Background pattern

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**Year 10 – Student Booklet TRIPLE**

Key Stage 4 Science:

**Chemical Changes**

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**This booklet is for use in your Science lessons. Please look after it in the same way you would your exercise book and ensure that your presentation is always PROUD.**

**Ensure that your booklet is returned to your class book box at the end of the lesson.**

**Lesson Breakdown**

Lesson 1: 4.4.1.1 Metal oxides (practical – pattern seeking enquiry)

Lesson 2: 4.4.1.2 The reactivity series (practical – pattern seeking enquiry)(water and acids)

4.4.2.1 Reactions of acids with metals

Lesson 3: 4.4.1.2 Displacement reactions

Lesson 4: 4.4.1.3 Extraction of metals and reduction

Lesson 5: 4.4.2.4 The pH scale and neutralisation & 4.4.2.6 Strong and weak acids (HT only)

Lesson 6: 4.4.2.2 Neutralisation of acids and salt production

Lesson 7: 4.4.2.3 Soluble salts & **Required practical:** Preparing a salt (practical – reinforcing theory)

Lesson 8: 4.4.3.1 The process of electrolysis & 4.4.3.2 Electrolysis of molten ionic compounds

Lesson 9: 4.4.3.3 Using electrolysis to extract metals

Lesson 10: 4.4.3.4 Electrolysis of aqueous solutions

Lesson 11: **Required practical 3**: Electrolysis of aqueous solutions

***Embedded in several lessons: 4.4.1.4 Oxidation and reduction in terms of electrons (HT only)***

***Embedded in lesson 8 – 11: 4.4.3.5 Representation of reactions at electrodes as half equations (HT only)***

**Keystone words**

Oxidise

Reduce

Atom

Element

Ion

Neutralisation

Solution

**Lesson 7: 4.4.2.3 Soluble salts & required practical: Preparing a salt**

**Date: .**

**Objective: You are learning to make crystals of a soluble salt from an insoluble solid.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**Catch up (complete this if you were absent last lesson):**

Complete these word equations for neutralisation reactions:

1. Sodium hydroxide + sulphuric acid 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ + water
2. Lithium hydroxide + nitric acid 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ + water
3. Potassium hydroxide + nitric acid 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Copper oxide + nitric acid 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Magnesium oxide + sulphuric acid 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_

Balance this symbol equation:

NaOH (aq) + HCl (aq) 🡪 NaCl (aq) + H2O (l)

**Connect**

The required practical that you are going to do requires several separation techniques.

You studied separation techniques in **KS3 Separating Mixtures.**

* Name the separation technique that you would use to separate the mixtures below.
* List the apparatus that would be required.

1. Sand and water (insoluble solid and a liquid)

Technique: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Apparatus:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Sodium chloride and water (soluble solid and a liquid)

Technique: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Iron and sand

Technique: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Apparatus:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Ethanol dissolved in water

Technique: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Notes**

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Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide

and a dilute acid.

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Describe a safe method for making pure crystals of copper sulfate from copper carbonate and dilute sulfuric acid. Use the information in the figure above to help you.

In your method you should name all of the apparatus you will use.

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The percentage atom economy for a reaction is calculated using:



The equation for the reaction of copper carbonate and sulfuric acid is:

CuCO3 + H2SO4 → CuSO4 + H2O + CO2

Relative formula masses : CuCO3 = 123.5; H2SO4 = 98.0; CuSO4 = 159.5

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

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Atom economy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(3)**

Give **one** reason why is it important for the percentage atom economy of a reaction to be as high as possible.

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**(1)**

**Lesson 8: 4.4.3.1 The process of electrolysis & 4.4.3.2 Electrolysis of molten ionic compounds**

**Date .**

**Objective: You are learning about the process of electrolysis and how it can be represented in equations.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 | **Catch up (complete this if you were absent last lesson):**  In the last lesson, the class completed a required practical. A sample of the results are below:  Table  Description automatically generated |  |

1. Identify the anomaly. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Calculate the mean. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Look carefully at the results.

1. Is the sulphuric acid more concentrated or less concentrated than the sodium hydroxide solution? (Remember, sulphuric acid releases 2 protons per molecule).

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**Connect**

You previously studied ionic compounds in **KS4 Structures and Bonding.**

The structure of sodium chloride, an ionic compound, is shown below:

A picture containing chart

Description automatically generated

1. Explain why sodium ions have a positive charge (sodium is in group 1 of the Periodic Table).

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1. Explain why chloride ions have a negative charge (chlorine is in group 7 of the Periodic Table).

