

Splitting compounds with electricity

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These twenty problems train you to predict the products of electrolysis, write balanced half equations and carry out calculations on masses, gas volumes and electrons. They move from key words to multi-step industrial problems on aluminium and brine.

They match GCSE and IGCSE chemistry, O Level, WAEC and KCSE courses, and CBSE Class 9-10 science. Work through the levels in order and check every equation for balanced atoms and charge.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C4

Problem 1 Key words (easy)

Define each term.

1. Electrolyte
2. Cathode
3. Anode

Problem 2 Why molten or dissolved? (easy)

Solid sodium chloride does not conduct, but molten sodium chloride does.

1. Explain why the solid does not conduct.
2. Explain why the molten salt does.

Problem 3 Molten potassium iodide (easy)

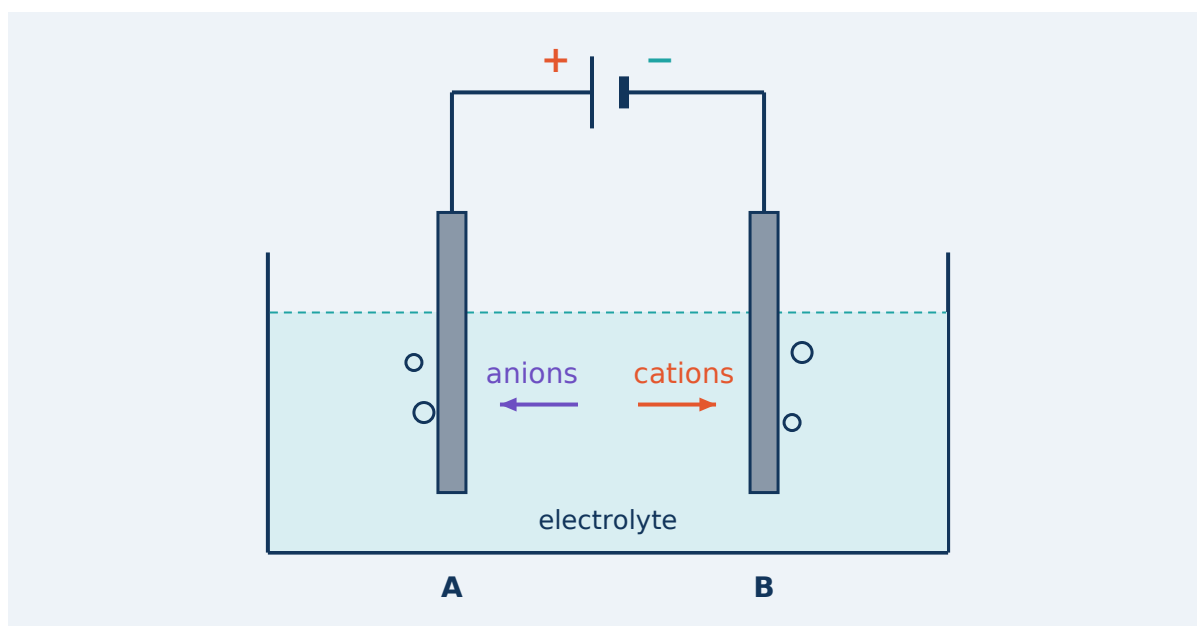
Chiamaka in Lagos electrolyses molten potassium iodide, KI, with inert electrodes.

1. State which ion moves to the cathode.
2. Name the product at each electrode.
3. Write the half equation at the anode.

Problem 4 Reading a cell diagram (easy)

The diagram shows a cell.

1. State which electrode, A or B, is the cathode.
2. Explain your choice using the battery symbol.
3. State the direction in which the positive ions move.



Electrodes A and B in an electrolyte.

Problem 5 Products from molten salts (easy)

Name the product at each electrode when each compound is molten and electrolysed with inert electrodes.

1. Zinc chloride, ZnCl_2
2. Sodium bromide, NaBr
3. Magnesium oxide, MgO

Problem 6 Complete the half equations (easy)

Complete each half equation by adding the missing electrons or product.

1. $\text{Na}^+ + \text{e}^- \rightarrow ?$
2. $2\text{Cl}^- \rightarrow \text{Cl}_2 + ?$
3. $\text{Cu}^{2+} + 2\text{e}^- \rightarrow ?$
4. State which two are reductions.

Problem 7 Three aqueous electrolytes (medium)

Predict the products at an inert cathode and anode for each solution.

