

Write your name here

Surname

Other names

Centre Number

Candidate Number

Edexcel GCE**Chemistry****Advanced Subsidiary****Unit 1: The Core Principles of Chemistry**

Friday 13 January 2012 – Afternoon

Time: 1 hour 30 minutes

Paper Reference

6CH01/01**Candidates may use a calculator.**

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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**PEARSON**

SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box . If you change your mind, put a line through the box and then mark your new answer with a cross .

1 A molecule is

- A a group of atoms bonded by ionic bonds.
- B a group of atoms bonded by covalent bonds.
- C a group of ions bonded by covalent bonds.
- D a group of atoms bonded by metallic bonds.

(Total for Question 1 = 1 mark)

2 The relative atomic mass is defined as

- A the mass of an atom of an element relative to $1/12$ the mass of a carbon-12 atom.
- B the mass of an atom of an element relative to the mass of a hydrogen atom.
- C the average mass of an element relative to $1/12$ the mass of a carbon atom.
- D the average mass of an atom of an element relative to $1/12$ the mass of a carbon-12 atom.

(Total for Question 2 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



3 The definition of the mole is

- A the amount of any substance which occupies a volume of 24 dm^3 at room temperature and pressure.
- B the amount of any substance containing the same number of identical entities as there are in exactly 12 g of the carbon-12 isotope.
- C the number of atoms in exactly 12 g of the carbon-12 isotope.
- D the number of molecules in exactly 2 g of hydrogen at room temperature and pressure.

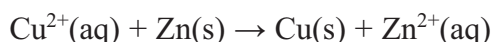
(Total for Question 3 = 1 mark)

4 The concentration of blood glucose is usually given in millimoles per dm^3 or mmol dm^{-3} . A reading of 5.0 mmol dm^{-3} is within the normal range. Glucose has a molar mass of 180 g mol^{-1} . What mass of glucose dissolved in 1 dm^3 of blood would give this normal reading?

- A 0.090 g
- B 0.18 g
- C 0.90 g
- D 9.0 g

(Total for Question 4 = 1 mark)

5 In an experiment performed to measure the enthalpy change for the reaction



3.0 g of zinc powder (an excess) was added to 30.0 cm^3 of copper(II) sulfate solution of concentration 1.00 mol dm^{-3} . The temperature rise of the mixture was 47.6 K. Assuming that the heat capacity of the solution is $4.2 \text{ J K}^{-1} \text{ g}^{-1}$, the enthalpy change for the reaction is given by

- A $\Delta H = -(30 \times 4.2 \times 47.6) \div 0.03$
- B $\Delta H = -(33 \times 4.2 \times 47.6) \div 0.03$
- C $\Delta H = -(30 \times 4.2 \times 47.6) \times 0.03$
- D $\Delta H = -(33 \times 4.2 \times 47.6) \times 0.03$

(Total for Question 5 = 1 mark)

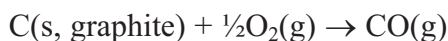


6 The enthalpy change of atomization of iodine is the value of ΔH for the process

- A $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$
 B $\text{I}_2(\text{s}) \rightarrow 2\text{I}(\text{g})$
 C $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$
 D $\frac{1}{2}\text{I}_2(\text{s}) \rightarrow \text{I}(\text{g})$

(Total for Question 6 = 1 mark)

7 The enthalpy change for the reaction



cannot be measured directly since some carbon dioxide is always formed in the reaction. It can be calculated using Hess's Law and the enthalpy changes of combustion of graphite and of carbon monoxide.



The enthalpy change for the reaction of graphite with oxygen to give carbon monoxide is

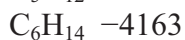
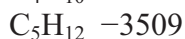
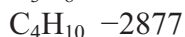
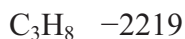
- A -677 kJ mol^{-1}
 B $+111 \text{ kJ mol}^{-1}$
 C -111 kJ mol^{-1}
 D $+677 \text{ kJ mol}^{-1}$

(Total for Question 7 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



8 The molar enthalpy change of combustion of some alkanes is given below in kJ mol^{-1} .



Another alkane was found to have an enthalpy change of combustion of $-6125 \text{ kJ mol}^{-1}$.
The alkane is