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1. Sodium chloride is a giant structure of ions.

Explain what this means.

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1. Explain why ionic compounds have high melting points and boiling points.

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1. Ionic compounds can conduct electricity but only when they aren’t a solid.

Explain why ionic compounds can not conduct electricity when solid.

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**Notes**

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**Which products would be formed at the positive and negative electrodes?**

|  |  |  |
| --- | --- | --- |
| **Solution** | **Positive electrode (anode)** | **Negative electrode (cathode)** |
| Copper (II) chloride |  |  |
| Sodium chloride |  |  |
| Aluminium oxide |  |  |
| Lithium Fluoride |  |  |

Electrolysis is used to separate ions and then produce atoms of the elements.

1. Explain why ionic substances only conduct electricity when molten or dissolved.

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1. Metal ions are positively charged. Do they migrate towards the positive or negative electrode?

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1. Non-metal ions are negatively charged. Do they migrate towards the positive or negative electrode?

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1. Are the metal ions oxidised or reduced when they reach the electrode?

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1. Are the non-metal ions oxidised or reduced when they reach the electrode?

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**Writing Half-Equations**

Complete these half-equations by adding the correct number of electrons:

1. Mg2+ + \_\_\_e- 🡪 Mg
2. Al3+ + \_\_\_e- 🡪 Al
3. 2Cl- 🡪 Cl2 + \_\_\_e-
4. 2O2- 🡪 O2 + \_\_\_e-

Complete by adding electrons to the correct side of the equation:

1. Ca2+ 🡪 Ca
2. 2H+ 🡪 H2
3. 2Br- 🡪 Br2
4. Pb2+ 🡪 Pb

Write balanced half equations for the following reactions:

1. Reduction of lithium (Li+) ions to lithium atoms
2. Oxidation of iodide (I-) ions to iodine atoms
3. \_\_\_\_\_\_\_\_\_ of zinc (Zn2+) ions to zinc atoms

Correct the mistakes in the following:

1. Co2+ - 2e- 🡪 Co
2. Cl- 🡪 Cl + e-
3. 2O2- + 4e- 🡪 O2

This question is about zinc and magnesium.

Zinc is produced by electrolysis of molten zinc chloride, as shown in the figure below.

Diagram

Description automatically generated

(a)    (i)      Why must the zinc chloride be molten for electrolysis?

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(ii)     Describe what happens at the negative electrode.

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**(3)**

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

\_\_\_\_\_\_\_\_        Cl2    +    \_\_\_\_\_\_\_\_    e–

**(1)**

(b)     Magnesium can be produced from magnesium oxide.

The equation for the reaction is:

Si(s)    +    2 MgO(s)        SiO2(s)    +    2 Mg(g)

(i)      How can you tell from the equation that the reaction is done at a high temperature?

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**(1)**

Some students investigated the electrolysis of copper nitrate solution using inert electrodes.

**Figure 1** shows the apparatus.

**Figure 1**

**Diagram, schematic

Description automatically generated**

The students investigated how the mass of copper produced at the negative electrode varied with time and current.

This is the method used.

1.   Weigh the negative electrode.

2.   Set up the apparatus shown in **Figure 1**.

3.   Adjust the power supply until the ammeter shows a current of 0.3 A

4.   Switch off the power supply after 5 minutes.

5.   Rinse the negative electrode with water and allow to dry.

6.   Reweigh the negative electrode.

7.   Repeat steps 1 to 6 for different times.

8.   Repeat steps 1 to 7 at different currents.

(d)  Some of the copper produced did not stick to the negative electrode but fell to the bottom of the beaker.

Suggest how the students could find the total mass of copper produced.

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**Lesson 9: 4.4.3.3 Using electrolysis to extract metals**

**Date: .**

**Objective: You are learning how electrolysis is used to extract metals from metal compounds.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
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**Catch up (complete this if you were absent last lesson):**

In the last lesson the class learnt about the process of electrolysis. This process can be used to extract pure metals from metal compounds.

Diagrams of the apparatus used can be fond in the Knowledge Booklet.

1. Electrolysis only works for ionic compounds. Are metal ions positively or negatively charged?

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1. Will the metal ions migrate towards the positive or negative electrode?

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1. When the metal ions reach the electrode, will they be oxidised or reduced?

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1. Electrolysis only works for ionic compounds. Are non-metal ions positively or negatively charged?

