Q1. This question is about electrolysis.

(a) Metal spoons can be coated with silver.
This is called electroplating.

Suggest **one** reason why spoons are electroplated.

.....

.....

(1)

(b) When sodium chloride solution is electrolysed the products are hydrogen and chlorine.

(i) What is made from chlorine?

Tick (✓) **one** box.

Bleach ☐

Fertiliser ☐

Soap ☐

(1)

(ii) Sodium chloride solution contains two types of positive ions, hydrogen ions (H^+) and sodium ions (Na^+).

Why is hydrogen produced at the negative electrode and **not** sodium?

Tick (✓) **one** box.

Hydrogen is a gas. ☐

Hydrogen is less reactive than sodium. ☐

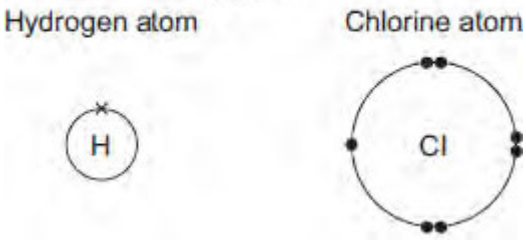
Hydrogen ions move faster than sodium ions. ☐

(1)

(iii) Hydrogen and chlorine can be used to produce hydrogen chloride.

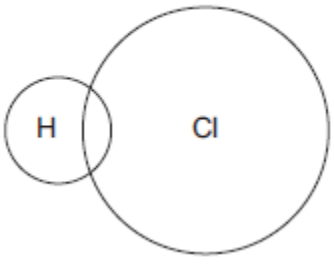
The diagrams in **Figure 1** show how the outer electrons are arranged in an atom of hydrogen and an atom of chlorine.

Figure 1



Complete **Figure 2** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

Figure 2



(1)

(iv) What is the type of bond in a molecule of hydrogen chloride?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

(v) Why is hydrogen chloride a gas at room temperature (20 °C)?

Tick (✓) **two** boxes.

Hydrogen chloride has a low boiling point. ☐

Hydrogen chloride has a high melting point. ☐

Hydrogen chloride is made of simple molecules. ☐

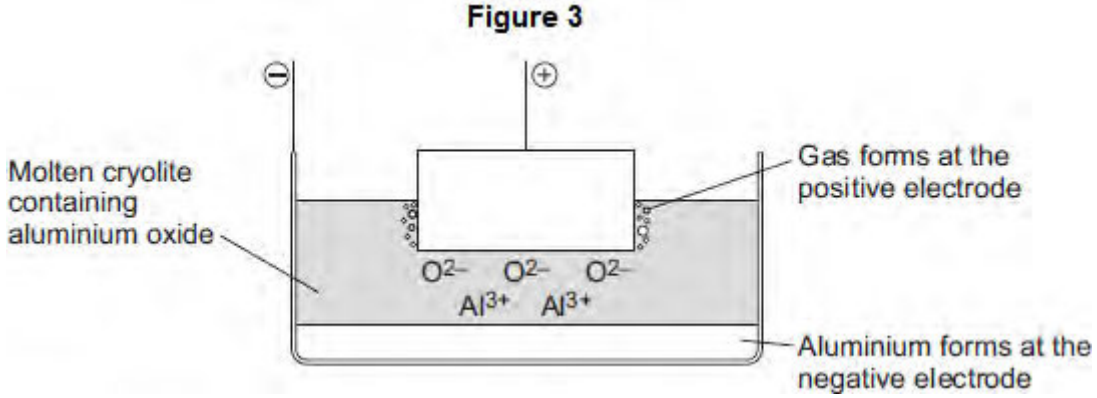
Hydrogen chloride does not conduct electricity. ☐

Hydrogen chloride has a giant structure. ☐

(2)

(c) Aluminium is produced by electrolysis of a molten mixture of aluminium oxide and cryolite. This is shown in **Figure 3**.