- A C_7H_{16}
- B C_8H_{18}
- C C_9H_{20}
- D $\text{C}_{10}\text{H}_{22}$

(Total for Question 8 = 1 mark)

9 If the mean C—H bond enthalpy is $+x$, which of the following represents a process with an enthalpy change of $+4x$?

- A $\text{C}(\text{g}) + 4\text{H}(\text{g}) \rightarrow \text{CH}_4(\text{g})$
- B $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$
- C $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{s, graphite}) + 2\text{H}_2(\text{g})$
- D $\text{C}(\text{s, graphite}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_4(\text{g})$

(Total for Question 9 = 1 mark)

10 The first eight ionization energies of an element are (in kJ mol^{-1}):

789, 1577, 3232, 4356, 16091, 19785, 23787, 29253.

The element is in

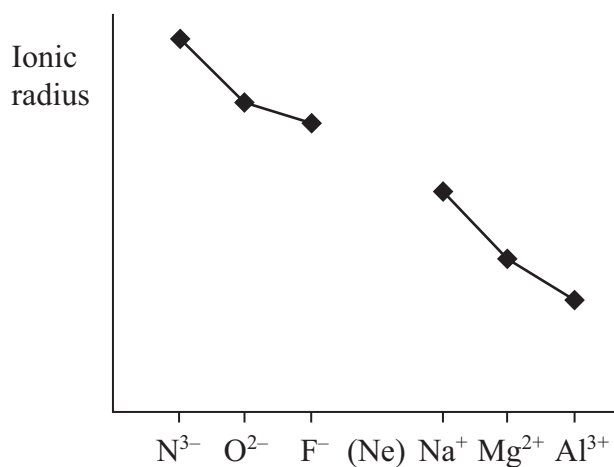
- A Group 1
- B Group 2
- C Group 3
- D Group 4

(Total for Question 10 = 1 mark)

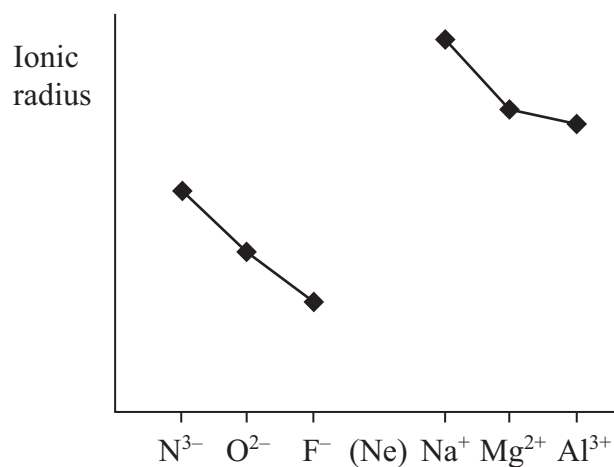


11 Which of the graphs shows (from left to right) the trend in the ionic radius of the isoelectronic ions N^{3-} , O^{2-} , F^- , Na^+ , Mg^{2+} , Al^{3+} ?