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1. Will the non-metal ions move towards the positive or negative electrode?

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1. When the metal ions reach the electrode, will they be oxidised or reduced?

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At KS3, and earlier in this topic, you learnt about how metals can be put in order of reactivity. This is called the Reactivity Series.

In **KS4 Atomic Structure and Periodic Table** you learnt why potassium (group 1) is more reactive that lithium (also in group 1).

You have also learnt about what the Reactivity Series tells us about how metals can be extracted.

1. Explain, in terms of reactivity, why gold is found as a pure metal in the ground.

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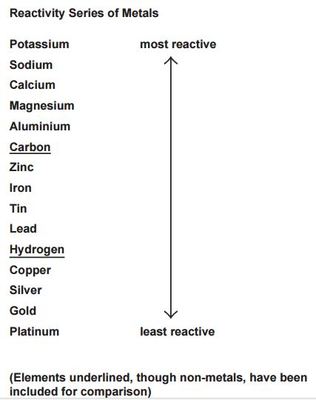
1. Explain, in terms of reactivity, why iron can be extracted from iron oxide by displacing it with carbon.

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1. Explain, in terms of reactivity, why magnesium can not be extracted from its ore by displacing it with carbon.

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**Connect**



**Notes**

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Aluminium is extracted by electrolysis using the ionic compound aluminium oxide.

Diagram

Description automatically generated  
              Molten aluminium

(i)      Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Suggest why.

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**(1)**

(ii)     Why is aluminium oxide dissolved in molten cryolite?

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**(1)**

(iii)    Aluminium metal is produced at the negative electrode (cathode).

Complete the half equation for the process.

Al3+    +    \_\_\_\_\_  e–         Al

**(1)**

(iv)      Use the half equation to state why Al3+ ions are reduced.

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**(1)**

(v)      Explain why the positive electrodes (anodes) burn away.

Use your knowledge of the products of electrolysis to help you.

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**(4)**

China is currently going through an industrial revolution. Other heavily industrialised countries have tried to discourage this because of the harm that is caused to the environment; they are concerned about global warming because carbon dioxide is a greenhouse gas.

Other countries disagree with large scale production of aluminium using electrolysis. They also disagree with building more fossil fuel power stations to generate electricity.

**Question: Explain how using electrolysis to extract aluminium contributes to global warming.**

**Suggest what the Chinese government could do to reduce the contribution to global**

**warming.**

**You should include:**

* An explanation of what global warming is and how it affects the environment.
* Two ways that using electrolysis to extract aluminium produces carbon dioxide.
* Suggestions of how to reduce the volume of carbon dioxide produced when the electricity is generated (how else could they generate electricity?).
* Suggestions of how to reduce the amount of carbon dioxide produced by the electrolysis process itself (which other conductor cold be used to make the electrodes?).

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**Lesson 10: 4.4.3.4 Electrolysis of aqueous solutions**

**Date: .**

**Objective: You are learning to predict the products made during electrolysis of aqueous solutions.**

**Skills Drill / Retrieval**

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| Answer | | PA / SA |
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**Catch up (complete this if you were absent last lesson):**

In the last lesson the class learnt how we extract metals using electrolysis. We specifically looked at extracting aluminium.

1. Which substance is mixed with bauxite (mainly aluminium oxide) to reduce its melting point?

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1. Why is it important to reduce the melting point?

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1. What are the electrodes made of?

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1. Why do the electrodes have to be replaced regularly?

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**Connect**

When ionic substances are dissolved in water to make an aqueous solution, more types of ions are present. This makes it more difficult to predict the products made by electrolysis.

When we learnt about neutralisation, we learnt that water is composed of two ions:

1. Hydrogen ion, H+.
2. Hydroxide ion, OH-.

A solution will also contain the ions from the ionic substance.

Questions:

1. Which ions are present in a solution of sodium chloride (NaCl)?
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Which ions will migrate towards the negative electrode (cathode)?

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Which ions will migrate towards the positive electrode (anode)?

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Notes**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What products would be made at the anode and cathode?

