

Ions in a sea of electrons

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

Name: _____ Date: _____ Class: _____

These problems train you to describe the metallic bond, link it to properties such as conduction, malleability and melting point, and do simple composition calculations for alloys. They suit GCSE and IGCSE students, O Level, WAEC and KCSE learners, and Class 9-10 students. Work from easiest to hardest and use the layer model whenever you explain a property.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C2

Problem 1 Metallic bond (easy)

Nneka is writing a glossary for chemistry class.

1. Define a metallic bond.
2. Name the two kinds of particle involved in a metallic bond.
3. State the overall charge of a piece of metal.

Problem 2 Properties of metals (easy)

Rohan lists five properties: conducts electricity, brittle, malleable, low melting point for most metals, conducts heat.

1. State which three are typical properties of metals.
2. State what the opposite of malleable is, and give one example of a substance that has it.

Problem 3 Outer electrons and ions (easy)

Sodium has 1 outer electron, magnesium has 2 and aluminium has 3. All three form metallic structures.

1. State the charge of the ion formed by each metal.
2. State how many electrons each atom adds to the electron sea.
3. Calculate the total number of delocalised electrons from 100 atoms of aluminium.

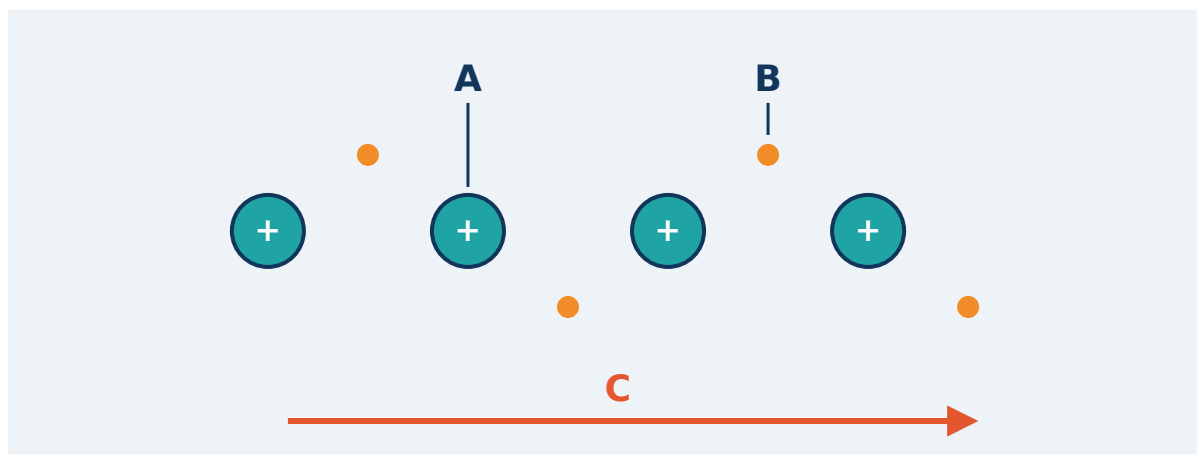
Problem 4 Property and use (easy)

Match each use to the metal property that makes it suitable.

1. Copper is used inside electrical cables.
2. Aluminium is used for saucepans.
3. Iron is used for bridge girders when it is alloyed as steel.
4. Gold is used for jewellery that can be shaped into thin chains.

Problem 5 Reading the diagram (easy)

The diagram shows part of a metal. Arrow C shows the way particles drift when the metal is joined to a cell.



Part of a metal structure.

1. Name the particle labelled A.
2. Name the particle labelled B.
3. Arrow C points to the right. State which terminal of the cell is connected to the left end.

