

Metals by reactivity and how we extract them

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

Name: _____ Date: _____ Class: _____

These problems cover the reactivity series, displacement reactions, oxidation and reduction, and the extraction of metals. They begin with ordering and predicting, then move on to equations, mass calculations and evaluation of data.

The set suits GCSE, IGCSE, O Level and Class 9-10 students. Write balanced equations, name the oxidised and reduced species carefully, and use the position of carbon to choose an extraction method.

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

Problem 1 Put them in order (easy)

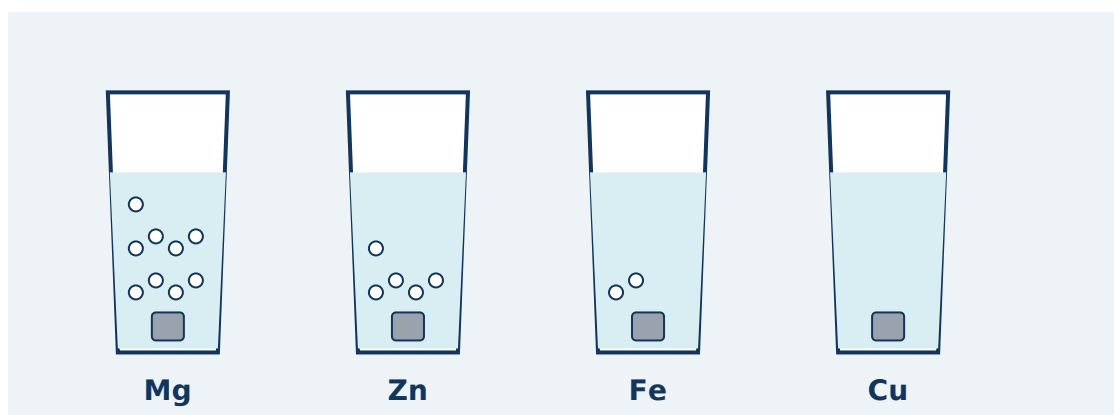
Six metals: potassium, copper, magnesium, zinc, iron, gold.

1. List them from most reactive to least reactive.
2. State which reacts with cold water.
3. State which two do not react with dilute acid.

Problem 2 Metals and dilute acid (easy)

Wanjiru adds equal strips of magnesium, zinc, iron and copper to dilute hydrochloric acid.

1. Predict the order in which the metals fizz, fastest first.
2. Write the word equation for magnesium and the acid.
3. Describe the test for hydrogen.



Bubbles of hydrogen in dilute acid after one minute.

Problem 3 Will it react? (easy)

State whether a reaction occurs and, if so, name the products.

1. Zinc + copper(II) sulfate solution.
2. Copper + zinc sulfate solution.
3. Magnesium + iron(II) sulfate solution.
4. Iron + magnesium sulfate solution.

Problem 4 Vocabulary of redox (easy)

1. Define oxidation in terms of oxygen.
2. Define reduction in terms of electrons.
3. In $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$, state which substance is oxidised and which is reduced.
4. Explain what OIL RIG stands for.

Problem 5 Choose the method (easy)