Figure 3



(i) Name a gas produced at the positive electrode.

.....

(1)

(ii) Aluminium ions move to the negative electrode.

Explain why.

.....

.....

.....

.....

(2)

(iii) At the negative electrode, the aluminium ions gain electrons to produce aluminium.

What is this type of reaction called?

Tick (✓) **one** box.

Combustion ☐

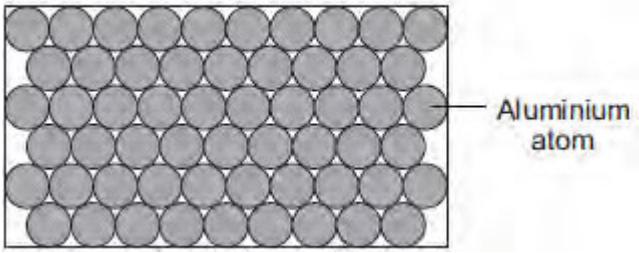
Oxidation ☐

Reduction ☐

(1)

(iv) Aluminium has layers of atoms, as shown in **Figure 4**.

Figure 4



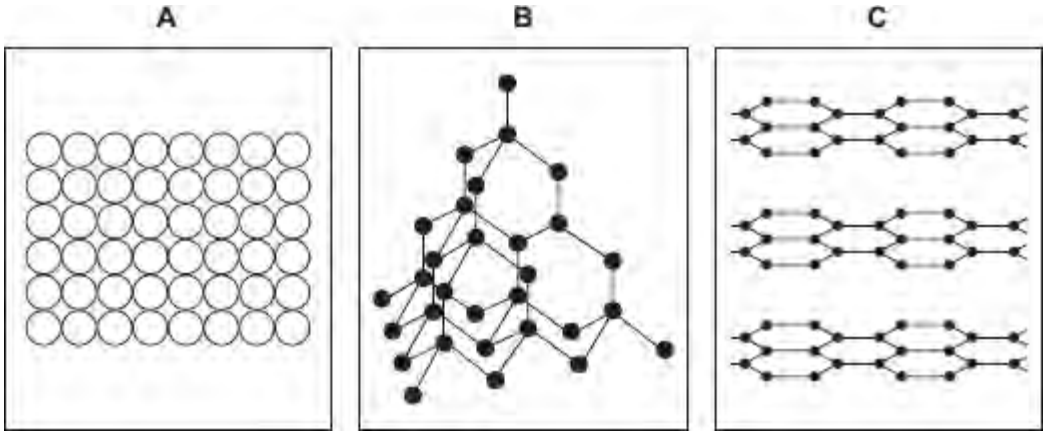
Complete the sentence.

Metals can be bent and shaped because the layers of atoms can .....

(1)

(d) Electrodes used in the production of aluminium are made from graphite.

(i) Which diagram, **A, B** or **C**, shows the structure of graphite?



The structure of graphite is shown in diagram ☐

(1)

(ii) The temperature for the electrolysis is 950 °C.

Use the correct answer from the box to complete the sentence.

cross links	**a giant ionic lattice**	**strong covalent bonds**

The graphite does not melt at 950 °C because

graphite has ..... .

(1)

(Total 14 marks)

Q2. Humphrey Davy was a professor of chemistry.

In 1807 Humphrey Davy did an electrolysis experiment to produce potassium.

(a) (i) Humphrey Davy was the first person to produce potassium.

Draw a ring around the correct answer to complete each sentence.

Humphrey Davy's experiment to produce this new element was quickly accepted by

other scientists because he

had a lot of money.
had a lot of staff to help.
was well qualified.

(1)

(ii) Other scientists were able to repeat Davy's experiment.

Draw a ring around the correct answer to complete each sentence.

