AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.4.3 ELECTROLYSIS (PACK 2)

SCORE	PERCENTAGE
/170	%

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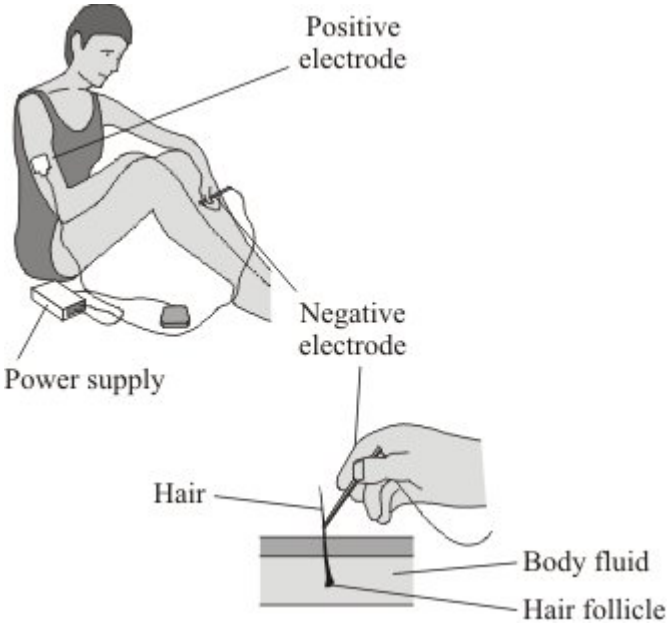
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Q1.

Electrolysis can be used to remove unwanted hair from the skin.



The hair is first coated with a layer of gel containing ions in solution.

The positive electrode is connected by a patch to the skin.

The negative electrode is connected to the hair. Electricity flows through the gel and causes electrolysis of the body fluid around the hair follicle.

(a) Metal wires conduct electricity to the electrodes.

Explain how metals conduct electricity.

_____

_____

_____

_____

(2)

(b) Explain why the gel containing ions in solution can conduct electricity.

_____

_____

(1)

(c) The body fluid is a solution that contains sodium chloride. The electricity causes the electrolysis of a small amount of this solution.

This solution contains hydrogen ions that move to the negative electrode.

(i) The half equation represents the reaction at the negative electrode.

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$2H^+ \quad + \quad 2e^- \quad \rightarrow \quad H_2$

Explain why this reaction is a reduction.

_____

_____

(1)

(ii) As a result of the electrolysis of sodium chloride solution, an alkali forms which kills the hair follicle.

What is the name of this alkali? _____

(1)

(iii) Complete the half equation for the reaction at the positive electrode.

$Cl^- \quad \rightarrow \quad Cl_2$

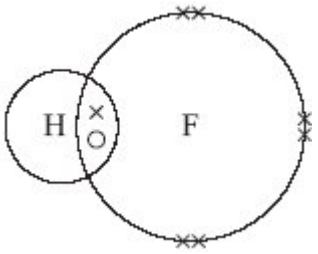
(1)

(Total 6 marks)

Q2.

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^+).

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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.

_____

_____

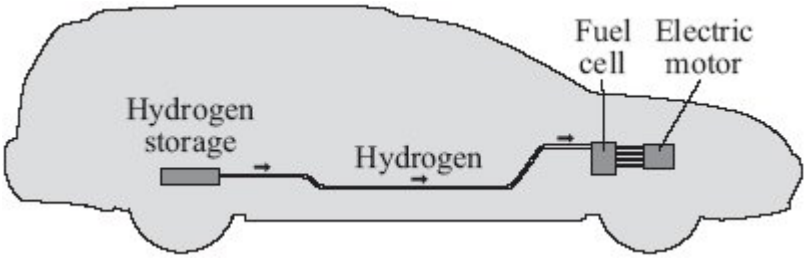
(1)

(Total 5 marks)

Q3.

Read the article and then answer the questions that follow.

Hydrogen fuel for cars?



Hydrogen is an excellent fuel. It can be made by the electrolysis of potassium hydroxide solution.

Hydrogen gas can be stored under pressure in a cylinder but a leak of the gas could cause an explosion.

It has been found that lithium nitride can absorb and then release large

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volumes of hydrogen. A chemical reaction takes place between the hydrogen and the lithium nitride. The hydrogen is held in the resulting compounds by chemical bonds.

The problem is that the rate at which hydrogen is absorbed and then released from normal sized particles of lithium nitride is slow.

Recently scientists have made 'nanosized' particles of lithium nitride. These particles absorb hydrogen in the same way as normal sized lithium nitride particles. The 'nanosized' particles have the advantage that they absorb and release the hydrogen much faster when needed in the fuel cell.

It is hoped that 'nanosized' particles of lithium nitride may provide a safe method of storing hydrogen in the future.

(a) Hydrogen is produced at the negative electrode during the electrolysis of potassium hydroxide solution.

(i) Why are hydrogen ions attracted to the negative electrode?

_____

_____

_____

(1)

(ii) Potassium ions are also attracted to the negative electrode.

Explain why hydrogen gas is formed but not potassium.

_____

_____

_____

(1)

(b) Lithium nitride is made by reacting lithium with nitrogen.

Balance the equation for this reaction.

_____ $Li + N_2 \rightarrow$ _____ Li_3N

(1)

(c) (i) The equation for the reaction of lithium nitride with hydrogen is:

$$Li_3N + 2H_2 \rightleftharpoons LiNH_2 + 2LiH$$

What feature of this reaction allows the hydrogen to be released?

_____

_____

(1)

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(ii) Hydrogen stored in a fuel tank filled with lithium nitride would be safer in an accident than a cylinder full of hydrogen.

Suggest and explain why.

_____

_____

_____

_____

_____

(2)

(d) Lithium nitride is an ionic compound which contains lithium ions (Li^+) and nitride ions (N^{3-}).

(i) The formation of a lithium ion from a lithium atom is an oxidation reaction.

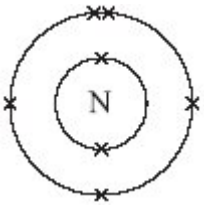
Explain why.

_____

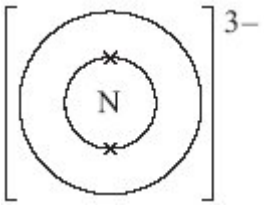
_____

(1)

(ii) The diagram shows the electronic structure of a nitrogen atom.



Complete the diagram below to show the electronic structure of a nitride ion (N^{3-}).



(1)

(Total 8 marks)

Q4.