1. Copper(II) chloride solution
2. Dilute sulfuric acid
3. Sodium nitrate solution

Problem 8 Why hydrogen, not sodium? (medium)

Kofi in Accra electrolyses concentrated sodium chloride solution and finds hydrogen at the cathode.

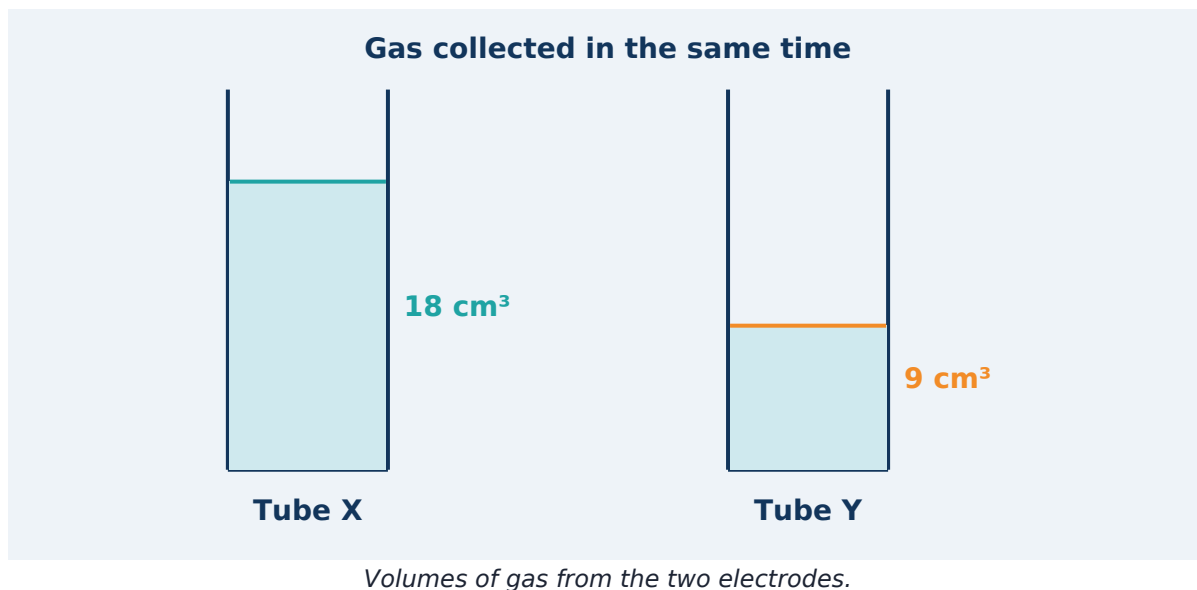
1. Name the two positive ions in the solution.

2. Explain why sodium is not formed.
3. State what remains in solution afterwards.

Problem 9 Gas volumes from acid (medium)

Dilute sulfuric acid is electrolysed. The figure shows the gases collected in the same time.

1. Identify the gas in each tube.
2. Write the half equation for the gas in tube X.
3. Explain why X holds twice the volume of Y.



Problem 10 Matching products to uses (medium)

Brine is electrolysed in a factory.

1. Name the three products.
2. Match each to a use: bleach and disinfectant; soap making; fuel.
3. Explain why the solution near the cathode becomes alkaline.

Problem 11 Copper plating (medium)

Bilal in Lahore passes a current until 0.20 mol of electrons has been transferred in copper(II) sulfate solution (Ar: Cu = 64).

1. Write the cathode half equation.
2. Calculate the moles of copper deposited.
3. Calculate the mass of copper deposited.

Problem 12 Refining copper (medium)

In copper refining the anode is impure copper and the cathode is pure copper, in copper(II) sulfate solution. The anode loses 12.8 g and 0.8 g of impurities fall to the bottom as sludge.

1. Write the half equation at each electrode.

2. Calculate the mass of copper that dissolves.
3. Calculate the percentage purity of the anode.

Problem 13 Silver-plated spoon (medium)

Emma in Leeds wants to coat a steel spoon with silver using silver nitrate solution.

1. State which electrode the spoon should be.
2. Name a suitable anode.
3. Write the half equation that makes the coating.

Problem 14 Balance the half equations (medium)

Balance each half equation by adding coefficients and electrons.