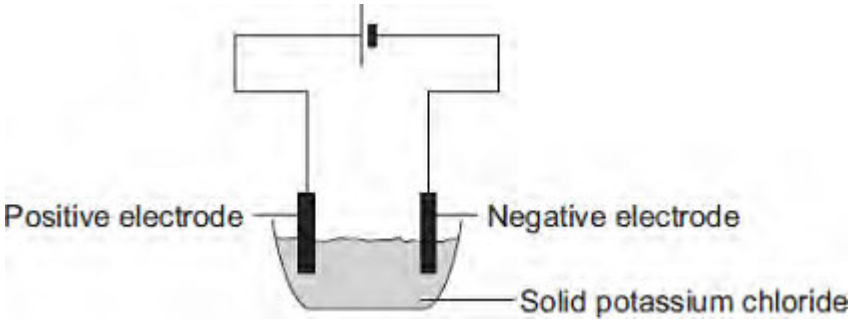
Being able to repeat Davy's experiment is important because

other scientists can

check the results of the experiment.
see if the experiment is safe.
take the credit for the discovery.

(1)

(b) A student tried to electrolyse potassium chloride.



Potassium chloride contains potassium ions (K^+) and chloride ions (Cl^-).

(i) The student found that solid potassium chloride does not conduct electricity.

Use the correct answer from the box to complete the sentence.

are too big	**cannot move**	**have no charge**

Solid potassium chloride does not conduct electricity because

the ions ..... .

(1)

(ii) What could the student do to the potassium chloride to make it conduct electricity?

.....

(1)

(iii) During electrolysis why do potassium ions move to the negative electrode?

.....

(1)

(iv) Draw a ring around the correct answer to complete the sentence.

When the potassium ions reach the negative electrode

they turn into potassium

- atoms.
- electrodes.
- molecules.

(1)
(Total 6 marks)

Q3. Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.

(a) Reacting iron oxide with carbon produces iron.

Draw a ring around the correct answer to complete the sentence.

The reaction to produce iron from iron oxide is

decomposition.
oxidation.
reduction.

(1)

(b) Aluminium cannot be produced by reacting aluminium oxide with carbon.

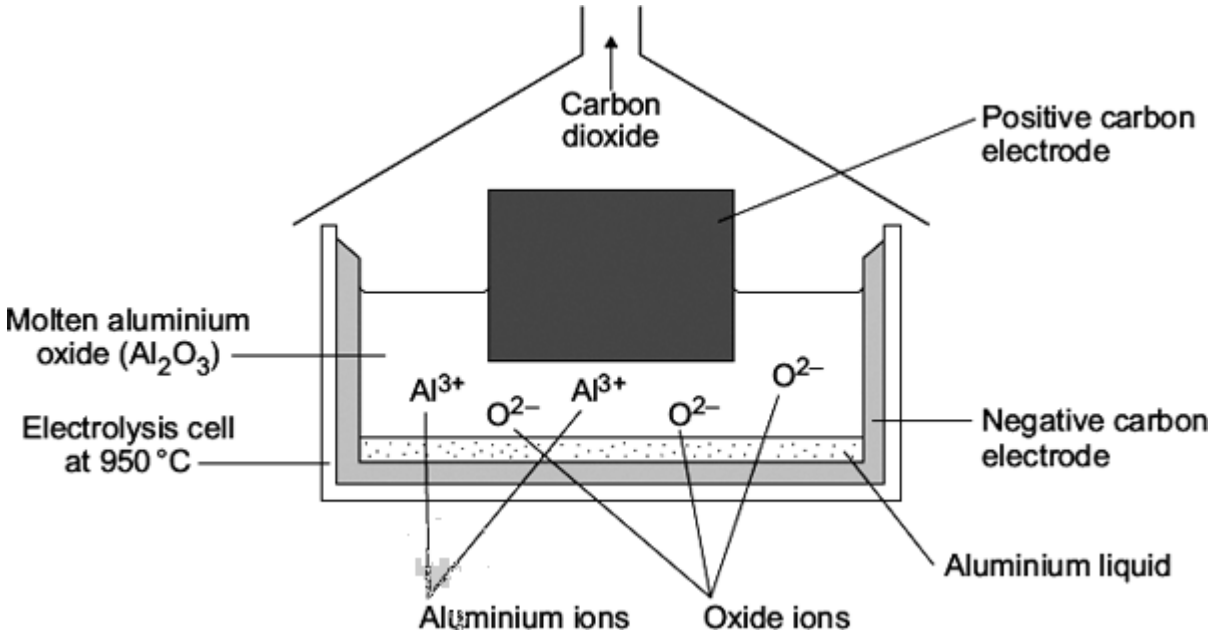
Why does aluminium oxide **not** react with carbon?