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**

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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.

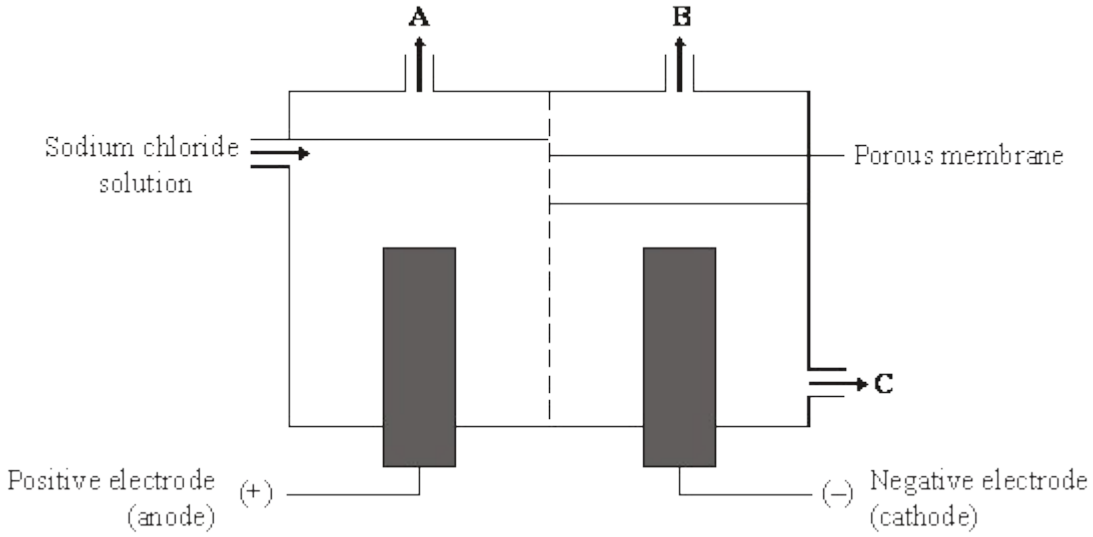
alkenes	**elements**	**salts**

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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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)

Q5.

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

(a) Explain the meaning of *electrolysis*.

_____

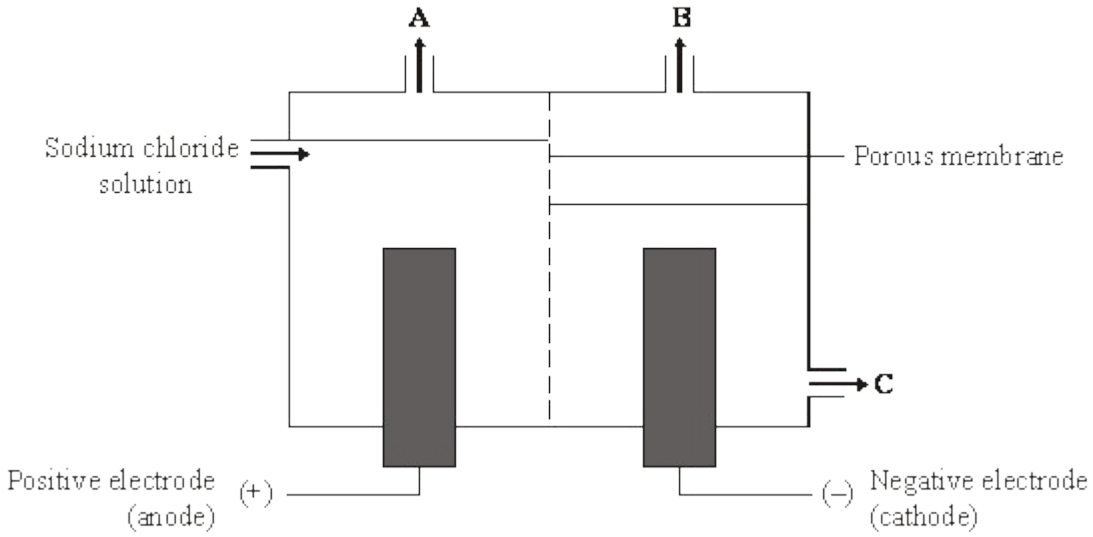
_____

_____

_____

(2)

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



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The electrolysis produces two gases, chlorine and Gas **A.**

Name Gas **A** _____

(1)

(c) The electrodes used in this process can be made of graphite. Explain why graphite conducts electricity.

_____

_____

_____

_____

(2)

(Total 5 marks)

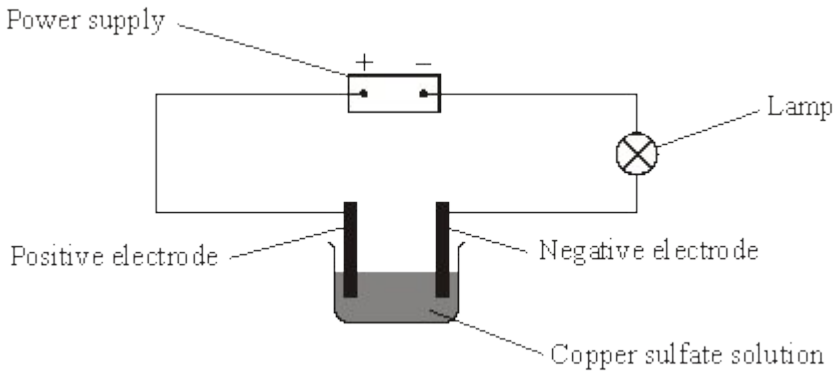
Q6.

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A student investigated the electrolysis of copper sulfate solution.
The student's method is shown below.

Two clean pieces of copper were weighed. One piece was used as the positive electrode and the other piece was used as the negative electrode.

The circuit was set up as shown in the diagram.



After the electrolysis, the pieces of copper were:

- washed with distilled water
- washed with propanone (a liquid with a lower boiling point than water)
- allowed to dry
- weighed.

(a) Explain why the electrode would dry faster when washed with propanone instead of water.

_____

_____

(1)

(b) The student's results are given in the table.

	Positive electrode	**Negative electrode**
mass of electrode before electrolysis, in grams	16.41	15.46
mass of electrode after electrolysis, in grams	16.10	15.75

The mass of the positive electrode decreased by 0.31 g.

(i) What is the change in mass of the negative electrode?

_____ g

(1)

(ii) The mass lost by the positive electrode should equal the mass gained by the negative electrode.

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Suggest **two** reasons why the results were **not** as expected.

