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 16 pages with a detachable data sheet in the centrefold.
Answer sheet for multiple-choice questions.

Instructions

Please ensure that you write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.
All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

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SECTION A: MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions. Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Question 1

Some properties of the elements that change across a period in the Periodic Table are:

I electronegativity

II atomic radius

III metallic character

Moving across Period 3 from sodium to chlorine, which of these properties increase?

A. I only

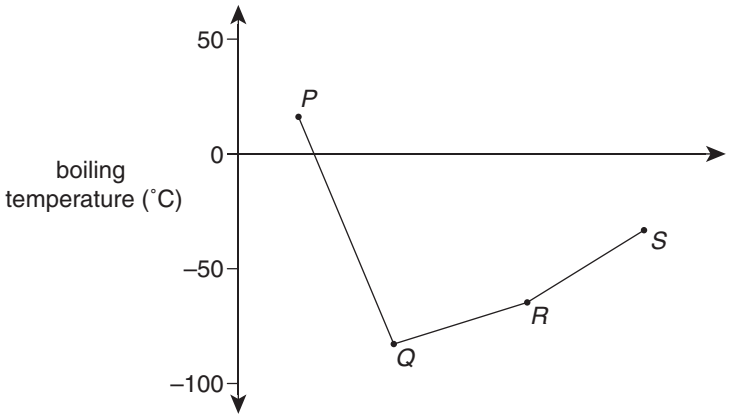
B. I and II only

C. II and III only

D. I, II and III

Question 2

Hydrides are compounds of hydrogen with another element. The letters *P*, *Q*, *R* and *S* represent the hydrides of elements in a group of the Periodic Table in order of increasing molar mass. The graph shows the variation in boiling temperature of the various hydrides.



The hydrides of which of the following groups of the Periodic Table are most likely to be represented in this graph?

A. Group 1

B. Group 14

C. Group 16

D. Group 17

Question 3

Alkynes are the homologous series of hydrocarbons which have one triple bond per molecule. The general formula of alkynes is C_nH_{2n-2} where n is an integer.

The number of structural isomers of the alkyne with four carbon atoms is

A. 1
B. 2
C. 3
D. 4

Question 4

The table below shows the relationship between a number of quantities, indicating whether the quantity in the first column is greater than (>) or less than (<) the quantity in the second column.

Which statement is incorrect?

A.	radius of an aluminium atom	>	radius of an aluminium ion
B.	electronegativity of chlorine	>	electronegativity of bromine
C.	radius of an oxygen atom	<	radius of an oxygen ion
D.	number of valence electrons in a magnesium atom	>	number of valence electrons in a magnesium ion

Question 5

The table below shows the electrical conductivity of two compounds in different states.

	Electrical conductivity		
Compound	**Solid**	**Molten**	**Aqueous solution**
HBr	very low	very low	high
NaBr	very low	high	high

Which of the following is a correct statement concerning the data presented?

A. In NaBr, electrons become delocalised only in the molten state and aqueous solution.
B. When each substance conducts electricity, electrons must be free to move.
C. There are no ions present in solid samples of either NaBr or HBr.
D. When HBr reacts with water, a solution containing ions is produced.

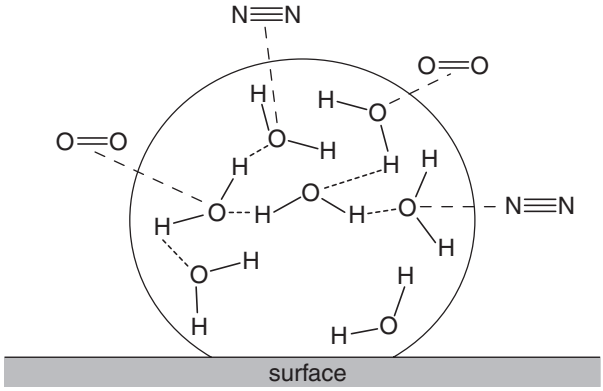
Question 6

Which of the following correctly shows the approximate diameter of the ^{19}F atom and its nucleus?

	atomic diameter (m)	**nuclear diameter (m)**
A.	10^{-10}	10^{-15}
B.	10^{-15}	10^{-11}
C.	10^{-5}	10^{-10}
D.	10^{-10}	10^{-12}

Questions 7 and 8 refer to the following information.

