Periodic Table, Group 2 & The Halogens AS & A Level

Question Paper 4

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Periodic Table & Energy
Topic	Periodic Table, Group 2 & The Halogens
Paper	AS & A Level
Booklet	Question Paper 4

Time allowed: **53 minutes**

Score: **/39**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

This question refers to the elements in the first three periods (H → Ar) of the Periodic Table.

(a) Select an element from the first three periods that fits each of the following descriptions.

(i) The element that forms a 1– ion with the same electron configuration as helium.

[1]

(ii) The element with the highest first ionisation energy.

[1]

(iii) The element in Period 3 which has the successive ionisation energies shown below.

Ionisation number	1st	2nd	3rd	4th
Ionisation energy/kJ mol^{-1}	738	1451	7733	10541

[1]

(iv) The element which forms a compound with fluorine that has octahedral molecules.

[1]

(v) An element which reacts with water to form an acidic solution.

[1]

(vi) The element **X**, which forms a compound with hydrogen, **X**H_3, with a molar mass of 34.0 g mol^{-1}.

[1]

(vii) An element which forms a compound with hydrogen in which the element has an oxidation number of –4.

[1]

(viii) The element which has a density of 1.33×10^{-3} g cm^{-3} at room temperature and pressure.

[1]

(b) Table 1.1 shows some properties of Period 3 chlorides.

Group		**1**	**2**	**14 (4)**	**15 (5)**	**16 (6)**
Chloride		$NaCl$	$MgCl_2$	$SiCl_4$	PCl_3	SCl_2
Electrical conductivity	**Solid**	poor	poor	poor	poor	poor
	Liquid	good	good	poor	poor	poor
Melting point		high	high	low	low	low

Table 1.1

Explain the properties shown in **Table 1.1** in terms of bonding and structure.

[5]

(Total 13 marks)

This question is about ions and compounds containing hydrogen.

(a) Lithium aluminium hydride, $LiAlH_4$, contains the AlH_4^- ion.

Draw a '*dot-and-cross*' diagram to show the bonding in an AlH_4^- ion.

Show outer electrons only.

[1]

(b) Nitrogen forms NH_4^+ and NH_2^- ions.

Predict the name of the shape of, and H–N–H bond angle in, NH_4^+ and NH_2^-.

Ion	Name of shape	H–N–H bond angle
NH_4^+	.....	.....
NH_2^-	.....	.....

[2]

(c) Nitrogen, phosphorus and arsenic are in Group 15 (5) of the periodic table.

The boiling points of their hydrides are shown below.

Element	Hydride	Boiling point / °C
N	NH_3	–33
P	PH_3	–88
As	AsH_3	–55

(i) Explain why the boiling point of PH_3 is lower than the boiling point of NH_3. **[2]**

(ii) Explain why the boiling point of PH_3 is lower than the boiling point of AsH_3.

[2]

(Total 7 marks)

This question is about properties of the halogens and halide ions.

(a) Bromine can be extracted by bubbling chlorine gas through concentrated solutions containing bromide ions.

(i) Write the electron configuration of a bromide ion, in terms of sub-shells.

[1]

(ii) Write an ionic equation for this reaction and state why this reaction takes place in terms of reactivity of the halogens.

[2]

(b) Chlorine is used in water treatment.

State **one** benefit and **one** risk of chlorine in water treatment.

[1]

(c) Precipitation reactions can be used to distinguish between halide ions.

(i) State the reagent needed for these precipitation reactions. **[1]**

(ii) How would the appearance of the precipitates allow you to distinguish between chloride, bromide and iodide ions?

Chloride .....

Bromide .....

Iodide .....

[1]

(Total 6 marks)

The chlor-alkali industry is an important part of the UK chemical industry.

The raw material is brine, a concentrated aqueous solution of sodium chloride, NaCl(aq). Two products that can be manufactured from brine are chlorine and sodium hydroxide — hence the name chlor-alkali.

(a) Bleach can be made by reacting chlorine with cold aqueous sodium hydroxide. A solution of bleach contains the chlorate compound NaClO.

Write the equation for the reaction taking place. [1]

(b) The systematic name for NaClO is sodium chlorate(I). Other chlorate compounds exist, such as $NaClO_3$.

(i) Give the systematic name for $NaClO_3$. [1]

(ii) When heated, $NaClO_3$ disproportionates as shown in the equation below.

$$4NaClO_3 \rightarrow 3NaClO_4 + NaCl$$

Using oxidation numbers, explain why this is a disproportionation reaction. [3]

(c) Chlorine has been added to drinking water for over a century. Recently, some scientists have put forward the case for **not** chlorinating drinking water. This is because chlorine may react with organic compounds in the water to form CH_3Cl.

(i) State **one** valid reason that supports the scientists' case and state **one** reason why chlorine should be added to drinking water [2]

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in a molecule of CH_3Cl.

Show **outer** electrons only. [1]

(iii) Name the shape of a molecule of CH_3Cl . [1]

(d) A sample of brine is a concentrated aqueous solution of sodium chloride, NaC*l*(aq).

Describe a simple chemical test that you could carry out to show that brine contains aqueous chloride ions. How would you confirm that no other halide ions are present?

Include an ionic equation in your answer. [4]

[Total: 13 Marks]