1. _____

_____

2. _____

_____

(2)

(c) Describe and explain how electrolysis is used to make pure copper from a lump of impure copper.

_____

_____

_____

_____

_____

_____

_____

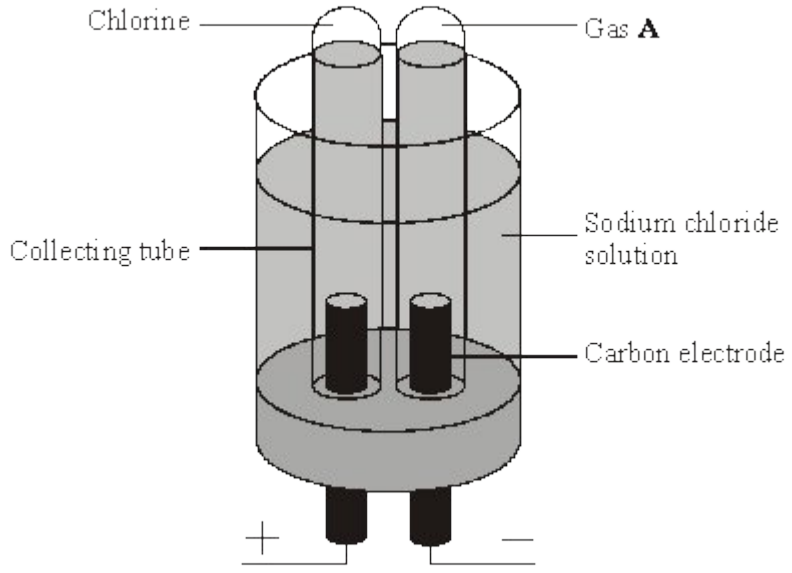
_____

(4)

(Total 8 marks)

Q7.

The electrolysis of sodium chloride solution is an important industrial process. The apparatus shown below can be used to show this electrolysis in the laboratory.



(a) Name gas **A**. _____

(1)

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(b) Chlorine is produced at the positive electrode. Describe and give the result of a chemical test to prove that the gas is chlorine.

_____

_____

_____

_____

(2)

(c) Chloride ions move to the positive electrode. Explain why.

_____

_____

(1)

(d) A small quantity of chlorine is added to drinking water. Explain why.

_____

_____

(1)

(e) The solution around the negative electrode becomes alkaline. Name the ion which makes the solution alkaline.

_____

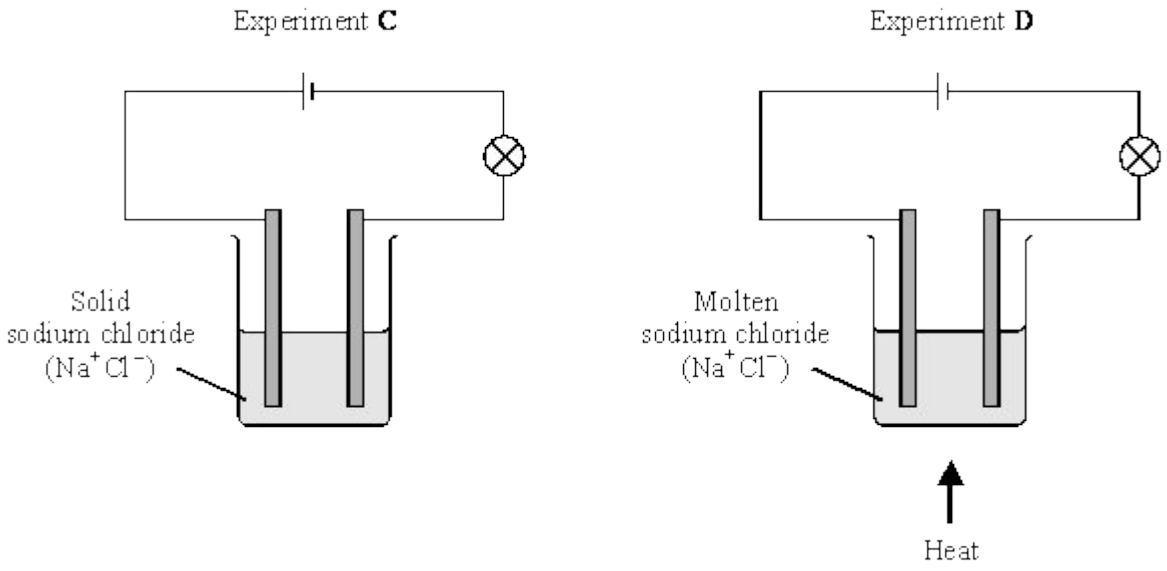
_____

(1)

(Total 6 marks)

Q8.

(a) Two experiments were set up as shown.



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(i) Give **two** observations which would be seen only in Experiment **D**.

1. _____

2. _____

(2)

(ii) Explain why in Experiment **C** no changes would be seen.

_____

_____

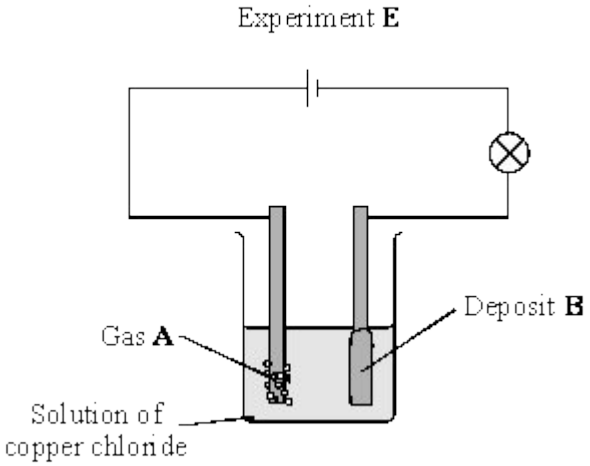
_____

_____

_____

(2)

(b) Another *electrolysis* experiment used an aqueous solution of copper chloride.



(i) What does *electrolysis* mean?

_____

_____

_____

(2)

(ii) Name the gas **A** and the deposit **B**.

_____

_____

(2)

(c) Give **one** industrial use of electrolysis.