Aqueous solutions:

|  |  |  |  |
| --- | --- | --- | --- |
| **Electrolyte** | **Ions present** | **Product at the cathode** | **Product at the anode** |
| Sodium chloride solution | Na+, Cl-, H+, OH‑ | Hydrogen, H2 | Chlorine, Cl2 |
| Lead bromide solution |  |  |  |
| Aluminium oxide solution |  |  |  |
| Copper(II) nitrate solution |  |  |  |
| Aqueous potassium bromide |  |  |  |
| Sulfuric acid  (H2SO4) |  |  |  |

Molten electrolytes:

|  |  |  |  |
| --- | --- | --- | --- |
| **Electrolyte** | **Ions present** | **Product at the cathode** | **Product at the anode** |
| Sodium chloride | Na+, Cl- | Sodium, Na | Chlorine, Cl2 |
| Molten lead bromide | Pb2+, Br- | Lead, Pb | Bromine, Br2 |
| Liquid aluminium oxide | Al3+, O2- | Aluminium, Al | Oxygen, O2 |
| Copper(II) Fluoride | Cu2+, F- | Copper, Cu | Fluorine, F2 |
| Molten potassium bromide | K+, Br- | Potassium, K | Bromine, Br2 |

**\*Modified from task authored by Ellenderr (Tes resources)**

**Products of Electrolysis**

If it’s molten, you don’t need the rules (there’s only 1 option for each electrode).  
E.g. molten zinc chloride makes zinc and chlorine – it doesn’t contain anything else.

But if it’s aqueous (a solution) you need to follow the rules:

Rule at the cathode: **‘Hydrogen or metal is produced – whichever is less reactive.’**

Rule at the anode: **‘Group 7 – if not, oxygen.’**

What would be produced if we electrolysed:

1. Molten sodium chloride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Aqueous sodium chloride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Molten magnesium oxide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Aqueous magnesium oxide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Molten copper fluoride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Aqueous copper fluoride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. Molten lead bromide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Aqueous lead bromide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Molten potassium chloride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
10. Aqueous potassium chloride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. Molten silver oxide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
12. Aqueous silver oxide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
13. Molten aluminium iodide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
14. Aqueous aluminium iodide 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
15. Molten copper chloride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
16. Aqueous copper chloride 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**\*Purchased from Miss Wetton Science (TES resources)**

Predict the products at each electrode and write half equations for all the ionic compounds in the table.

|  |  |  |
| --- | --- | --- |
| Electrolyte | Negative Cathode | Positive Anode |
| NaBr(l) |  |  |
| PbCl2(l) |  |  |
| SnO(l) |  |  |
| Na2SO4(aq) |  |  |
| CuCl2(aq) |  |  |
| KBr(aq) |  |  |
| AgNO3(aq) |  |  |
| MnCl2(l) |  |  |
| NiBr2(l) |  |  |
| AuCl3(aq) |  |  |
| Al2O3(l) |  |  |
| H2SO4(aq) |  |  |
| NaOH(aq) |  |  |
| CuSO4(aq) |  |  |
| CsF(l) |  |  |
| CsI(aq) |  |  |
| ZnCl2(aq) |  |  |
| Li2CO3(aq) |  |  |
| CoBr2(l) |  |  |
| FeBr3(l) |  |  |
| Mg(NO3)2(aq) |  |  |
| HCl(aq) |  |  |

**\*Purchased from gerwynb (TES resources)**

**Lesson 11: Required practical 3: Electrolysis**

**Date: .**

**Objective: You are learning how to test your predictions related to electrolysis of aqueous solutions.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**Catch up (complete this if you were absent last lesson):**

|  |  |  |  |
| --- | --- | --- | --- |
| **Electrolyte** | **Ions present** | **Product at the cathode** | **Product at the anode** |
| Sodium chloride solution | Na+, Cl-, H+, OH‑ | Hydrogen, H2 | Chlorine, Cl2 |
| Lead bromide solution |  |  |  |
| Aluminium oxide solution |  |  |  |
| Copper(II) nitrate solution |  |  |  |
| Aqueous potassium bromide |  |  |  |
| Sulfuric acid  (H2SO4) |  |  |  |

**Connect**

You will be performing a required practical today.

A plan for the practical is shown below. However, it isn’t a very good plan.

Improve the plan where required.

1. Pour copper (II) chloride solution into a beaker.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Connect crocodile clips to the electrodes and connect these to the power supply.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Turn the power supply on.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Look at both electrodes and record your observations.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Hold the blue litmus in the solution.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Notes**

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**Required practical: Electrolysis.**

Predict what substances will be made at the electrodes if the following solutions are used:

|  |  |  |
| --- | --- | --- |
| **Solution** | **Positive electrode (anode)** | **Negative electrode (cathode)** |
| Copper (II) chloride |  |  |
| Sodium chloride |  |  |

**Results**

Table

Description automatically generated

**Draw a fully labelled diagram of your apparatus:**