The diagram below shows some particle interactions when a drop of water is placed on a solid surface.



Question 7

The range of interactions between different particles includes:

I covalent bonding

II hydrogen bonding

III dispersion forces

IV ion-dipole bonding

Which of these interactions are depicted in the diagram above?

A. I and II only

B. II and III only

C. I, II and III only

D. II, III and IV only

Question 8

It can be deduced from the diagram that surface energy of the solid surface is

A. greater than water's surface energy and the solid surface is hydrophobic.

B. less than water's surface energy and the solid surface is hydrophobic.

C. greater than water's surface energy and the solid surface is hydrophilic.

D. less than water's surface energy and the solid surface is hydrophilic.

Question 9

Listed below are four metallic compounds with their molar masses (shown in the brackets).

Which of these compounds contains the metallic element with the highest percentage by mass?

A. U_3O_8 (M = 842 g mol^{-1})

B. Fe_2O_3 (M = 159.6 g mol^{-1})

C. $Cu(NO_3)_2$ (M = 187.5 g mol^{-1})

D. $CrBr_3$ (M = 291.7 g mol^{-1})

Question 10

Which of the following molecules contains the largest F–C–C bond angle?

A. C_2H_5F

B. C_2H_3F

C. C_2HF

D. CH_3F

Question 11

The relative isotopic masses of the two isotopes of copper are 62.95 and 64.95.

In a sample of 150 copper atoms, how many are likely to be the lighter isotope?

A. 30

B. 45

C. 73

D. 109

Question 12

The electronic configuration of a particle is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$. This particle is most likely to be

A. an atom of iron in its ground state.

B. an atom of cobalt in an excited state.

C. a doubly charged nickel cation.

D. a doubly charged chromium anion.

Question 13

The total number of oxygen atoms in 0.53 g of sodium carbonate (Na_2CO_3) is closest to

A. 3×10^{21}

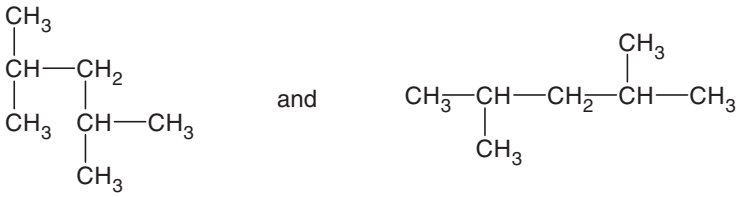
B. 6×10^{21}

C. 9×10^{21}

D. 2×10^{22}

Question 14

Two molecular structures are shown below.



This pair of molecular structures are

A. different isomers of the same compound.

B. members of an unsaturated homologous series.

C. different compounds that are not isomers of each other.

D. different representations of the same compound.

Question 15

The number of electrons and the mass number of a series of particles are shown in the table below (the symbols used, U to Z, are not the correct symbols for the elements).

Particle	Electrons	Mass number
U	12	24
V^-	10	19
W^+	10	23
X	10	20
Y^{2+}	10	24
Z	10	22

Which two particles are isotopes?

A. X and Z
B. U and Y
C. W and Y
D. V and X

Question 16

Which of the following shows the substances in order of increasing melting temperature?

A. F_2; CF_4; NaF
B. CF_4; F_2; NaF
C. F_2; NaF; CF_4
D. NaF; CF_4; F_2

Question 17

An ionic compound of formula Q_2R_3 forms from the elements Q and R.

If the electron configuration of one of the elements is $1s^2 2s^2 2p^6 3s^2 3p^1$, then the electron configuration of the other element is most likely to be

A. $1s^2 2s^1$
B. $1s^2 2s^2 2p^4$
C. $1s^2 2s^2 2p^6 3s^2$
D. $1s^2 2s^2 2p^6 3s^2 3p^5$

Question 18

In 1808, an atomic theory proposed by John Dalton included the following ideas:

I Atoms are indivisible and cannot be created or destroyed.

II Atoms of the same element are identical and have the same mass.

III Chemical reactions occur when atoms are separated, joined or rearranged.