_____

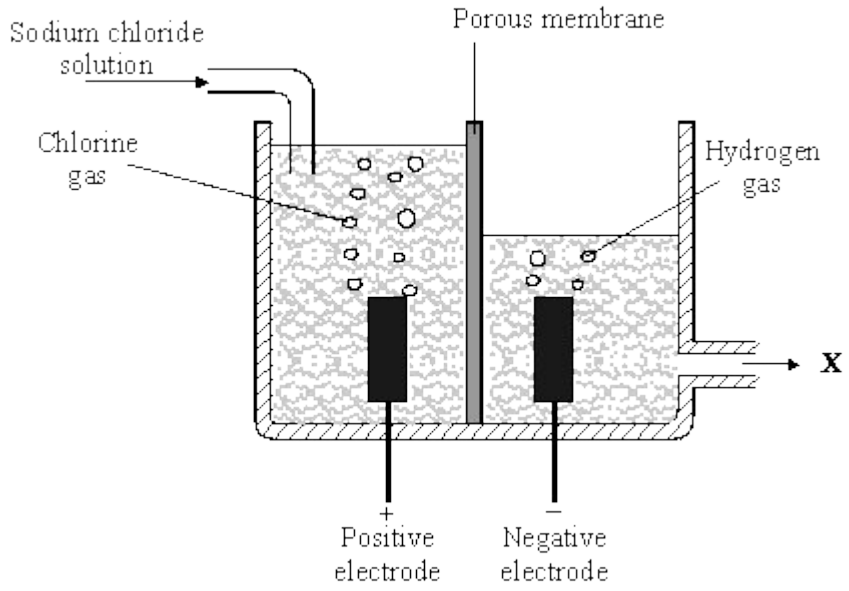
(1)

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(Total 9 marks)

Q9.

Sodium chloride solution is a useful raw material for the manufacture of other substances.



(i) What is the name of the process shown?

_____

(1)

(ii) Chloride ions lose electrons at the positive electrode. What is the name of this type of reaction?

_____

(1)

(iii) The solution formed at **X** is alkaline. What causes this solution to be alkaline?

_____

_____

_____

(2)

(iv) Give a balanced ionic equation for the formation of hydrogen gas at the negative electrode.

_____

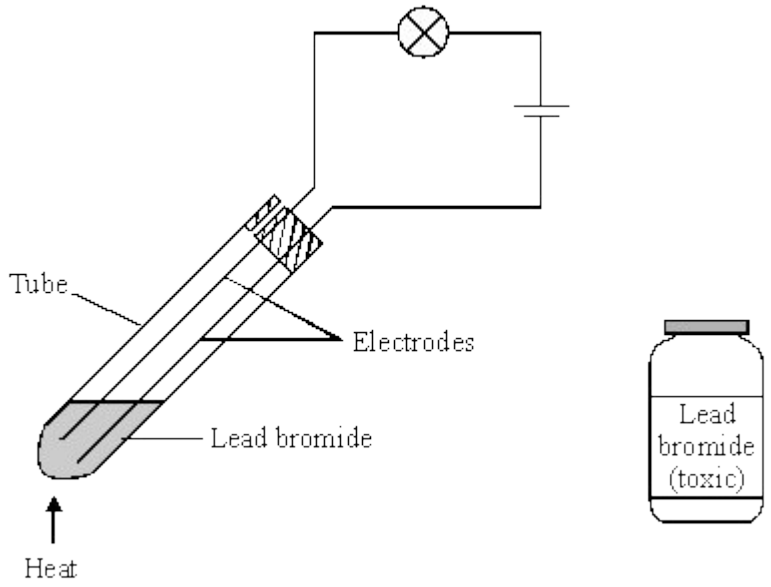
(3)

(Total 7 marks)

Q10.

A student investigated the *electrolysis* of lead bromide.

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Lead bromide was placed in the tube and the circuit was switched on. The light bulb did not light up.

The tube was heated and soon the bulb lit up. The observations are shown in the table.

Positive electrode	Negative electrode
red-brown gas	silver liquid

(a) What is meant by *electrolysis?*

_____

(2)

(b) Why did the lead bromide conduct electricity when the tube was heated?

_____

(1)

(c) Name the substances formed at the:

positive electrode; _____

negative electrode. _____

(2)

(d) Suggest **one** safety precaution that should be taken during this investigation.

_____

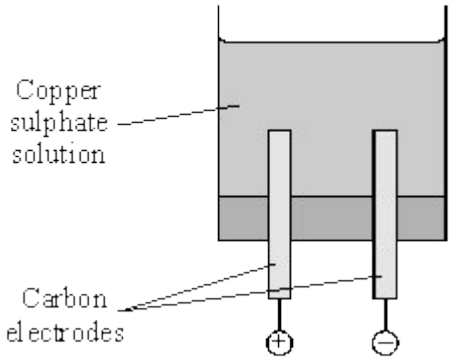
(1)

(Total 6 marks)

Q11.

An investigation into the *electrolyte* copper sulphate solution was carried out as shown.

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(a) What does *electrolyte* mean?

_____

_____

_____

(2)

(b) These were the observations.

Negative electrode	solid formed
Positive electrode	gas given off

(i) Name the solid formed.

_____

(1)

(ii) Name the gas given off.

_____

(1)

(c) How could a sample of gas be collected at the positive electrode?

_____

_____

(2)

(d) Suggest why the blue colour of copper sulphate becomes paler during the investigation.

_____

_____

(2)

(Total 8 marks)

Q12.

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Many everyday substances can be classified as acids, bases or salts. For example, car batteries contain sulphuric acid, oven cleaners contain sodium hydroxide and table salt contains sodium chloride.

(a) A solution of each of these substances was tested with universal indicator.

Solution	Colour of universal indicator
Sulphuric acid (H_2SO_4)	red
Sodium hydroxide (NaOH)	purple
Sodium chloride (NaCl)	green

(i) Explain how these universal indicator colours and the corresponding pH values could be used to identify each of these solutions.

_____

_____

_____

_____

_____

(3)

(ii) Name and give the formula of the ion which causes the solution to be acidic.

Name of ion _____

Formula of ion _____

(2)

(b) Sodium chloride can be made by reacting sodium hydroxide with hydrochloric acid in the presence of an indicator.

(i) What is the name of this type of reaction?

_____

(1)

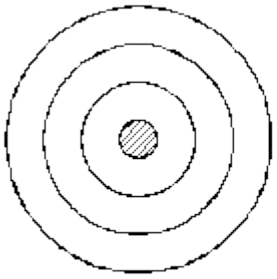
(ii) Write a balanced chemical equation for this reaction.

_____(aq) + _____(aq) → _____(aq) + _____(l)

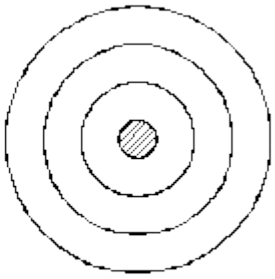
(2)

(c) The atomic number for sodium is 11 and for chlorine is 17.