Tick (✓) the correct answer.

Answer	**Tick (✓)**
aluminium is less reactive than carbon	
carbon is less reactive than aluminium	
oxygen is more reactive than carbon	

(1)

(c) Aluminium can be produced by electrolysis.



Why do the aluminium ions collect at the negative electrode?

.....

.....

.....

.....

(2)

(d) Some statements about aluminium are given below.

Tick (✓) **two** statements that are correct reasons why aluminium is used to make cans.

Statement	**Tick (✓)**
aluminium conducts electricity	
aluminium is not a transition metal	
aluminium has a low density	
aluminium is resistant to corrosion	

(2)

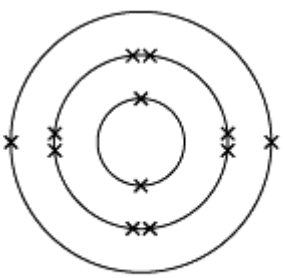
(e) Recycling aluminium cans uses less fossil fuels than producing aluminium from its ore.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of recycling aluminium to make aluminium cans.

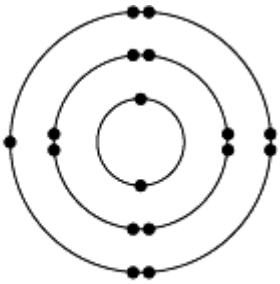
Statement	Advantage Tick (✓)	Disadvantage Tick (✓)
aluminium is the most common metal in the Earth's crust		
less carbon dioxide is produced		
more aluminium ore needs to be mined		
used aluminium cans have to be collected and transported		

(2)
(Total 8 marks)

Q4. The diagrams represent the electronic structure of a magnesium atom and a chlorine atom.



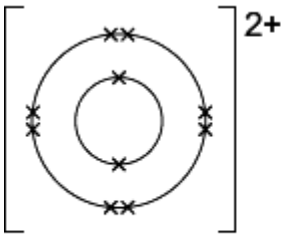
Magnesium atom



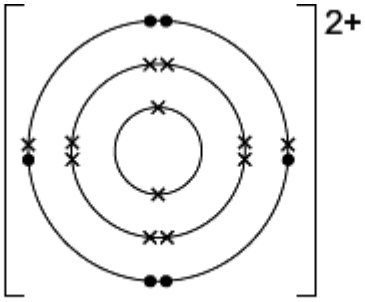
Chlorine atom

Magnesium reacts with chlorine to make the ionic compound called magnesium chloride. This contains magnesium ions, Mg^{2+}, and chloride ions, Cl^{-}

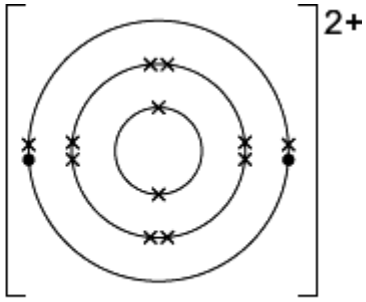
(a) (i) Which structure, **A**, **B** or **C**, represents a magnesium ion?