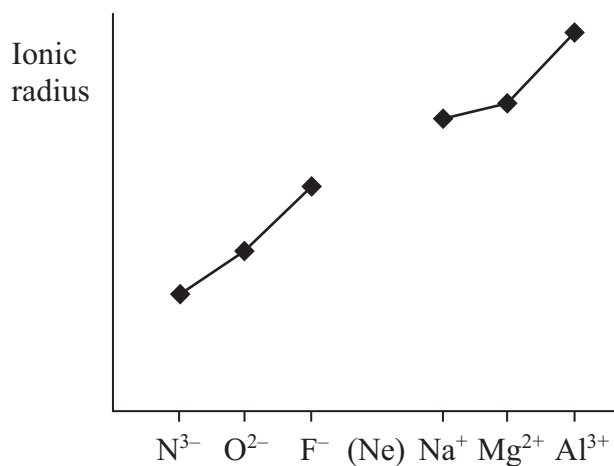
A



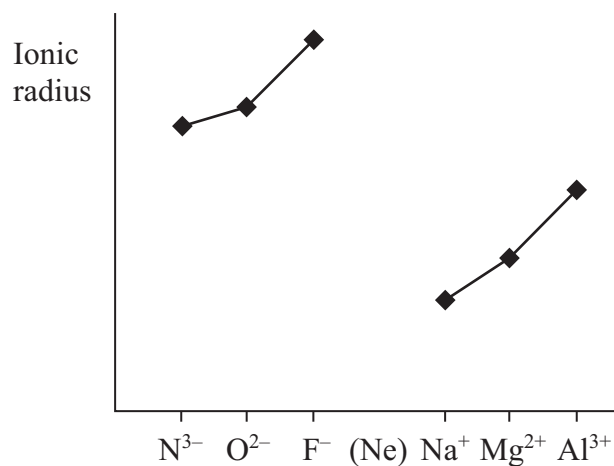
B



C



D



(Total for Question 11 = 1 mark)

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12 Oxygen can be prepared using several different reactions. Which of those given below has the highest atom economy by mass?

- A $\text{NaNO}_3 \rightarrow \text{NaNO}_2 + \frac{1}{2}\text{O}_2$
- B $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \frac{1}{2}\text{O}_2$
- C $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow 2\text{HCl} + \frac{1}{2}\text{O}_2$
- D $\text{PbO}_2 \rightarrow \text{PbO} + \frac{1}{2}\text{O}_2$

(Total for Question 12 = 1 mark)

13 The ionic radii in nm of some ions are given below.

Li^+	0.074	F^-	0.133
Ca^{2+}	0.100	Cl^-	0.180
		O^{2-}	0.140
		S^{2-}	0.185

(a) Which of the following compounds has the most exothermic lattice energy? They all have the same crystal structure.

(1)

- A LiF
- B LiCl
- C CaO
- D CaS

(b) Which of the following compounds will show the greatest difference between the experimental (Born-Haber) lattice energy and that calculated from a purely ionic model?

(1)

- A LiF
- B Li_2O
- C CaO
- D CaS

(Total for Question 13 = 2 marks)

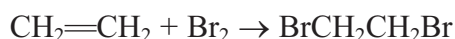


14 Which of the following is the correct order for the processes used to obtain petrol from petroleum (crude oil)?

- A Petroleum → fractional distillation → reforming → cracking → petrol.
- B Petroleum → reforming → fractional distillation → cracking → petrol.
- C Petroleum → cracking → reforming → fractional distillation → petrol.
- D Petroleum → fractional distillation → cracking → reforming → petrol.

(Total for Question 14 = 1 mark)

15 In the reaction between ethene and bromine, the bromine molecule acts as an electrophile.

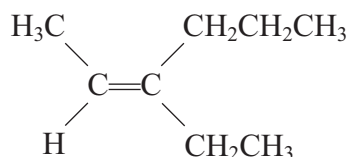


Which of the following statements is true?

- A Ethene acts as a nucleophile because it is polar.
- B Ethene acts as a nucleophile because it can donate a pair of electrons to bromine.
- C Ethene is not a nucleophile in this reaction.
- D Ethene acts as a nucleophile because it donates a single electron to bromine.

(Total for Question 15 = 1 mark)

16 Name the alkene shown below.



- A Z-4-ethylhex-4-ene
- B E-3-ethylhex-2-ene
- C Z-3-ethylhex-2-ene
- D E-3-propylpent-2-ene

(Total for Question 16 = 1 mark)



17 If propene, $\text{CH}_3\text{CH}=\text{CH}_2$, is reacted with aqueous acidified potassium manganate(VII) the organic product is

- A $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{OH}$
- B $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- C $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{OH}$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

(Total for Question 17 = 1 mark)

18 How many compounds have the formula C_5H_{12} ?

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

(Total for Question 18 = 1 mark)

19 An organic compound reacts with chlorine in the presence of ultraviolet light. The relative molecular mass of the product has increased by 34.5 compared with the original compound. What is the reaction mechanism?