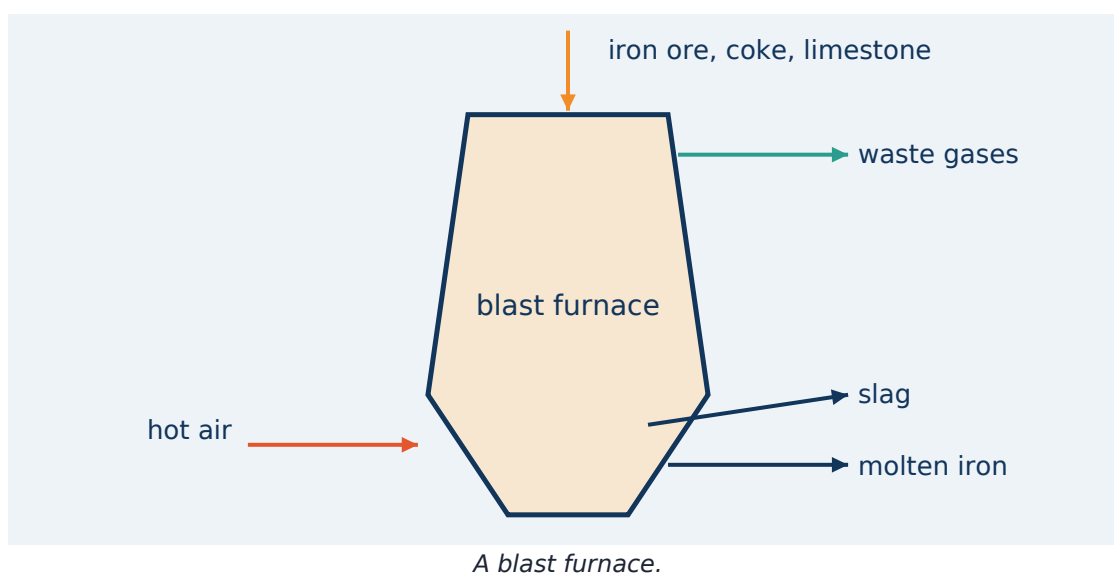
Choose the extraction method for each: electrolysis, heating with carbon, or found uncombined.

1. Aluminium.
2. Iron.
3. Gold.
4. Sodium.
5. Zinc.

Problem 6 Inside a blast furnace (easy)

An iron works in Jamshedpur uses iron ore, coke, limestone and hot air.

1. State the role of coke.
2. Name the gas that reduces the iron oxide.
3. State the purpose of the limestone.



Problem 7 Balance the equations (medium)

Balance each equation.

- $\text{Na} + \text{H}_2\text{O} \rightarrow \text{NaOH} + \text{H}_2$
- $\text{Al} + \text{HCl} \rightarrow \text{AlCl}_3 + \text{H}_2$
- $\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$
- $\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO}$

Problem 8 Ionic equation and half-equations (medium)

Zinc is added to copper(II) sulfate solution: $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$.

- Write the ionic equation.
- Write the half-equation for the zinc and state whether it is oxidation or reduction.
- Write the half-equation for copper and identify the spectator ion.

Problem 9 Redox spotting (medium)

For each reaction state what is oxidised, what is reduced and name the reducing agent.

- $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$
- $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
- $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$
- $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$

Problem 10 Deduce the order (medium)

Four unknown metals W, X, Y and Z are added to solutions of each other's sulfates. A tick means a reaction occurred.

Metal added	W sulfate	X sulfate	Y sulfate	Z sulfate
W	–	✓	✓	✓
X	no	–	no	✓
Y	no	✓	–	✓
Z	no	no	no	–

- Deduce the order of reactivity.
- Identify the metal most likely to be copper.
- Predict whether Y would react with W sulfate.

Problem 11 Welding rails (medium)

Railway workers in India weld rails with thermite: $2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$ (Ar: Al = 27, Fe = 56, O = 16).

- Explain why aluminium can take oxygen from iron oxide.
- Calculate the moles of aluminium in 5.4 kg.

3. Calculate the mass of molten iron formed and the mass of Fe_2O_3 needed.

Problem 12 Galvanised roofs (medium)

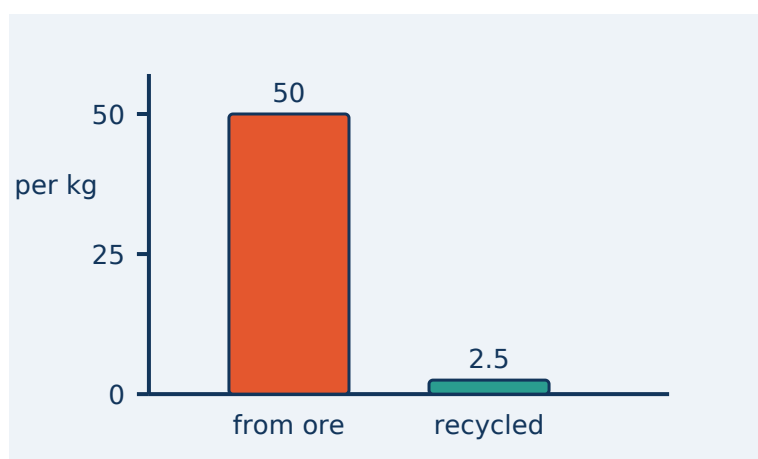
Iron roofing sheets in Nairobi are coated with zinc. A sheet of area 2.0 m^2 has a coating 0.0020 cm thick (density of zinc 7.1 g/cm^3 ; $1 \text{ m}^2 = 10\,000 \text{ cm}^2$).

