Paper 3

Questions are applicable for both core and extended candidates

1 The chemical elements are arranged in the Periodic Table in groups and periods.

(b) Chlorine, bromine and iodine are in Group VII of the Periodic Table.

(i) Aqueous chlorine reacts with aqueous sodium bromide to produce aqueous bromine and aqueous sodium chloride.

Complete the symbol equation for this reaction.

$$Cl_2 + ...NaBr \rightarrow ..... + 2NaCl$$ [2]

(ii) Suggest why aqueous iodine does **not** react with aqueous sodium bromide.

.....

..... [1]

(iii) Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of iodine.

Show outer shell electrons only.

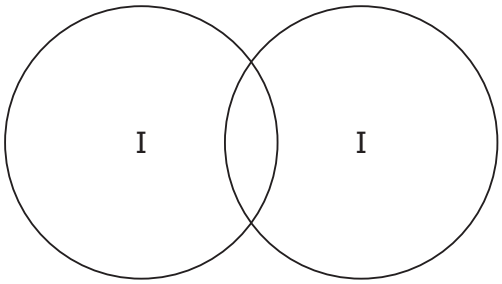

Fig. 3.1

[2]

2 Potassium iodide is an ionic compound.

(d) Aqueous chlorine reacts with aqueous potassium iodide.

(i) Complete the symbol equation for this reaction.

$$Cl_2 + 2KI \rightarrow \text{.....} + \text{....}KCl$$ [2]

(ii) Choose from the list the name of this type of reaction.

Draw a circle around your chosen answer.

addition **combustion** **displacement** **neutralisation** [1]

(iii) State the colour of chlorine gas at room temperature and pressure.

..... [1]

3 **(a)** Table 2.1 shows some properties of the halogens.

Table 2.1

halogen	melting point in °C	boiling point in °C	density at room temperature and pressure in g/cm^3
fluorine	–220	–188	0.0016
chlorine	–101	–35	0.0032
bromine		+59	3.1
iodine	+114	+184	

Use the information in Table 2.1 to predict:

(i) the melting point of bromine

..... [1]

(ii) the density of iodine at room temperature and pressure

..... [1]

(iii) the physical state of chlorine at –10 °C. Give a reason for your answer.

physical state .....

reason .....

.....
[2]

(b) The equation for the reaction of aqueous chlorine with aqueous potassium iodide is shown.

$$Cl_2 + 2KI \rightarrow I_2 + 2KCl$$

(i) Choose the word which best describes this type of chemical reaction.
Draw a circle around your chosen answer.

addition **displacement** **neutralisation** **polymerisation** [1]

(ii) Explain why aqueous iodine does **not** react with aqueous potassium chloride.

..... [1]

4 **(a)** Table 7.1 shows some properties of some of the halogens.

Table 7.1

halogen	melting point / °C	boiling point / °C	colour
chlorine	−101	−35	yellow-green
bromine	−7		red-brown
iodine	+114	+184	grey-black
astatine	+302	+337	

Use the information in Table 7.1 to suggest:

- the colour of astatine .....
- the boiling point of bromine .....
- the state of iodine at 190 °C. .....

[3]

(b) Aqueous chlorine reacts with aqueous potassium bromide as shown.

$$Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$$

(i) Name the salt formed in this reaction.

..... [1]

(ii) Explain why aqueous bromine does **not** react with aqueous potassium chloride.

.....

..... [1]

(iii) Complete the dot-and-cross diagram in Fig. 7.1 of a molecule of chlorine.

Show outer shell electrons only.

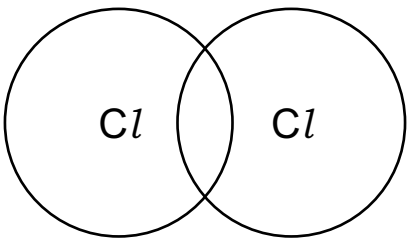

Fig. 7.1

[2]

[Total: 7]

5 This question is about chlorine and compounds of chlorine.

(a) Chlorine is an element in Group VII of the Periodic Table.

State the meaning of the term *element*.

.....

..... [1]

(b) State **one** use of chlorine.

..... [1]

(c) Chlorine reacts with phosphorus to produce phosphorus(V) chloride.

(i) Balance the equation for this reaction.

$$\text{.....P} + \text{.....C}l_2 \rightarrow 2\text{PC}l_5$$ [2]

(ii) This reaction is exothermic.

State the meaning of the term *exothermic*.

..... [1]

(d) Chlorine reacts with aqueous sodium bromide.

(i) Complete the word equation for this reaction.

chlorine	+	sodium bromide	→	.....	+	....

[2]

(ii) Describe a test for bromide ions.

test .....

observations .....

[2]

(iii) When bromine is mixed with aqueous sodium chloride there is no reaction.

Suggest in terms of chemical reactivity why there is no reaction.

..... [1]

6 This question is about halogens and halogen compounds.

(a) Deduce the number of electrons, neutrons and protons in one atom of the isotope of chlorine shown.