- A Free radical substitution
- B Electrophilic substitution
- C Nucleophilic substitution
- D Free radical addition

(Total for Question 19 = 1 mark)

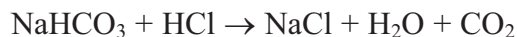
TOTAL FOR SECTION A = 20 MARKS



SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

- 20 (a) An impure sample of sodium hydrogencarbonate, NaHCO_3 , of mass 0.227 g, was reacted with an excess of hydrochloric acid. The volume of carbon dioxide evolved was measured at room temperature and pressure and found to be 58.4 cm^3 .



The molar volume of any gas at the temperature and pressure of the experiment is $24 \text{ dm}^3 \text{ mol}^{-1}$. The molar mass of sodium hydrogencarbonate is 84 g mol^{-1} .

- (i) Calculate the number of moles of carbon dioxide given off. (1)

- (ii) Calculate the mass of sodium hydrogencarbonate present in the impure sample. (2)

- (iii) Calculate the percentage purity of the sodium hydrogencarbonate. Give your answer to two significant figures. (2)



(b) (i) The total error in reading the gas syringe is $\pm 0.4 \text{ cm}^3$. Calculate the percentage error in measuring the gas volume of 58.4 cm^3 . (1)

(ii) Suggest why the carbon dioxide should not be collected over water in this experiment. (1)

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(Total for Question 20 = 7 marks)



- 21 (a) On strong heating, calcium carbonate decomposes to calcium oxide and carbon dioxide:



Owing to the conditions under which the reaction occurs, it is not possible to measure the enthalpy change directly.

An indirect method employs the enthalpy changes when calcium carbonate and calcium oxide are neutralized with hydrochloric acid.

- (i) Write the equation for the reaction of calcium carbonate with hydrochloric acid. State symbols are **not** required.

$[\Delta H_1$ is the enthalpy change for this reaction]

(1)

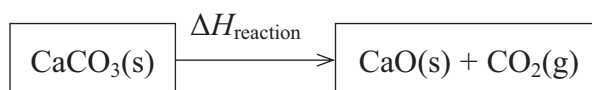
..... ΔH_1

- (ii) The reaction of calcium oxide with hydrochloric acid is



Use the equations in parts (i) and (ii) to complete the Hess's Law cycle below to show how you could calculate the enthalpy change for the decomposition of calcium carbonate, $\Delta H_{\text{reaction}}$. Label the arrows in your cycle.

(3)



(iii) Complete the expression for $\Delta H_{\text{reaction}}$ in terms of ΔH_1 and ΔH_2 .

(1)

$$\Delta H_{\text{reaction}} =$$

(b) Suggest **two** reasons why the value obtained by carrying out these two experiments and using the equation gives a value different to the data booklet value for the decomposition reaction of calcium carbonate.

(2)

1

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2

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(Total for Question 21 = 7 marks)



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22 (a) State how the following processes are achieved in a mass spectrometer.

(i) Ionization of the sample. (1)

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(ii) Acceleration of the ions. (1)

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(iii) Deflection of the ions. (1)

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(b) State how you could find the molecular mass of a substance from its mass spectrum. (1)

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(c) Living things take up the radioactive isotope carbon-14 from the atmosphere. In recent years a particular linen cloth was shown, using mass spectrometry, to have been made from flax grown in the early 14th century. Suggest how mass spectrometry can be used to estimate the age of the cloth. (2)

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(Total for Question 22 = 6 marks)



*23 The melting temperatures of the elements of Period 3 are given in the table below. Use these values to answer the questions that follow.

Element	Na	Mg	Al	Si	P (white)	S (monoclinic)	Cl	Ar
Melting temperature / K	371	922	933	1683	317	392	172	84

(a) Explain why the melting temperature of sodium is very much less than that of magnesium.

(3)

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(b) Explain why the melting temperature of silicon is very much greater than that of white phosphorus.

(3)

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- 24 (a) Briefly describe an experiment, with a diagram of the apparatus you would use, which shows that there are oppositely charged ions in copper(II) chromate(VI), CuCrO_4 . Describe what you would expect to see.

Formula of ion	Colour
$\text{Cu}^{2+}(\text{aq})$	blue
$\text{CrO}_4^{2-}(\text{aq})$	yellow

(4)

Diagram

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- (b) The ions in an ionic lattice are held together by an **overall** force of attraction.