Structure **A**



Structure **B**

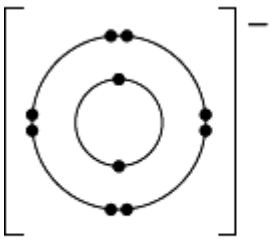


Structure **C**

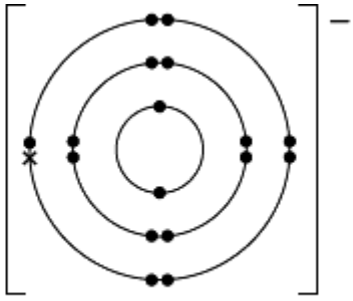
The magnesium ion is Structure ☐

(1)

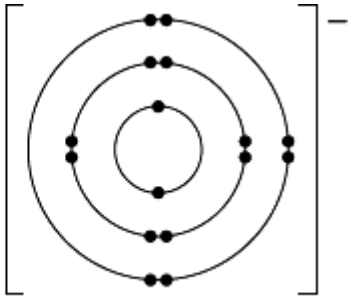
(ii) Which structure, **D**, **E** or **F**, represents a chloride ion?



Structure **D**



Structure **E**



Structure **F**

The chloride ion is Structure ☐

(1)

(b) Magnesium metal can be extracted from sea water.
Sea water contains magnesium chloride, $MgCl_2$

(i) Calcium hydroxide, $Ca(OH)_2$, is added to the sea water.
Magnesium hydroxide, $Mg(OH)_2$, is produced as a solid.

This is the equation for the reaction:

$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$

Draw a ring around the correct answer to complete each sentence.

Magnesium hydroxide forms as a solid because it is [soluble / insoluble / dissolved] in water.

This type of reaction is called [precipitation. / neutralisation. / thermal decomposition.]

(2)

(ii) How is the solid magnesium hydroxide separated from the solution?

.....

(1)

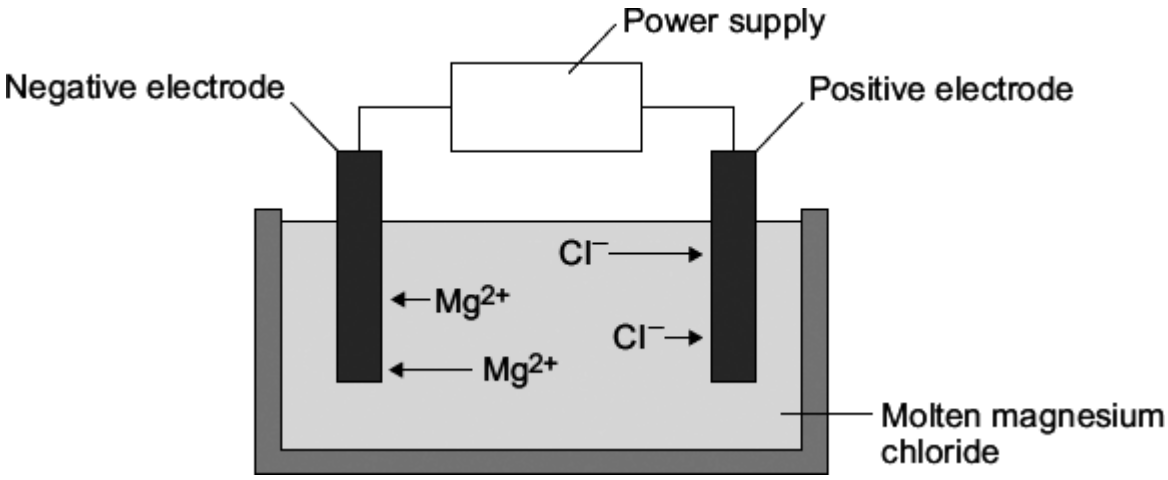
(iii) An acid is then added to the solid magnesium hydroxide to make magnesium chloride.

Draw a ring around the name of this acid.

nitric acid **hydrochloric acid** **sulfuric acid**

(1)

(c) Electrolysis is used to extract magnesium metal from magnesium chloride.