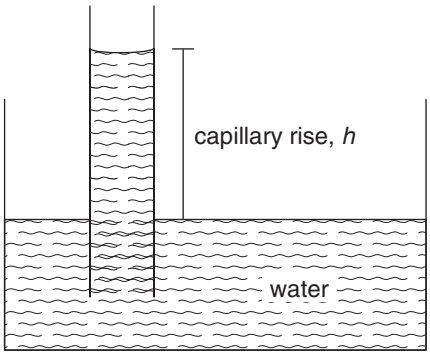
IV Atoms of different elements can combine with one another in simple whole number ratios to form compounds.

Which of these ideas are still part of modern atomic theory?

A. II and IV only
B. II and III only
C. III and IV only
D. I, II, III and IV

Question 19

The diagram below shows water rising up a narrow capillary tube. The height to which the water rises is given by the letter *h*. The water rises in the tube until the attractive forces between the water and the material of the tube are balanced by the weight of the column of water.



Assuming that the water wets the material of the capillary tube, which of the following combinations of conditions would result in the largest value for *h*?

A. a material with high surface energy in a capillary tube of large diameter
B. a material with high surface energy in a capillary tube of small diameter
C. a material with low surface energy in a capillary tube of large diameter
D. a material with low surface energy in a capillary tube of small diameter

Question 20

Which of the following statements about nanoparticles is correct?

A. The different properties of nanoparticles compared to bulk materials are usually due to the ability to form hydrogen bonds.
B. The fraction of atoms present at the surface of a particle increases with decreasing particle size.
C. Nanoparticles have sizes ranging from one to one thousand nanometres.
D. One thousand nanoparticles with the same total volume as a larger particle have a surface area one thousand times greater than the larger particle.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer all questions in the spaces provided.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example $H_2(g)$; NaCl(s).

Question 1

Molecules of carbon dioxide (CO_2) and dimethyl ether (C_2H_6O) both contain two carbon to oxygen bonds. The carbon–oxygen bond length in carbon dioxide is 0.12 nm, while the carbon–oxygen bond length in dimethyl ether is 0.14 nm. Carbon dioxide sublimes at a temperature of –78°C, while the boiling point of dimethyl ether is –25°C.

a. In the spaces below, draw structural diagrams showing the arrangement of atoms and all bonds in each of these molecules.

carbon dioxide (CO_2)	dimethyl ether (C_2H_6O)

2 marks

b. Account for the difference in the carbon–oxygen bond lengths in these two molecules.

_____

_____

1 mark

c. Account for the much higher boiling point of dimethyl ether, compared with that of carbon dioxide.

_____

_____

_____

_____

2 marks

Total 5 marks

Neap:

Trial Examination 2010

VCE Chemistry Unit 1

Written Examination

Data Sheet

Directions to students

This data sheet is provided for your reference.

Make sure that you remove this data sheet from the centrefold during reading time.

Any writing, jottings, notes or drawings you make on this data sheet will not be considered in the marking.

At the end of the examination, make sure that you do not leave the data sheet in the centrefold of the question and answer book.

You may keep this data sheet.