(i) Describe the forces of attraction in an ionic lattice.

(1)

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(ii) Suggest **two** forces of repulsion which exist in an ionic lattice.

(2)

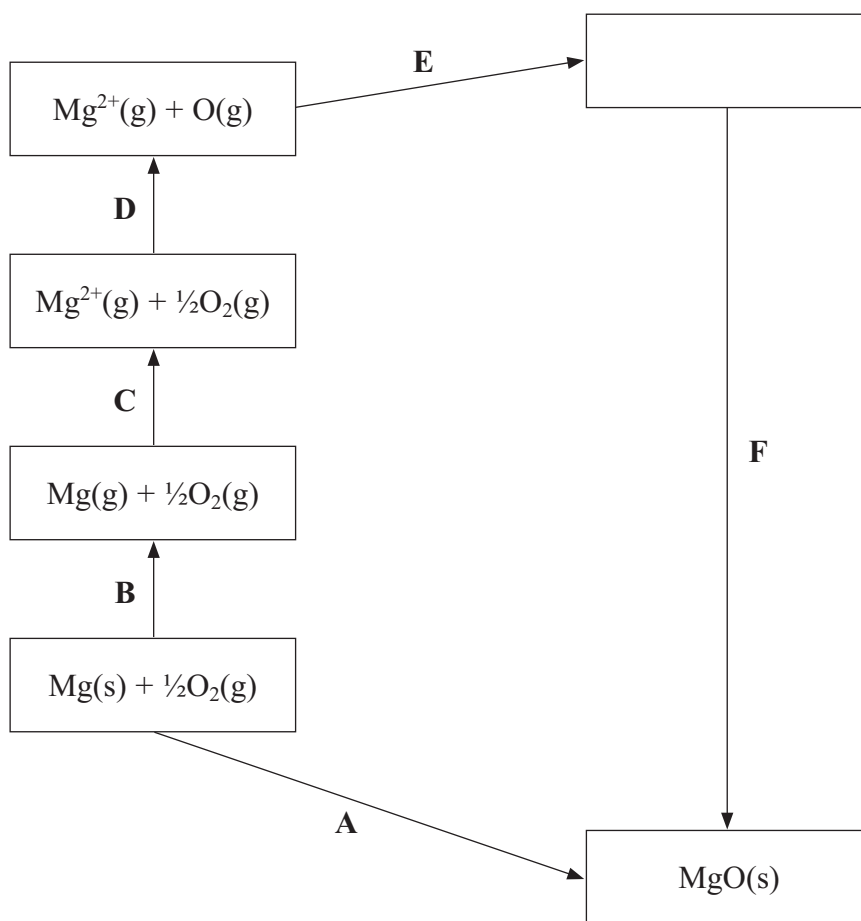
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(c) Part of the Born-Haber cycle for magnesium oxide, MgO, is shown below.



- (i) Complete the empty box with the appropriate formulae and state symbols. (2)
- (ii) Identify the enthalpy changes represented by the letters A and C. (2)

A

C

- (iii) Give the expression for the enthalpy change F in terms of the other enthalpy changes A to E. (1)

F =



(d) The lattice composed of the ions Mg^{2+} and O^{2-} is stronger than a lattice composed of the ions Mg^+ and O^- .

(i) Explain, in terms of the charges on the ions and the size of the cations, why this is so.

(2)

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(ii) Suggest how the lattice energy of $\text{Mg}^{2+}\text{O}^{2-}$ would differ from that of Mg^+O^- .

(1)

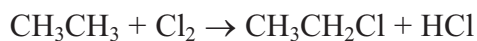
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(Total for Question 24 = 15 marks)



25 Chloroethane can be made from ethane and chlorine in the gas phase in the presence of ultraviolet light. The equation for the reaction is



(a) Complete the mechanism for the reaction. Two of the steps have been given for you.

(4)

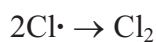
Initiation: $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$

Propagation (two steps)

(i)

(ii)

Termination (three steps)



(iii)

(iv)

(b) This reaction gives a poor yield of chloroethane. Give the structural formula and name of another organic product, not included in your mechanism for part (a), which could be produced in the reaction.