$^{37}_{17}Cl$

number of electrons .....

number of neutrons .....

number of protons .....

[3]

(b) State why chlorine is used in water treatment.

..... [1]

(c) Aqueous chlorine reacts with aqueous potassium iodide.

(i) Complete the chemical equation for this reaction.

Cl_2 + ...KI $\rightarrow$ .....KCl + I_2 [2]

(ii) Explain in terms of the reactivity of the halogens why aqueous iodine does **not** react with aqueous potassium chloride.

.....

..... [1]

(d) The table shows some properties of four halogens.

halogen	melting point / °C	boiling point / °C	density of liquid at boiling point in g / cm^3
fluorin	–220	.....	1.51
chlorine	–101	–35	.....
bromine	–7	59	3.12
iodine	114	184	4.93

(i) Complete the table by predicting:
- the boiling point of fluorine
- the density of liquid chlorine at its boiling point. [2]

(ii) Predict the physical state of chlorine at –105 °C.
Give a reason for your answer.

.....

..... [2]

[Total: 11]

7 This question is about halogens.

(a) The table shows some properties of four halogens.

halogen	melting point in °C	boiling point in °C	density at room temperature and pressure in g / cm^3
fluorin	–220	–188	.....
chlorine	.....	–35	0.003
bromine	–7	59	3.12
iodine	114	184	4.93

(i) Complete the table by predicting:
- the melting point of chlorine
- the density of fluorine at room temperature and pressure.

[2]

(ii) Predict the physical state of fluorine at °C.
Give a reason for your answer.

.....

..... [2]

(b) Fluorine reacts with water to produce hydrogen flu ride and oxygen.

(i) Complete the chemical equation for this reaction.

$$.....F_2 + 2H_2O \rightarrow .....HF + O_2$$ [2]

(ii) In this reaction both oxidation and reduction take place.

State the meaning of the term *oxidation*.

..... [1]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

8 The elements in Group VII of the Periodic Table are known as the halogens. Halogens can form halide ions.

(a) Identify the halogen with the lowest density at r.t.p. (room temperature and pressure).

..... [1]

(b) State the appearance of bromine at r.t.p.

..... [1]

(c) Use the Periodic Table to:

- give the symbol of the halogen with the highest atomic number

.....

- deduce the number of occupied electron shells in an atom of this element.

.....

[2]

(d) Bromine molecules have covalent bonding.

(i) State what is meant by the term covalent bond.

.....

..... [2]

(ii) Name **one** halide ion which bromine molecules can displace.

..... [1]

(iii) Explain why bromine can displace the halide ion in **(d)(ii)**.

..... [1]

(e) Name a halide compound which can be used to detect the presence of water.

..... [2]

9 Order of reactivity can be determined by displacement reactions.

(a) A student investigates the reactivities of four metals by carrying out a series of experiments.

Each of the metals lead, manganese, silver and zinc are added separately to aqueous metal nitrates of the other metals.

(i) Table 3.1 shows some of the results.

Table 3.1

aqueous solution	lead Pb	manganese Mn	silver Ag	zinc Zn
lead(II) nitrate		✓		
manganese(II) nitrate				
silver nitrate	✓	✓		✓
zinc nitrate	✗	✗		

key

✓ = displacement reaction occurs

✗ = displacement reaction does not occur

Complete Table 3.1 and place the four metals in their order of reactivity with the most reactive first.

1 ..... most reactive

2 .....

3 .....

4 .....

[3]

(ii) Suggest why the metal nitrates and not the metal sulfates of these four metals are used as the aqueous solutions.

..... [1]

(iii) Write the symbol equation for the reaction between zinc and silver nitrate.

..... [2]

(b) The reactivity of Group VII elements can be investigated experimentally.

A student bubbles chlorine gas into a test-tube containing aqueous potassium bromide.

(i) Describe the colour change seen in the test-tube.

from ..... to ..... [2]

(ii) Complete the ionic equation for this reaction.

Include state symbols.

..... + ...Br^-(aq) → ..... + ... [3]

(iii) The reactivity trend seen in C*l*, Br and I applies to all the elements in Group VII.

Use the Periodic Table to identify the Group VII element which **cannot** displace any other Group VII elements.

..... [1]

[Total: 12]

10 The Periodic Table can be used to classify elements.

(c) Group VII elements are known as the halogens.

Astatine is below iodine in Group VII.

Predict the physical state of astatine at room temperature and pressure.

..... [1]

(d) Some Group VII elements react with aqueous solutions containing halide ions.

When aqueous chlorine is added to aqueous potassium bromide a reaction occurs.

The ionic half-equations for the reaction are shown.

$$Cl_2(aq) + 2e^- \rightarrow 2Cl^-(aq)$$

$$2Br^-(aq) \rightarrow Br_2(aq) + 2e^-$$

(i) Describe the colour change of the solution.

original colour of potassium bromide solution .....

final colour of reaction mixture .....

[2]

(ii) Identify the species that is oxidised.

Explain your decision.

species oxidised .....

explanation .....

[2]