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Sodium atom



Chlorine atom

(i) Complete the diagrams to show the electron arrangements for a sodium atom and a chlorine atom.

(2)

(ii) These atoms form different particles by one electron transferring from the sodium atom to the chlorine atom. What is the name given to the particles formed?

_____

(1)

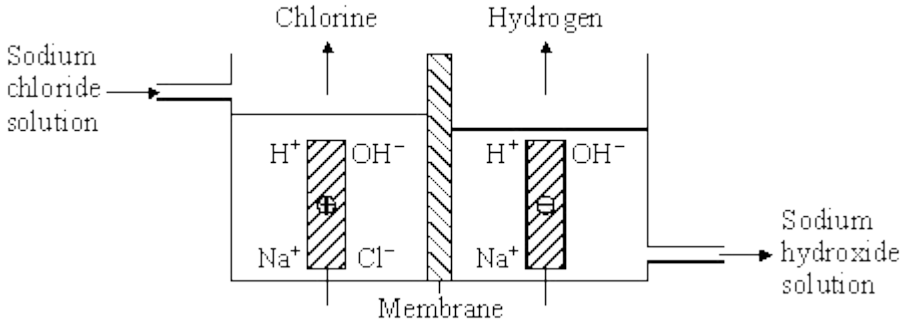
(iii) Why do these sodium and chloride particles bond?

_____

_____

(1)

(d) Sodium chloride solution is electrolysed to form three products, hydrogen, chlorine and sodium hydroxide.



Describe how each of these products are formed.

_____

_____

_____

_____

_____

_____

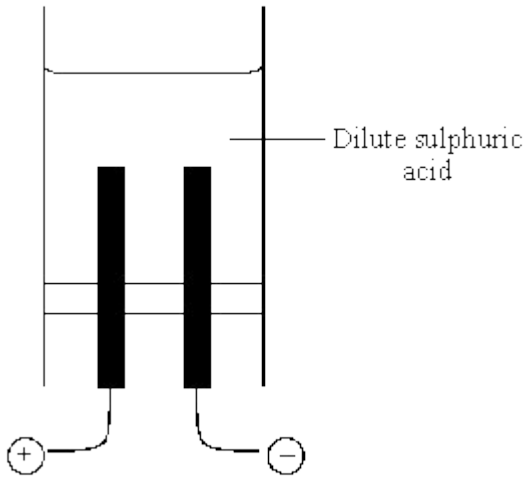
(3)

(Total 15 marks)

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Q13.

An electric current was passed through dilute sulphuric acid. The apparatus used is shown. Oxygen was formed at the anode.



(a) What name is given to solutions which decompose when electricity is passed through them?

_____

(1)

(b) The ionic equation for the reaction at the anode is:

$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

Explain this type of reaction.

_____

_____

(2)

(c) Write a **balanced** ionic equation for the reaction at the cathode.

_____

(2)

(d) What happens to the concentration of the sulphuric acid as the electricity is passed through it? Explain your answer.

_____

_____

_____

_____

(3)

(Total 8 marks)

Q14.

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This question is about sodium chloride (common salt) which is an important chemical.

Sodium chloride can be made by burning sodium in chlorine gas.

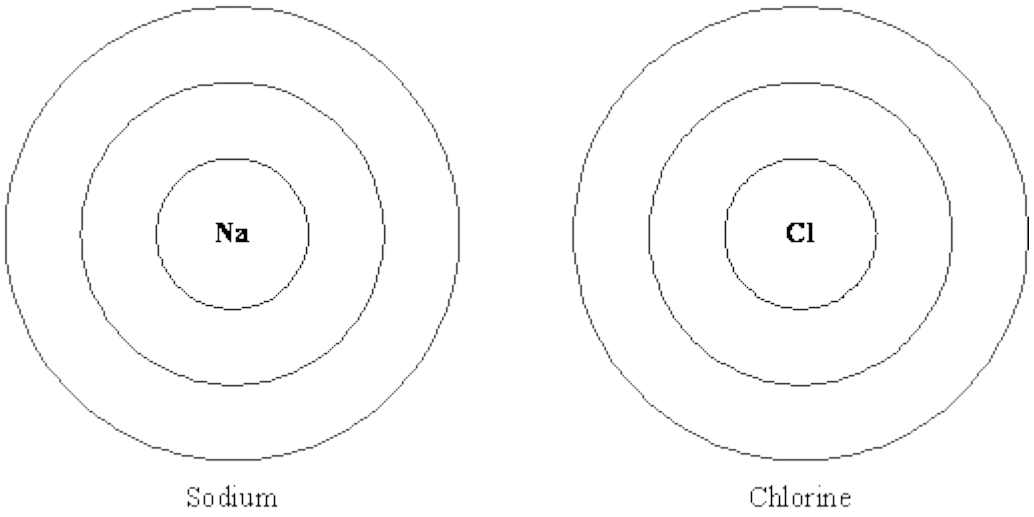


(a) Balance the symbol equation for the reaction of sodium with chlorine.

$Na_{(s)}$ + $Cl_{2(g)}$ → $NaCl_{(s)}$

(1)

(b) (i) Complete the diagrams below to show the electronic structures of a sodium and a chlorine atom. (Atomic number of sodium = 11 and chlorine = 17.)



(3)

(ii) When sodium reacts with chlorine the sodium atoms are changed into sodium ions (Na^+) and the chlorine atoms are changed into chlorine ions (Cl^-).

Explain how:

1. a sodium atom changes into a sodium ion;

_____

_____

(2)

2. a chlorine atom changes into a chloride ion.

_____

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_____

(2)

(c) The element potassium is in the same group of the Periodic Table as sodium. Potassium reacts with chlorine to make potassium chloride which is sometimes used instead of common salt in cooking.

(i) Predict the formula of potassium chloride.