(2)

Formula

Name



(c) Chlorine gas is extremely toxic and is therefore a significant hazard. The preparation must be performed so as to minimise the risk to the experimenter.

(i) Explain the difference between **hazard** and **risk**.

(2)

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(ii) Give one precaution that you would use in this experiment to minimise the risk, other than the use of a laboratory coat and safety goggles.

(1)

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(Total for Question 25 = 9 marks)



26 (a) The alkenes have the general formula C_nH_{2n} . However, a compound with this general formula is not necessarily an alkene. Suggest why this is so. (1)

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(b) Give the equation, using skeletal formulae, for the reaction of propene with each of the following.

(i) Hydrogen: (1)

(ii) Hydrogen bromide to form the major product: (2)

(c) Give the mechanism for the reaction of propene with hydrogen bromide, HBr, to form the major product. (3)

(Total for Question 26 = 7 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS



The Periodic Table of Elements

	1	2	3	4	5	6	7	0 (8)											
	1.0 H hydrogen 1							4.0 He helium 2											
								(18)											
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	6.9 Li lithium 3	9.0 Be beryllium 4	11 Na sodium 11	12 Mg magnesium 12	13 Al aluminium 13	14 Si silicon 14	15 P phosphorus 15	16 S sulfur 16	17 Cl chlorine 17	18 Ar argon 18									
	19 K potassium 19	20 Ca calcium 20	21 Sc scandium 21	22 Ti titanium 22	23 V vanadium 23	24 Cr chromium 24	25 Mn manganese 25	26 Fe iron 26	27 Co cobalt 27	28 Ni nickel 28	29 Cu copper 29	30 Zn zinc 30	31 Ga gallium 31	32 Ge germanium 32	33 As arsenic 33	34 Se selenium 34	35 Br bromine 35	36 Kr krypton 36	
	37 Rb rubidium 37	38 Sr strontium 38	39 Y yttrium 39	40 Zr zirconium 40	41 Nb niobium 41	42 Mo molybdenum 42	43 Tc technetium [98]	44 Ru ruthenium 44	45 Rh rhodium 45	46 Pd palladium 46	47 Ag silver 47	48 Cd cadmium 48	49 In indium 49	50 Sn tin 50	51 Sb antimony 51	52 Te tellurium 52	53 I iodine 53	54 Xe xenon 54	
	55 Cs caesium 55	56 Ba barium 56	57 La* lanthanum 57	72 Hf hafnium 72	73 Ta tantalum 73	74 W tungsten 74	75 Re rhenium 75	76 Os osmium 76	77 Ir iridium 77	78 Pt platinum 78	79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Pb lead 82	83 Bi bismuth 83	84 Po polonium 84	85 At astatine 85	86 Rn radon 86	
	87 Fr francium 87	88 Ra radium 88	89 Ac* actinium 89	104 Rf rutherfordium 104	105 Db dubnium 105	106 Sg seaborgium 106	107 Bh bohrium 107	108 Hs hassium 108	109 Mt meitnerium 109	110 Ds darmstadtium 110	111 Rg roentgenium 111	112-116 Elements with atomic numbers 112-116 have been reported but not fully authenticated	117 Tl tennessine 117	118 Og oganesson 118	119 Uue unbinilium 119	120 Uub unbinilium 120	121 Uut ununilium 121	122 Uuq ununilium 122	123 Uuq ununilium 123
	124 Uuq ununilium 124	125 Uuq ununilium 125	126 Uuq ununilium 126	127 Uuq ununilium 127	128 Uuq ununilium 128	129 Uuq ununilium 129	130 Uuq ununilium 130	131 Uuq ununilium 131	132 Uuq ununilium 132	133 Uuq ununilium 133	134 Uuq ununilium 134	135 Uuq ununilium 135	136 Uuq ununilium 136	137 Uuq ununilium 137	138 Uuq ununilium 138	139 Uuq ununilium 139	140 Uuq ununilium 140	141 Uuq ununilium 141	142 Uuq ununilium 142