1. $\text{Al}^{3+} + ?\text{e}^- \rightarrow \text{Al}$
2. $? \text{O}^{2-} \rightarrow \text{O}_2 + ?\text{e}^-$ (find both numbers)
3. $\text{Br}^- \rightarrow \text{Br}_2 + \text{e}^-$ (balance fully)

Problem 15 Cost of an aluminium plant (medium)

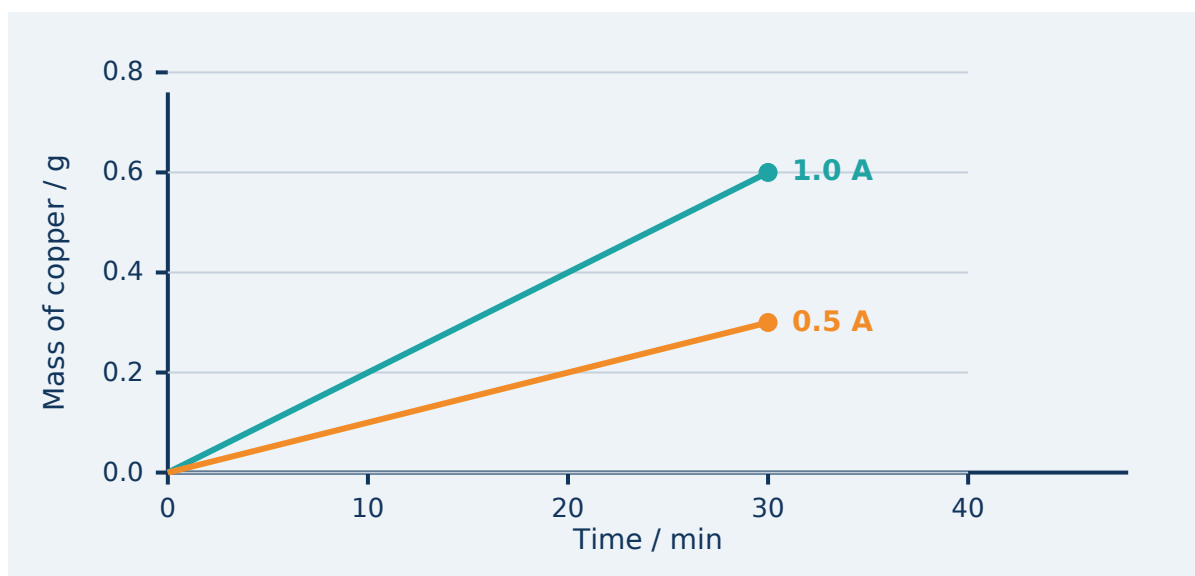
Aluminium oxide has a melting point of 2072 °C. Plants dissolve it in molten cryolite and use carbon anodes.

1. Explain why cryolite is added.
2. Explain why the anodes must be replaced.
3. Write the equation for the reaction that wastes carbon.

Problem 16 Current and mass (hard)

Wanjiru plates copper at two currents. Study the graph.

1. Read the mass of copper at 20 minutes for the 1.0 A line.
2. Calculate the rate of deposition for each line in g/min.
3. Calculate the time for 0.15 g at 0.5 A.
4. Explain why doubling the current doubles the mass.



Copper deposited against time.

Problem 17 Masses in aluminium extraction (hard)

A smelter in Kenya makes 54 kg of aluminium from aluminium oxide, Al_2O_3 (Ar: Al = 27, O = 16, C = 12).

1. Calculate the moles of aluminium.
2. Calculate the mass of aluminium oxide needed.
3. Calculate the mass of carbon burned if all the oxygen formed makes CO_2 .

Problem 18 Brine plant output (hard)

A plant electrolyses 11.7 kg of sodium chloride in solution: $2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 + \text{Cl}_2$ (Ar: Na = 23, Cl = 35.5, O = 16, H = 1).

1. Calculate the moles of NaCl.
2. Calculate the mass of NaOH.
3. Calculate the volume of chlorine at room conditions ($24 \text{ dm}^3/\text{mol}$).

Problem 19 Carbon or copper electrodes? (hard)

Diego electrolyses copper(II) sulfate solution twice. With carbon electrodes the anode gains no mass, gas bubbles form there and the blue colour fades. With copper electrodes the anode loses 0.50 g, the cathode gains 0.50 g and the colour stays the same.

1. Name the gas with carbon electrodes.
2. Explain the mass changes with copper electrodes.
3. Write both half equations for copper electrodes.
4. Explain why the colour stays constant only with copper electrodes.

Problem 20 Spot the errors (hard)

A student wrote: 'The anode is negative. In brine, sodium forms at the cathode. At the

anode, $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$. Solid salt works as an electrolyte because it has ions.' Find and correct each of the four errors.