(i) What must be done to solid magnesium chloride to allow it to conduct electricity?

.....

(1)

(ii) Why do the magnesium ions move to the negative electrode?

.....

.....

(1)

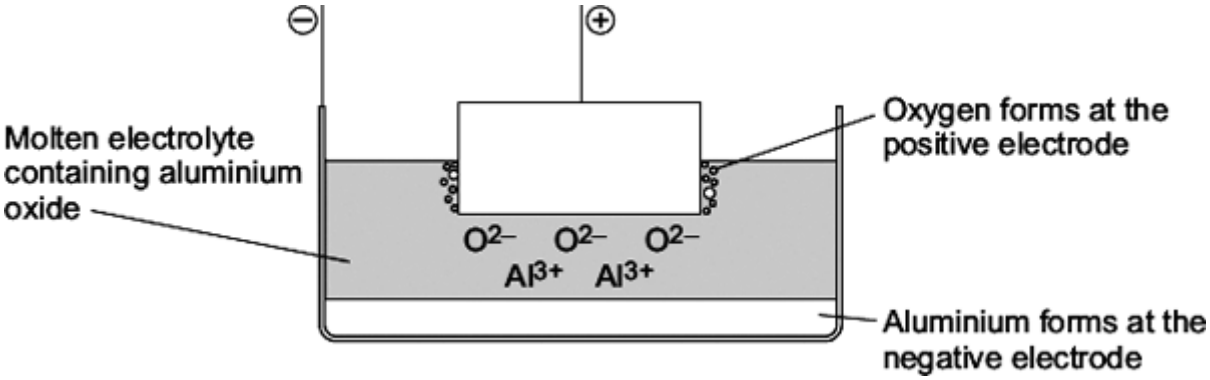
(iii) Name the product formed at the positive electrode.

.....

(1)

(Total 9 marks)

Q5. The diagram represents an electrolysis cell for extracting aluminium.
The current will only flow when the electrolyte is molten.



(a) The electrolyte is aluminium oxide mixed with another substance.

(i) What is the name of the other substance in the electrolyte?

Draw a ring around the correct answer.

cryolite **rock salt** **limestone**

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

This other substance is added to

condense the aluminium oxide.
lower the melting point of the aluminium oxide.
raise the boiling point of the aluminium oxide.

(1)

(b) (i) Oxide ions (O^{2-}) move to the positive electrode.

Explain why.

.....

.....

.....

.....

(2)

(ii) Oxygen is formed at the positive electrode. The oxygen then forms carbon dioxide.

The equation for the reaction is shown below.

$$C + O_2 \rightarrow CO_2$$

Complete the sentence.

The name of the element which reacts with oxygen is .....

(1)

(iii) The positive electrode gets smaller.

Suggest why.

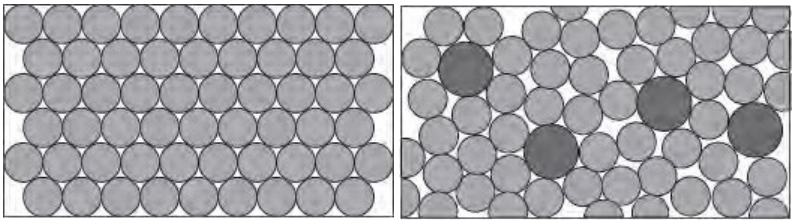
.....

.....

(1)

(c) Aluminium is used in an alloy with magnesium to make drinks cans.

The diagrams show the arrangement of atoms in pure aluminium and in the alloy.



Pure aluminium Alloy

The alloy is harder than pure aluminium.

Explain why. Use the diagrams to help you.

.....

.....