	143 Uuq ununilium 143	144 Uuq ununilium 144	145 Uuq ununilium 145	146 Uuq ununilium 146	147 Uuq ununilium 147	148 Uuq ununilium 148	149 Uuq ununilium 149	150 Uuq ununilium 150	151 Uuq ununilium 151	152 Uuq ununilium 152	153 Uuq ununilium 153	154 Uuq ununilium 154	155 Uuq ununilium 155	156 Uuq ununilium 156	157 Uuq ununilium 157	158 Uuq ununilium 158	159 Uuq ununilium 159	160 Uuq ununilium 160	161 Uuq ununilium 161
	162 Uuq ununilium 162	163 Uuq ununilium 163	164 Uuq ununilium 164	165 Uuq ununilium 165	166 Uuq ununilium 166	167 Uuq ununilium 167	168 Uuq ununilium 168	169 Uuq ununilium 169	170 Uuq ununilium 170	171 Uuq ununilium 171	172 Uuq ununilium 172	173 Uuq ununilium 173	174 Uuq ununilium 174	175 Uuq ununilium 175	176 Uuq ununilium 176	177 Uuq ununilium 177	178 Uuq ununilium 178	179 Uuq ununilium 179	180 Uuq ununilium 180
	181 Uuq ununilium 181	182 Uuq ununilium 182	183 Uuq ununilium 183	184 Uuq ununilium 184	185 Uuq ununilium 185	186 Uuq ununilium 186	187 Uuq ununilium 187	188 Uuq ununilium 188	189 Uuq ununilium 189	190 Uuq ununilium 190	191 Uuq ununilium 191	192 Uuq ununilium 192	193 Uuq ununilium 193	194 Uuq ununilium 194	195 Uuq ununilium 195	196 Uuq ununilium 196	197 Uuq ununilium 197	198 Uuq ununilium 198	199 Uuq ununilium 199
	200 Uuq ununilium 200	201 Uuq ununilium 201	202 Uuq ununilium 202	203 Uuq ununilium 203	204 Uuq ununilium 204	205 Uuq ununilium 205	206 Uuq ununilium 206	207 Uuq ununilium 207	208 Uuq ununilium 208	209 Uuq ununilium 209	210 Uuq ununilium 210	211 Uuq ununilium 211	212 Uuq ununilium 212	213 Uuq ununilium 213	214 Uuq ununilium 214	215 Uuq ununilium 215	216 Uuq ununilium 216	217 Uuq ununilium 217	218 Uuq ununilium 218
	219 Uuq ununilium 219	220 Uuq ununilium 220	221 Uuq ununilium 221	222 Uuq ununilium 222	223 Uuq ununilium 223	224 Uuq ununilium 224	225 Uuq ununilium 225	226 Uuq ununilium 226	227 Uuq ununilium 227	228 Uuq ununilium 228	229 Uuq ununilium 229	230 Uuq ununilium 230	231 Uuq ununilium 231	232 Uuq ununilium 232	233 Uuq ununilium 233	234 Uuq ununilium 234	235 Uuq ununilium 235	236 Uuq ununilium 236	237 Uuq ununilium 237
	238 Uuq ununilium 238	239 Uuq ununilium 239	240 Uuq ununilium 240	241 Uuq ununilium 241	242 Uuq ununilium 242	243 Uuq ununilium 243	244 Uuq ununilium 244	245 Uuq ununilium 245	246 Uuq ununilium 246	247 Uuq ununilium 247	248 Uuq ununilium 248	249 Uuq ununilium 249	250 Uuq ununilium 250	251 Uuq ununilium 251	252 Uuq ununilium 252	253 Uuq ununilium 253	254 Uuq ununilium 254	255 Uuq ununilium 255	256 Uuq ununilium 256
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	409 Uuq ununilium 409	410 Uuq ununilium 410	411 Uuq ununilium 411	412 Uuq ununilium 412	413 Uuq ununilium 413	414 Uuq ununilium 414	415 Uuq ununilium 415	416 Uuq ununilium 416	417 Uuq ununilium 417	418 Uuq ununilium 418	419 Uuq ununilium 419	420 Uuq ununilium 420	421 Uuq ununilium 421	422 Uuq ununilium 422	423 Uuq ununilium 423	424 Uuq ununilium 424	425 Uuq ununilium 425	426 Uuq ununilium 426	