1. Calculate the volume of zinc.
2. Calculate the mass of zinc.
3. Explain why the iron still resists rusting where the coat is scratched.

Problem 13 Recycling aluminium (medium)

Making 1 kg of aluminium from its ore uses 50 MJ of energy, but recycling uses only 2.5 MJ . A collection point gathers 1000 cans of 15 g each.

1. Calculate the mass of aluminium collected.
2. Calculate the energy saved by recycling it instead of extracting it.
3. Calculate the percentage saving and suggest one reason for it.



Energy needed per kilogram of aluminium.

Problem 14 How much iron in the ore? (medium)

A mine in Odisha produces 50 tonnes of ore containing $80\% \text{ Fe}_2\text{O}_3$ (Ar: Fe = 56 , O = 16).

1. Calculate the percentage of iron by mass in Fe_2O_3 .
2. Calculate the mass of iron in the 50 tonnes of ore.
3. The furnace has a 92% yield. Calculate the mass of iron actually obtained.

Problem 15 Reactions with water (medium)

Diego in Texas watches three metals in water. Sodium melts into a ball, fizzes and darts about. Calcium sinks and gives steady bubbles. Magnesium gives only a few bubbles after a long time.

1. Place the metals in order of reactivity.
2. Explain, in terms of electrons, why sodium is more reactive than magnesium.

3. Write the equation for sodium and water.

Problem 16 Smelting copper oxide (hard)

Heating copper(II) oxide with carbon: $2\text{CuO} + \text{C} \rightarrow 2\text{Cu} + \text{CO}_2$. Bilal in Lahore heats 159 g of CuO with 6.0 g of carbon (Ar: Cu = 63.5, O = 16, C = 12).

1. Calculate the moles of each reactant.
2. Identify the limiting reactant.
3. Calculate the mass of copper formed and the mass of CuO left.

Problem 17 Zinc in copper sulfate (hard)

$\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$. Chiamaka adds 3.25 g of zinc to 100 cm³ of 0.400 mol/dm³ copper(II) sulfate (Ar: Zn = 65, Cu = 63.5).

1. Calculate the moles of zinc and of copper(II) sulfate.
2. Identify the limiting reactant and the mass of copper formed.
3. Calculate the mass of zinc left and the concentration of zinc sulfate at the end.

Problem 18 Spot the errors (hard)

A student writes: "(a) Carbon displaces aluminium from aluminium oxide because carbon is cheap. (b) Copper is more reactive than iron because copper is used for coins. (c) Sodium added to copper sulfate solution gives copper metal."

1. Identify the error in each statement.
2. Rewrite each statement correctly.
3. Explain what actually happens when sodium is added to copper sulfate solution.

Problem 19 Aluminium electrolysis (hard)

Aluminium oxide is electrolysed: $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$ (Ar: Al = 27, O = 16). A smelter makes 1000 kg of aluminium.

1. Calculate the moles of aluminium (in kmol).
2. Calculate the mass of Al_2O_3 needed.
3. Calculate the mass of oxygen formed and explain why the carbon anodes need replacing.

Problem 20 Which metal is M? (hard)

An unknown metal M forms M^{2+} ions. Observations: M displaces copper from copper sulfate; M does not displace iron from iron sulfate; M reacts slowly with dilute acid. A 5.90 g piece of M displaces exactly 6.35 g of copper (Ar: Cu = 63.5).

1. Place M in the reactivity series.
2. Write the ionic equation for the displacement.
3. Calculate the Ar of M and suggest its name.
4. State the likely method of extraction.