1. *Periodic Table of the elements*

1 **H** 1.0 hydrogen																	**2** **He** 4.0 helium
3 **Li** 6.9 lithium	**4** **Be** 9.0 beryllium											**5** **B** 10.8 boron	**6** **C** 12.0 carbon	**7** **N** 14.0 nitrogen	**8** **O** 16.0 oxygen	**9** **F** 19.0 fluorine	**10** **Ne** 20.2 neon
11 **Na** 23.0 sodium	**12** **Mg** 24.3 magnesium											**13** **Al** 27.0 aluminium	**14** **Si** 28.1 silicon	**15** **P** 31.0 phosphorus	**16** **S** 32.1 sulfur	**17** **Cl** 35.5 chlorine	**18** **Ar** 39.9 argon
19 **K** 39.1 potassium	**20** **Ca** 40.1 calcium	**21** **Sc** 44.9 scandium	**22** **Ti** 47.9 titanium	**23** **V** 50.9 vanadium	**24** **Cr** 52.0 chromium	**25** **Mn** 54.9 manganese	**26** **Fe** 55.8 iron	**27** **Co** 58.9 cobalt	**28** **Ni** 58.7 nickel	**29** **Cu** 63.5 copper	**30** **Zn** 65.4 zinc	**31** **Ga** 69.7 gallium	**32** **Ge** 72.6 germanium	**33** **As** 74.9 arsenic	**34** **Se** 79.0 selenium	**35** **Br** 79.9 bromine	**36** **Kr** 83.8 krypton
37 **Rb** 85.5 rubidium	**38** **Sr** 87.6 strontium	**39** **Y** 88.9 yttrium	**40** **Zr** 91.2 zirconium	**41** **Nb** 92.9 niobium	**42** **Mo** 95.9 molybdenum	**43** **Tc** 98.1 technetium	**44** **Ru** 101.1 ruthenium	**45** **Rh** 102.9 rhodium	**46** **Pd** 106.4 palladium	**47** **Ag** 107.9 silver	**48** **Cd** 112.4 cadmium	**49** **In** 114.8 indium	**50** **Sn** 118.7 tin	**51** **Sb** 121.8 antimony	**52** **Te** 127.6 tellurium	**53** **I** 126.9 iodine	**54** **Xe** 131.3 xenon
55 **Cs** 132.9 casesium	**56** **Ba** 137.3 barium	**57** **La** 138.9 lanthanum	**72** **Hf** 178.5 hafnium	**73** **Ta** 180.9 tantalum	**74** **W** 183.8 tungsten	**75** **Re** 186.2 rhenium	**76** **Os** 190.2 osmium	**77** **Ir** 192.2 iridium	**78** **Pt** 195.1 platinum	**79** **Au** 197.0 gold	**80** **Hg** 200.6 mercury	**81** **Tl** 204.4 thallium	**82** **Pb** 207.2 lead	**83** **Bi** 209.0 bismuth	**84** **Po** (209) polonium	**85** **At** (210) astatine	**86** **Rn** (222) radon
87 **Fr** (223) francium	**88** **Ra** (226) radium	**89** **Ac** (227) actinium	**104** **Rf** (261) rutherfordium	**105** **Db** (262) dubnium	**106** **Sg** (263) seaborgium	**107** **Bh** (264) bohrium	**108** **Hs** (265) hassium	**109** **Mt** (268) meitnerium	**110** **Ds** (271) darmstadtium	**111** **Rg** (272) roentgenium	**112** **Uub**		**114** **Uuq**		**116** **Uuh**		**118** **Uuo**

58 **Ce** 140.1 cerium	**59** **Pr** 140.9 praseodymium	**60** **Nd** 144.2 neodymium	**61** **Pm** (145) promethium	**62** **Sm** 150.3 samarium	**63** **Eu** 152.0 europium	**64** **Gd** 157.2 gadolinium	**65** **Tb** 158.9 terbium	**66** **Dy** 162.5 dysprosium	**67** **Ho** 164.9 holmium	**68** **Er** 167.3 erbium	**69** **Tm** 168.9 thulium	**70** **Yb** 173.0 ytterbium	**71** **Lu** 175.0 lutetium
90 **Th** 232.0 thorium	**91** **Pa** 231.0 protactinium	**92** **U** 238.0 uranium	**93** **Np** 237.1 neptunium	**94** **Pu** (244) plutonium	**95** **Am** (243) americium	**96** **Cm** (251) curium	**97** **Bk** (247) berkelium	**98** **Cf** (251) californium	**99** **Es** (252) einsteinium	**100** **Fm** (257) fermium	**101** **Md** (258) mendelevium	**102** **No** (259) nobelium	**103** **Lr** (260) lawrencium

atomic number
relative atomic mass
79 **Au** 197.0 gold
symbol of element
name of element

2. Physical constants

Avogadro's constant (N_A) = 6.02×10^{23} mol^{-1}

Charge on one electron = -1.60×10^{-19} C

Faraday constant (F) = 96 500 C mol^{-1}

Gas constant (R) = 8.31 J $K^{-1}mol^{-1}$

Ionic product for water (K_W) = 1.00×10^{-14} mol^2 L^{-2} at 298 K (self ionisation constant)

