1 Sodium and chlorine react together to produce sodium chloride. The bonding in the product is different from that in both of the reactants. Evidence for the type of bonding present can be obtained in a number of different ways.

(a) Draw the electron density map for a chlorine molecule to show covalent bonding.

(1)

(b) Sodium chloride is ionically bonded. What is meant by the term **ionic bond**?

(1)

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(c) Electrolysis is an experiment which you could carry out in a school or college laboratory on an aqueous solution of sodium chloride, to provide evidence for the presence of ionic bonding.

Draw a labelled diagram of the apparatus that you would use for this experiment, indicating how your results would show that the bonding was ionic.

(3)

(d) Chlorine gains an electron when it reacts with sodium to form sodium chloride.

(i) Draw the dot and cross diagram of a chloride ion showing outer electrons only.

(1)

(ii) Give the formula of an ion from **Period 3** that is isoelectronic with the chloride ion.

(1)

(e) Sodium and sodium chloride can both be good conductors of electricity.

Under what conditions do these substances conduct electricity?

Compare the method of conductivity in each case.

(3)

(Total for Question = 10 marks)

2 Metals are good conductors of heat and electricity and usually have high melting temperatures and boiling temperatures.

(a) (i) Describe the **structure** of a metal.

(2)

(ii) Describe the **bonding** in a metal.

(2)

(b) Explain why the melting temperature of magnesium (650 °C) is much higher than that of sodium (98 °C).

(3)

(c) Explain how metals conduct electricity.

(2)

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(Total for Question 9 marks)

3 (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
$Cu^{2+}(aq)$	blue
CrO_4^{2} (aq)	yellow

(4)

Diagram

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

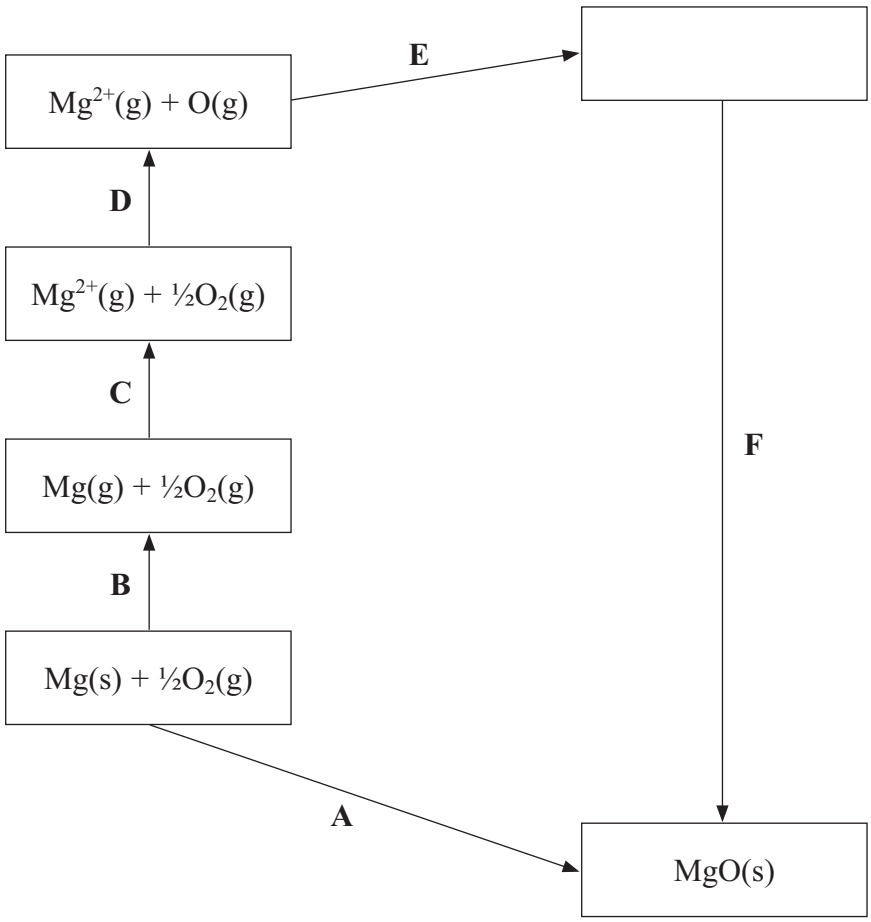
(i) Describe the forces of attraction in an ionic lattice.

(1)

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

(2)

(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 $Mg^{2+}O^{2}$ would differ from that of $Mg^{+}O$.

(1)

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(Total for Question 15 marks)

4 This question is about the element chlorine (atomic number 17).

(a) Complete the electronic structure of chlorine.

(1)

$1s^2\ 2s^2$ .....

(b) Chlorine forms compounds with magnesium and with carbon.

(i) Draw a dot and cross diagram to show the electronic structure of the compound magnesium chloride (only the outer electrons need be shown).
Include the charges present.

(2)

(ii) Draw a dot and cross diagram to show the electronic structure of the compound tetrachloromethane (only the outer electrons need be shown).

(2)

*(iii) Suggest why the melting temperature of magnesium oxide is higher than that of magnesium chloride, even though both are almost 100% ionic.

(3)

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(c) Magnesium chloride may be prepared from magnesium by reaction with chlorine or with hydrochloric acid. Compare these two preparations in terms of the atom economies of the reactions. No calculation is required.

(2)

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(Total for Question 10 marks)