_____

(1)

By reference to the electronic structures of potassium and sodium explain:

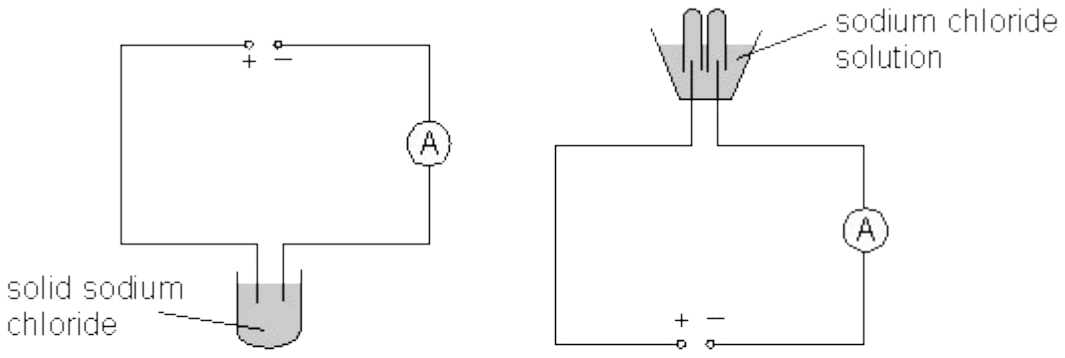
(ii) Why the reaction of potassium with chlorine is similar to the reaction of sodium with chlorine.

_____

_____

(1)

(d) The electrolysis of sodium chloride solution is an important industrial process. The diagrams below show two experiments set up during an investigation of the electrolysis of sodium chloride.



Experiment 1 Experiment 2

(i) What would be the reading on the ammeter in experiment 1?

_____ A

(ii) Explain your answer.

_____

_____

_____

(3)

(e) The equations below show the reactions which take place in experiment 2.

$$H_2O_{(l)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}$$

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$$2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$$

$$2Cl^-_{(aq)} - 2e^- \rightarrow Cl_{2(g)}$$

(i) Which substance provides hydrogen ions?

_____

(1)

(ii) Name the product formed at:

(A) the positive electrode;

_____

(B) the negative electrode.

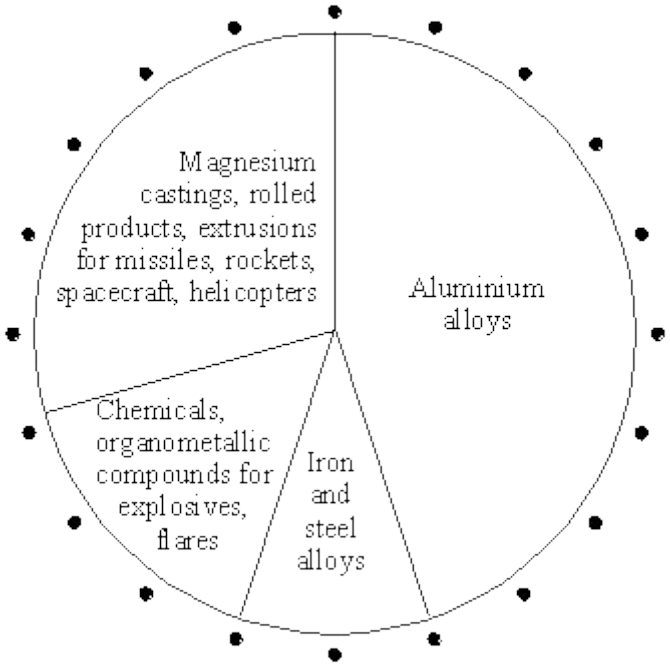
_____

(1)

(Total 15 marks)

Q15.

280 000 tonnes of magnesium are produced in the world each year. The pie chart below shows the ways in which magnesium is used.



(a) (i) Use the pie chart to calculate the percentage of magnesium used to make aluminium alloys.

_____ %

(1)

(ii) How many tonnes of magnesium are used to make aluminium alloys each year?

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_____ tonnes

(1)

(b) Magnesium is produced by the electrolysis of molten magnesium chloride. The reactions which take place at the electrodes are represented by the equations below.

$Mg^{2+} + 2e^- \rightarrow Mg$

$2Cl^- - 2e^- \rightarrow Cl_2$

(i) Calculate the mass of chlorine produced when one kilogram of magnesium is made.
(Relative atomic masses: Mg = 24, Cl = 35.5)

_____

_____

_____

_____

(3)

(ii) Give a use for chlorine.

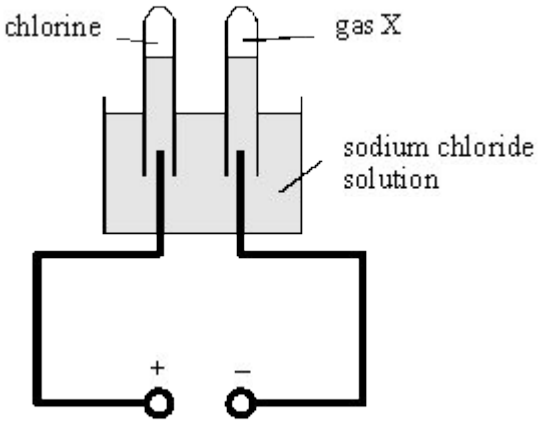
_____

(1)

(Total 6 marks)

Q16.

(a) In an industrial process electricity is passed through a solution of sodium chloride in water. A student set up the apparatus shown below to investigate this process.



(i) Name gas X.

_____

(1)

(ii) Complete the half equation for the production of chlorine gas during the electrolysis.

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_____ Cl^- → _____ e^- → Cl_2

(1)

(iii) The student found that the solution left in the cell was alkaline.

Which ion makes the solution alkaline?

_____

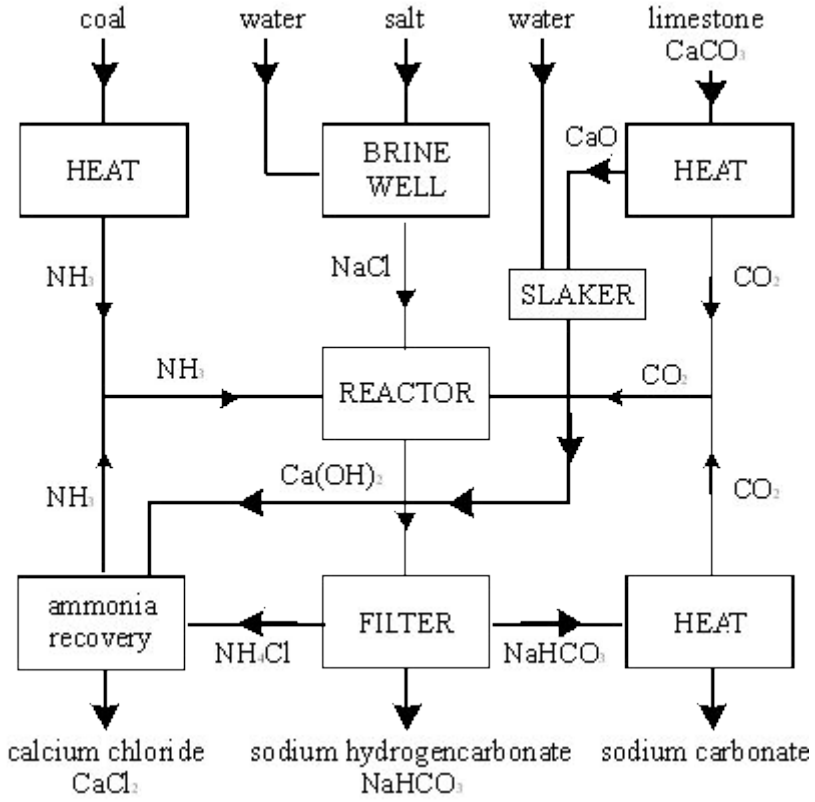
(1)

(iv) Name the useful substance that can be obtained from the solution in the cell.