Molar volume (V_m) of an ideal gas at 273 K, 101.3 kPa (STP) = 22.4 L mol^{-1}

Molar volume (V_m) of an ideal gas at 298 K, 101.3 kPa (SLC) = 24.5 L mol^{-1}

Specific heat capacity (c) of water = 4.18 J g^{-1} K^{-1}

Density (d) of water at 25°C = 1.00 g mL^{-1}

1 atm = 101.3 kPa = 760 mmHg

0°C = 273 K

3. SI prefixes, their symbols and values

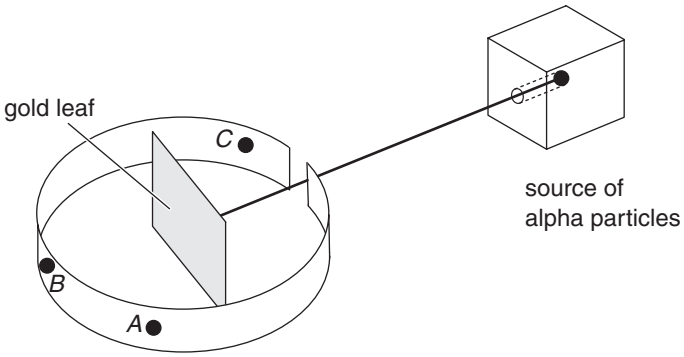
SI prefix	Symbol	Value
giga	G	10^9
mega	M	10^6
kilo	k	10^3
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

END OF DATA SHEET

Question 2

Knowledge about the structure of the atom, and the development of the modern Periodic Table, have been the result of the work of scientists over the last two centuries. This question concerns some of those scientists and their experiments.

a. In 1911, Ernest Rutherford conducted an experiment (shown below) to test the accuracy of the accepted atomic model of the time.



i. Alpha particles were detected in many locations including points *A*, *B* and *C*.

List the points *A*, *B* and *C* in order from where the lowest number of alpha particles was detected to the highest number.

_____

ii. From the results of this experiment, what did Rutherford conclude about the structure of the atom?

_____

_____

_____

_____

1 + 2 = 3 marks

b. William Ramsey discovered a number of elements at the beginning of the 20th century. In one experiment, a sample of air, with oxygen, carbon dioxide and water vapour removed, was passed repeatedly over red-hot magnesium until there was no further change in the gas volume. The final gas volume was one eightieth of the original volume of air.

i. Give the formula of the compound formed during the reaction using this technique.

_____

ii. Ramsey found that the remaining gas would not react with any substance.
In what group of the modern Periodic Table is this gas located?

_____

iii. Using modern atomic theory, explain why this remaining gas is so unreactive.

_____

_____

_____

_____

1 + 1 + 2 = 4 marks

c. In 1915, Henry Moseley studied the X-ray spectrum of ten elements which were placed consecutively in the Periodic Table. He concluded that 'there is in the atom a fundamental quantity which increases in regular steps as we pass from one element to the next'.

i. Identify the 'fundamental quantity'.

_____

ii. Moseley's findings moved chemists to change the arrangement of the elements of the Periodic Table from the method used by Mendeleev.

What property of the elements did Mendeleev use to place the elements in order?

_____

1 + 1 = 2 marks
Total 9 marks

Question 3

When paraffin oil is heated strongly in the presence of steel wool, the larger hydrocarbon molecules can be split apart to produce smaller saturated and unsaturated molecules.

a. One hydrocarbon in paraffin oil is $C_{17}H_{36}$.

Identify the homologous series to which this compound belongs.

_____

1 mark

b. In one experiment using this heating process, ethene and one other product was formed.

Write a balanced chemical equation for this reaction, using $C_{17}H_{36}$ as the reactant. Symbols of state are not required.

_____

1 mark

c. The following types of reactions were performed on the samples of ethene collected.

Write a balanced equation for each reaction. Symbols of state are not required.

i. Complete combustion of ethene.

_____

ii. Ethene reacted with chlorine gas.

_____

1 + 1 = 2 marks

d. One product collected in another experiment using the heating process is a saturated hydrocarbon with 82.8% carbon by mass.

Give the name and molecular formula of this saturated hydrocarbon.