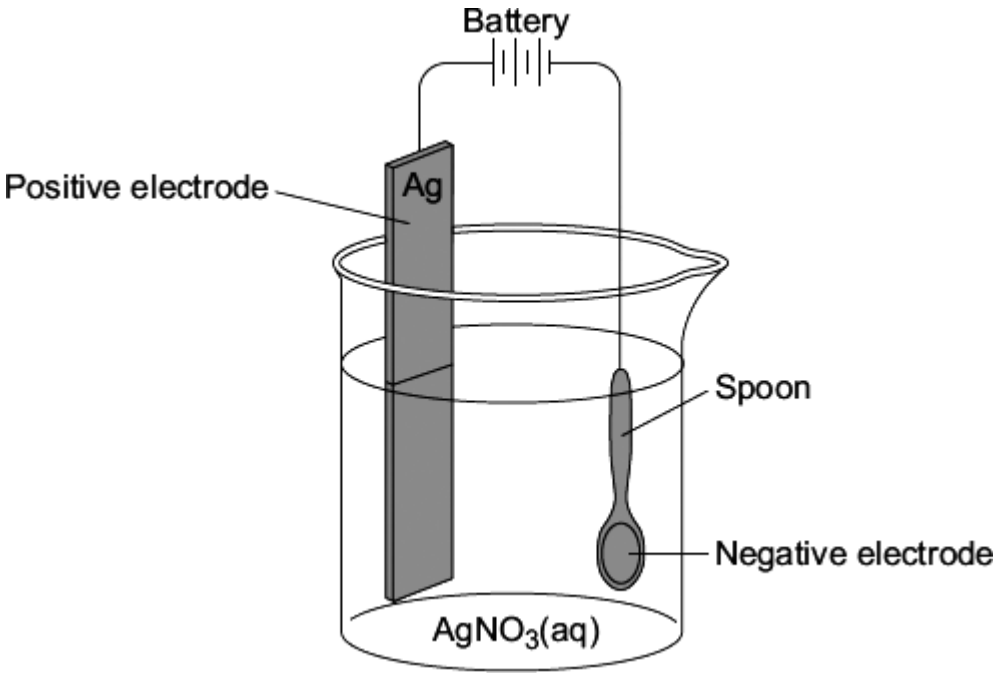
.....

.....

(2)
(Total 8 marks)

Q6. Electroplating is used to coat a cheap metal with a thin layer of an expensive metal.

In the diagram a teaspoon made of nickel is being coated with silver.



Silver nitrate, $AgNO_3$, contains silver ions (Ag^+) and nitrate ions (NO_3^-).

(a) Solid silver nitrate, $AgNO_3(s)$, does **not** conduct electricity.

Choose the correct answer in the box to complete the sentence.

are too big	**cannot move**	**are too small**

Solid silver nitrate does **not** conduct electricity because the ions

.....

(1)

(b) What substance is added to $AgNO_3(s)$ to turn it into $AgNO_3(aq)$?

Draw a ring around the correct answer.

petrol **alcohol** **water**

(1)

(c) Draw a ring around the correct answer to complete each sentence.

(i) Silver ions move to the negative electrode because they have

no charge.

a negative charge.

a positive charge.

(1)

(ii) When silver ions reach the negative electrode they turn into silver

atoms

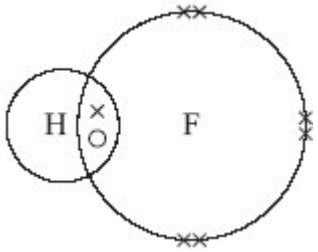
compounds.

molecules.

(1)
(Total 4 marks)

Q7. This question is about fluorine and some of its compounds.

(a) The diagram represents a molecule of hydrogen fluoride.



Draw a ring around the type of bonding that holds the hydrogen and fluorine atoms together in this molecule.

covalent **ionic** **metallic**

(1)

(b) Fluorine is made in industry by the electrolysis of a mixture of potassium fluoride and hydrogen fluoride.