_____

(1)

(b) Sodium carbonate is another useful chemical that can be made from sodium chloride. The flow chart below shows one way in which sodium carbonate can be made.



(i) Write the formula of sodium carbonate.
Use the Data Sheet to help you to answer this question.

_____

(1)

(ii) Salt is one raw material used in this process.

Name **one** other raw material used in this process.

_____

(1)

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(iii) Sodium carbonate is one of the products of this process.

Name **one** other product.

_____

(1)

(iv) 1. Give **one** example of a thermal decomposition reaction shown in the flow chart.

_____

_____

(1)

2. Explain what is meant by a thermal decomposition reaction.

_____

_____

(2)

(v) Name **one** substance that is recycled in this process.

_____

(1)

(c) When sodium carbonate solution is added to zinc sulphate solution a white solid is precipitated.

(i) Use the Data Sheet to help you to name the white solid that is produced in this reaction.

_____

(1)

(ii) State why this solid is formed.

_____

_____

_____

(1)

(Total 13 marks)

Q17.

Sando-K is a medicine. It is given to people whose bodies contain too little of a particular element.

Sando-K is a mixture of two compounds. The formulae of the two compounds are given below.

$KHCO_3$ **KC1**

(a) Which metal do people given Sando-K need?

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_____

(1)

(b) Sando-K contains the ion, CO_3^{2-}. Which gas would be produced if a dilute acid was added to Sando-K? (The Data Sheet may help you to answer this question.)

_____

(1)

(c) The compounds in Sando-K contain ions.

Complete the two sentences below.

Atoms change into positive ions by _____ one or more

_____ .

Atoms change into negative ions by _____ one or

more _____ .

(4)

(d) Electricity can be used to show that an aqueous solution of Sando-K contains ions.

(i) Draw a diagram of an apparatus that you could use to prove that Sando-K contains ions.

(4)

(ii) Explain, as fully as you can, what would happen when the electricity is switched on.

_____

_____

_____

_____

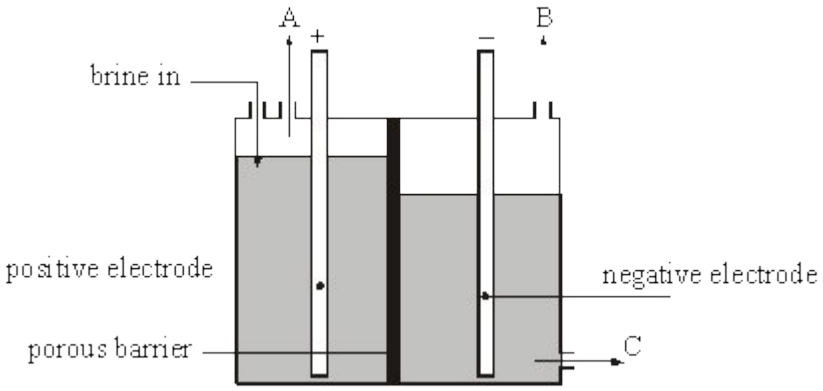
(3)

(Total 13 marks)

Q18.

Sodium hydroxide, hydrogen and chlorine can all be made in one industrial process. Electricity is passed through aqueous sodium chloride solution (brine). The diagram below shows a cell that can be used for this process.

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(a) Name A, B and C.

Gas A _____

Gas B _____

Solution C _____

(2)

(b) Balance the equations for the reactions at the electrodes.

(i) _____ Cl^- – _____ e^- → Cl_2

(ii) _____ H^+ + _____ e^- → H_2

(2)

(c) Name the compound in this cell which produces the hydrogen ions.

_____

(1)

(d) Which type of particles must be able to pass through the barrier to allow the electrolysis to take place?

_____

(1)

(Total 6 marks)

Q19.

The electrolysis of sodium chloride solution is an important industrial process. Three useful substances are produced:

- chlorine gas is formed at the positive electrode;
- hydrogen gas is formed at the negative electrode;
- an alkali is left in the solution.

The reactions which take place at the electrodes are represented by the equations shown below:

$$2Cl^- - 2e^- \rightarrow Cl_2$$

$$2H^+ + 2e^- \rightarrow H_2$$

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(a) Name the important alkali which is left in the solution.

_____

(1)

(b) State why chloride ions move towards the positive electrode.

_____

(1)

(c) Why is the formation of chlorine at this electrode said to be an oxidation reaction?

_____

(1)

(Total 3 marks)

Q20.

Use the Reactivity Series of Metals on the Data Sheet to help you to answer this question.

The table gives information about the extraction of some metals.

Metal	Date of discovery	Main source	Main extraction method
Gold	Known to ancient civilisations	In the Earth as the metal itself	Physically separating it from the rocks it is mixed with
Zinc	1500	Zinc carbonate	Reduction by carbon
Sodium	1807	Sodium chloride	Electrolysis

(a) Explain why gold is found mainly as the metal itself in the Earth.

_____

_____

(1)

(b) One of the reactions involved in producing zinc is represented by this equation.

$ZnO + C \rightarrow Zn + CO$

Explain why carbon can be used to extract zinc.

_____

_____

(1)

(c) Sodium is one of the most abundant metals on Earth.

Explain, as fully as you can, why sodium was not extracted until 1807.

_____

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_____

_____

_____

(2)

(Total 4 marks)

Q21.

Read the passage carefully and then answer the questions.