_____

_____

_____

_____

2 marks

e. The usual method of collecting the hydrocarbons produced in the heating reaction relies on their insolubility in water.

Explain why hydrocarbons are not soluble in water.

_____

_____

_____

_____

2 marks

f. The steel wool used in this heating process is a catalyst, allowing the chemical reaction to occur at a lower temperature. Steel is an alloy, consisting mostly of iron with a small percentage of carbon added.

i. State one reason why metals are alloyed.

_____

_____

ii. Using the metallic bonding model, explain why the metal can be drawn out into the fine wires that compose steel wool.

_____

_____

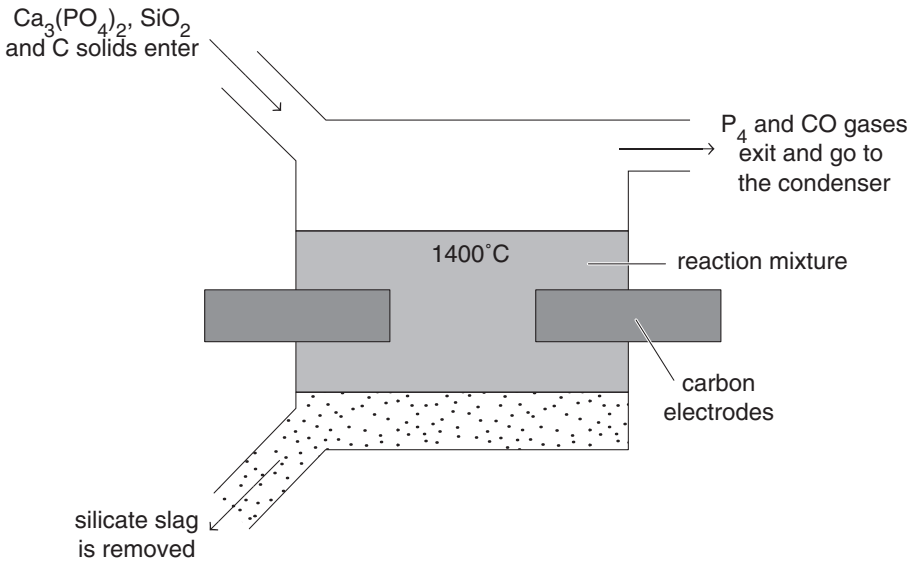
_____

_____

1 + 2 = 3 marks
Total 11 marks

Question 4

The element phosphorus is prepared industrially by heating calcium phosphate, $Ca_3(PO_4)_2$, with silicon dioxide, SiO_2, and carbon. A series of chemical reactions occurs in the furnace which eventually produces P_4 vapour.



a. The substance used for the carbon electrodes is graphite.

i. Using a labelled diagram, explain how the atoms are arranged in graphite.

_____

_____

_____

_____

ii. Which feature of the structure of graphite allows it to conduct electricity?

_____

_____

3 + 1 = 4 marks

b. Silicon dioxide is liquefied in the reaction mixture which is heated to 1400°C by electricity.

Explain why such high temperatures are needed to liquefy silicon dioxide.

_____

_____

_____

_____

2 marks

c. Phosphorus reacts readily with the Group 17 elements. One compound formed is phosphorus trifluoride, PF_3.

What shape is the PF_3 molecule?

_____

1 mark

d. A phosphorus atom can be ionised to form the phosphide ion, $^{31}P^{3-}$.

i. How many neutrons are in the nucleus of this ion?

_____

ii. Write the electron configuration of the ion using subshell notation.

_____

1 + 1 = 2 marks

e. Calculate the mass, in grams, of one P_4 molecule.

_____

_____

_____

1 mark

Total 10 marks

Question 5

One method to determine the empirical formula of a compound of lead and chlorine is to dissolve the solid in hot water and then add aluminium powder. A chemical reaction occurs that causes solid lead metal to form and aluminium ions to be produced. The results from such an experiment are shown below.

mass of lead chloride compound	1.213 g
mass of aluminium powder added	3.384 g
mass of lead metal recovered	0.902 g

a. Some of the aluminium powder remained unreacted. The unreacted aluminium powder was dissolved using sodium hydroxide solution.