(i) Use **one** word from the box to complete the sentence.

gas	**liquid**	**solid**

To allow electrolysis to take place the mixture of potassium fluoride and

hydrogen fluoride must be ..... .

(1)

(ii) The mixture of potassium fluoride and hydrogen fluoride contains fluoride ions (F^-), hydrogen ions (H^+) and potassium ions (K^+).

Use **one** word from the box to complete the sentence.

fluorine	**hydrogen**	**potassium**

During electrolysis the element formed at the **positive** electrode is

..... .

(1)

(c) Fluoride ions are sometimes added to drinking water. It is thought that these ions help to reduce tooth decay.

(i) Tick (✓) **one** question that **cannot** be answered by scientific investigation alone.

Question	**Tick (✓)**
Do fluoride ions in drinking water reduce tooth decay?	
Are fluoride ions in drinking water harmful to health?	
Should fluoride ions be added to drinking water?	

(1)

(ii) Explain why you have chosen this question.

.....

.....

(1)
(Total 5 marks)

Q8. The electrolysis of sodium chloride solution produces useful substances.

(a) (i) Choose a word from the box to complete the sentence.

covalent	**ionic**	**non-metallic**

Electrolysis takes place when electricity passes through .....

compounds when they are molten or in solution.

(1)

(ii) Choose a word from the box to complete the sentence.

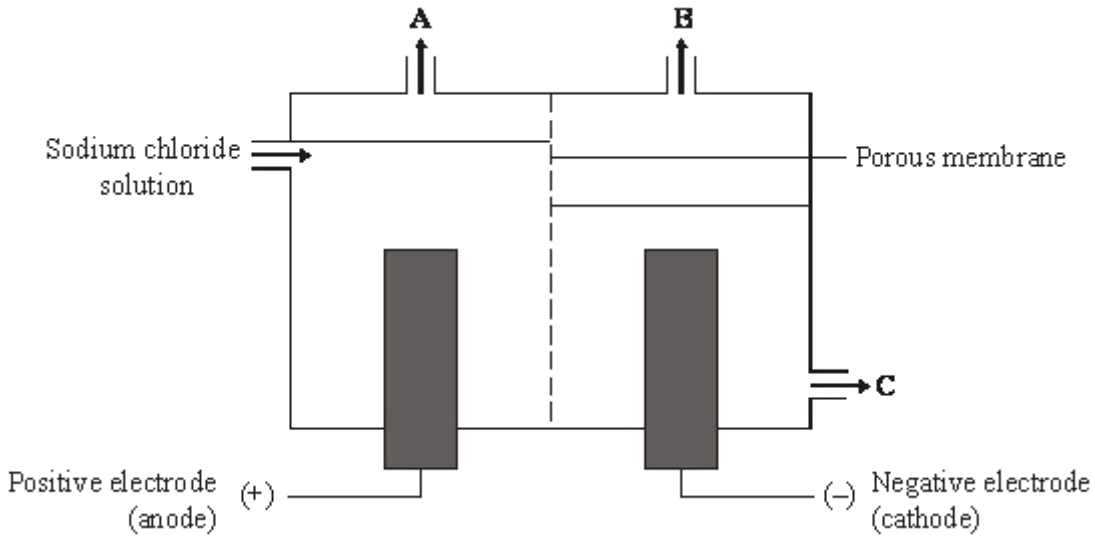
alkenes	**elements**	**salts**

During electrolysis the compound is broken down to form.....

(1)

(b) The table of ions on the Data Sheet may help you to answer this question.

The diagram shows an apparatus used for the electrolysis of sodium chloride solution.



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ISBN 0-7487-9644- 4. First published in 2006

Identify the products **A**, **B** and **C** on the diagram using substances from the box.

chlorine gas	**hydrogen gas**	**oxygen gas**
sodium hydroxide solution		**sodium metal**

(i) **A** is .....
(1)

(ii) **B** is .....
(1)

(iii) **C** is .....
(1)
(Total 5 marks)