> **The electrolysis of acidified water**
>
> After a few drops of dilute sulphuric acid have been added to some distilled water, there will be three types of ion in solution:
>
> from the water, $H_2O(l) \rightarrow H^+(aq) + OH^-(aq)$
>
> from the acid, $H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$
>
> When the electrodes (anode and cathode) in a circuit are put into the acidified water, the hydroxide ions and the sulphate ions are both attracted to the electrode called the anode. However, it is harder for the sulphate ions to give up their electrons than for the hydroxide ions to do this. So the hydroxide ions are the ones which react and bubbles of oxygen are formed at the anode.
>
> There are only hydrogen ions to be attracted towards the cathode and, when they get there, they take up electrons to form hydrogen molecules.

From Chemistry Matters by Richard Hart, reproduced by permission of Oxford University Press

Even in a small volume of water acidified with dilute sulphuric acid there will be billions of ions. Some will be anions and some will be cations.

(i) Name the ions in water acidified with dilute sulphuric acid.

_____

(1)

(ii) Explain why only some of the ions are attracted to the anode.

_____

_____

_____

(2)

(iii) Balance the equation for the reaction of hydroxide ions at the anode.

$4OH^- \rightarrow H_2O + O_2 + e^-$

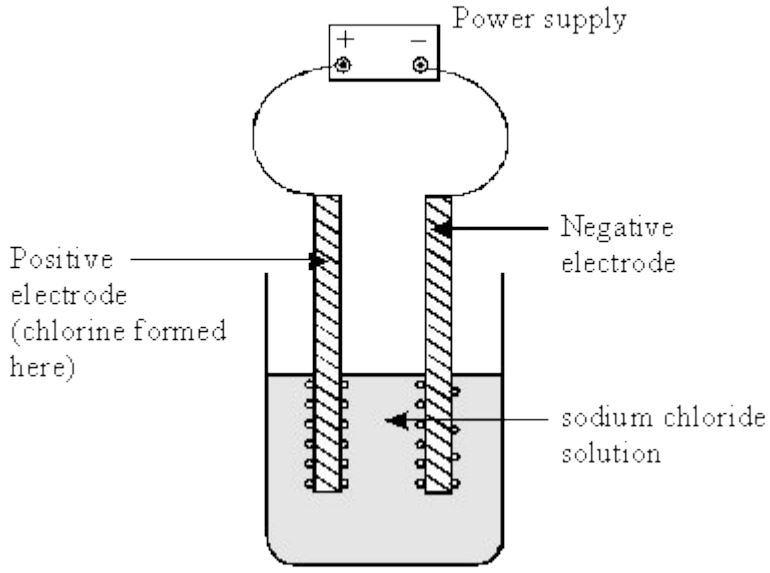
(1)

(Total 4 marks)

Q22.

The diagram below shows the electrolysis of sodium chloride solution, in the laboratory.

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(a) Which gas forms at the negative electrode? _____

(1)

(b) Explain why chlorine gas forms at the positive electrode.

_____

_____

_____

(2)

(c) State **one** use of chlorine gas.

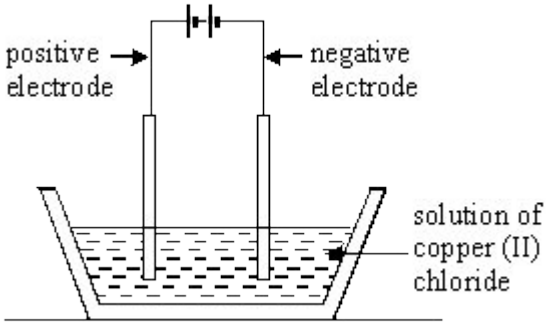
_____

(1)

(Total 4 marks)

Q23.

Copper metal can be extracted from a solution of copper(II) chloride.



Copper chloride is an ionic compound.

State where the copper would collect and explain your answer fully.

_____

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_____

_____

(Total 2 marks)

Q24.

Cassiterite is an ore of the metal tin.

(a) What is an ore?

_____

_____

(2)

(b) Some metals are obtained by removing oxygen from the metal oxide.

What name do we give to this chemical reaction?

_____

(1)

(c) Name **one** metal which must be extracted from its melted ore by electrolysis rather than by using carbon.

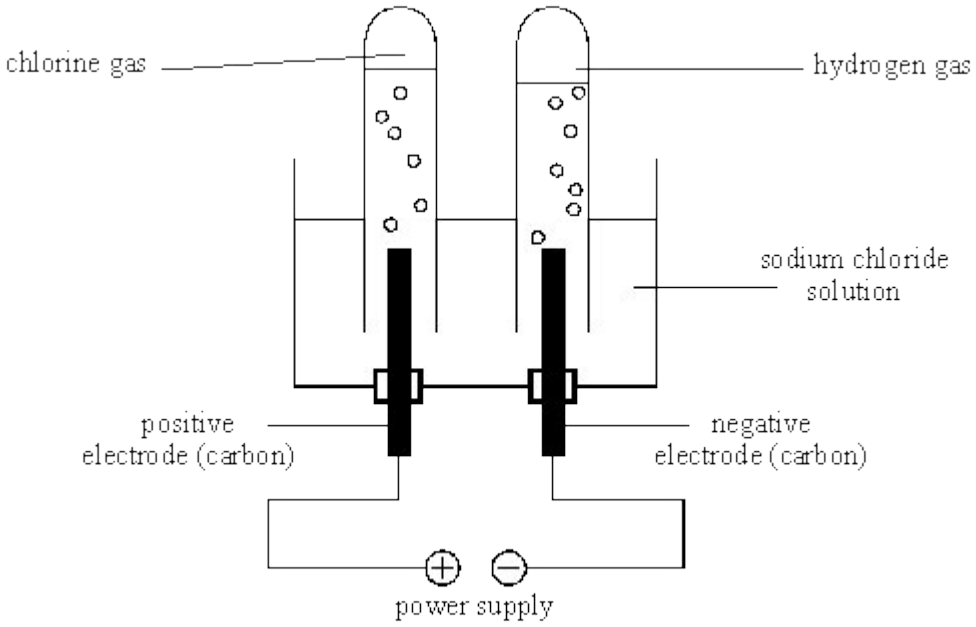
_____

(1)

(Total 4 marks)

Q25.

The diagram shows electrolysis of sodium chloride solution.



(a) Complete and balance these equations to show the reactions during electrolysis.

At the positive electrode

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Cl^- – e^- → Cl_2

At the negative electrode

Na → **Na**

(2)

(b) Silver halides such as silver chloride and silver bromide are used in photography. The equation shows a reaction to prepare a silver halide.



Name and describe the products of this reaction, in words, as fully as you can.

product 1

_____

_____

product 2

_____

_____

(4)

(Total 6 marks)

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