Explain why this step was necessary.

_____

_____

1 mark

b. Calculate the amount (in mol) of lead recovered.

_____

_____

1 mark

c. Calculate the amount (in mol) of chlorine in the sample of lead chloride compound used.

_____

_____

_____

1 mark

d. Determine the empirical formula of the lead chloride compound.

_____

_____

1 mark

e. The situations shown in the table could occur during this experiment.

By ticking **one** box in each row, show the effect that each situation would have on the calculated amount of **chlorine** in the compound.

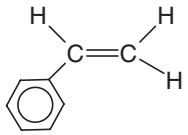
Situation	Calculated amount of chlorine would be too low	No effect on the calculated amount of chlorine	Calculated amount of chlorine would be too high
The lead metal was not completely dry before weighing.			
A greater mass of aluminium powder was used.			

2 marks

Total 6 marks

Question 6

Many familiar addition polymers are made by polymerising derivatives of ethene. These ethene derivatives are formed when one or more hydrogen atoms in the ethene molecule are replaced by another atom or group of atoms. One such derivative is styrene, produced when one hydrogen in ethene is replaced by a benzene ring (C_6H_6). The benzene ring is often represented by the symbol  for simplicity. A sketch of the styrene molecule is shown below.



Polystyrene is one of the most widely used kinds of plastics, for example in disposable cutlery and DVD cases. Foamed polystyrene is also common, for example in foam drink cups and packing materials.

a. **i.** Draw a small section of the polystyrene polymer.

ii. Give the empirical formula for polystyrene.

_____

iii. Would you expect polystyrene to be thermosetting or thermosoftening? Explain your choice.

_____

_____

_____

_____

1 + 1 + 2 = 4 marks

b. Two of the forms of polystyrene produced are atactic and syndiotactic. In the atactic form the large benzene rings are distributed randomly on both sides of the hydrocarbon backbone. In the syndiotactic form the benzene rings are produced on alternating sides of the hydrocarbon backbone.

Which form of polystyrene, atactic or syndiotactic, would be expected to have the higher melting point? Explain your choice.

_____

_____

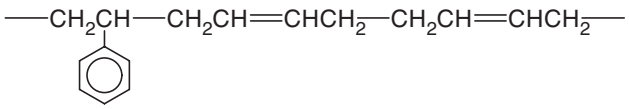
_____

_____

_____

2 marks

c. Styrene is also used as a monomer in the production of the copolymer styrene-butadiene rubber (SBR). SBR is a copolymer of approximately 25% styrene and 75% butadiene. A section of the copolymer is shown below.

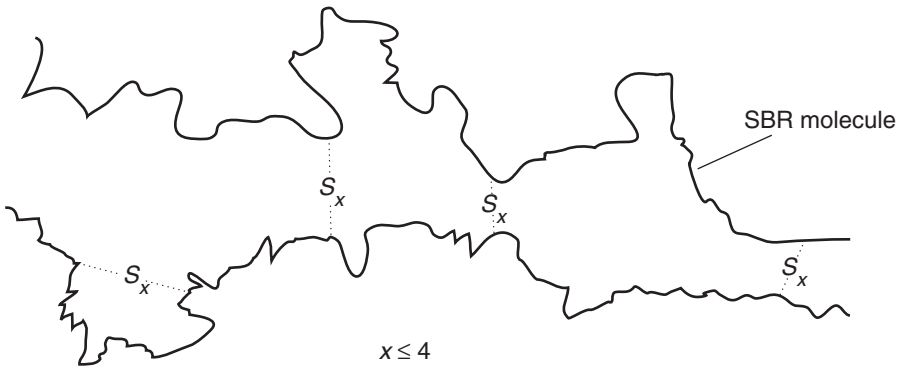


Give the molecular formula for butadiene.

_____

1 mark

d. Like natural rubber, SBR molecules contain double bonds which can be cross-linked by vulcanisation. In this process the polymer is reacted with sulfur, resulting in a small number of crosslinks as shown in the diagram below.



Explain the effect of this cross-linking on the properties of SBR.

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2 marks

Total 9 marks

END OF QUESTION AND ANSWER BOOKLET