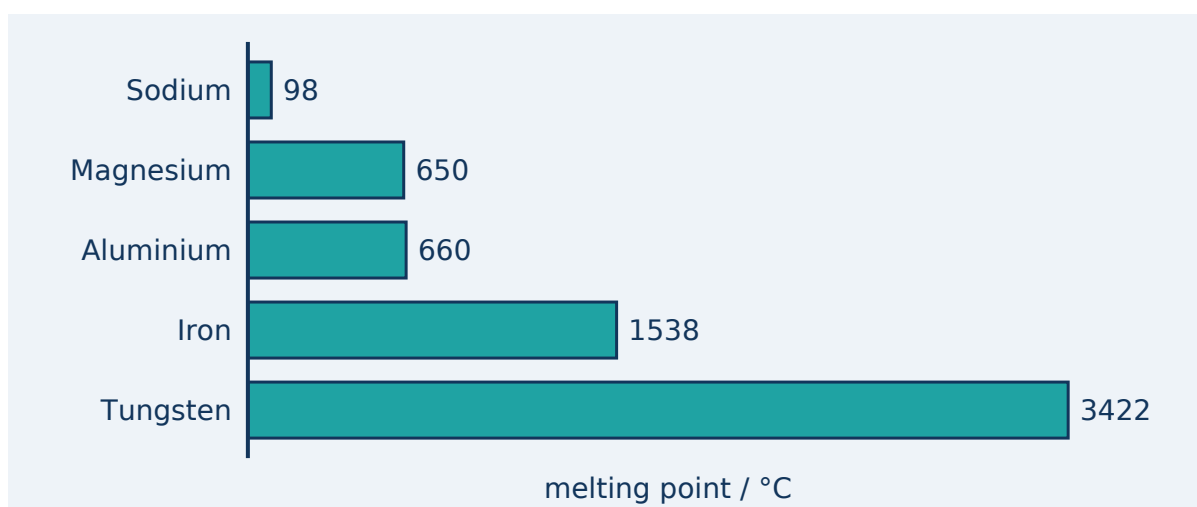
Problem 6 What is an alloy? (easy)

Siddharth has a bronze bell and a steel spoon.

1. Define an alloy.
2. State the elements in bronze.
3. State the elements in steel.

Problem 7 Melting points of metals (easy)

The bar chart shows the melting points of five metals.



Melting points of five metals.

1. Name the metal with the highest melting point.
2. Name the metal with the lowest melting point.

3. Name the metals that are solid at 700 °C.

Problem 8 Why metals are malleable (medium)

Hammered copper sheet does not shatter, but a salt crystal does.

1. Explain why copper can be hammered into shape.
2. Explain what prevents the metal from falling apart when the layers slide.

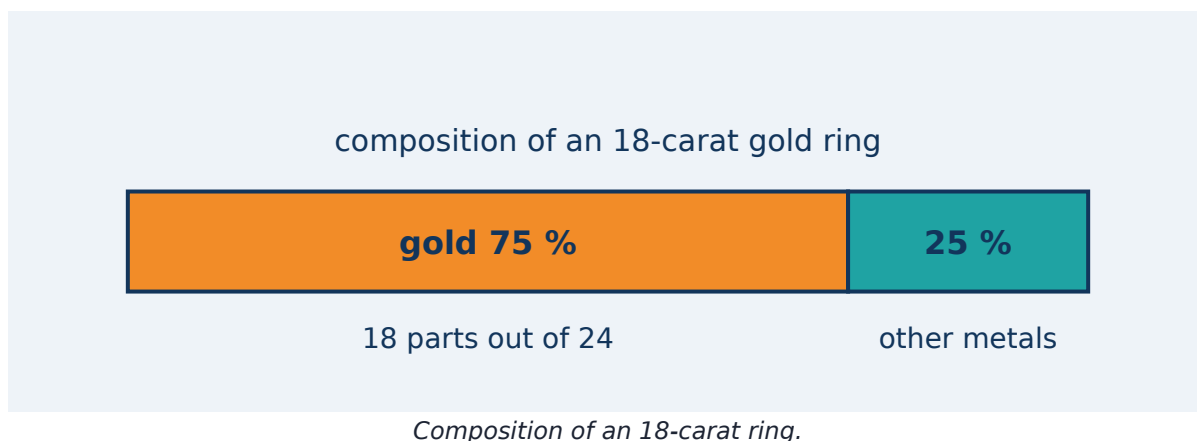
Problem 9 Sodium and aluminium (medium)

Sodium melts at 98 °C and aluminium melts at 660 °C.

1. State the ion formed by each metal.
2. Compare the number of delocalised electrons given by each atom.
3. Explain why aluminium has the higher melting point.

Problem 10 Gold in a ring (medium)

Wanjiru buys an 18-carat gold ring of mass 8.0 g. The diagram shows its composition.



1. Calculate the mass of gold in the ring.
2. Calculate the mass of other metals.
3. Calculate the mass of gold in an 8.0 g ring of 9-carat gold.

Problem 11 Lead-free solder (medium)

Lead-free solder for electronics contains 99.3 % tin and 0.7 % copper by mass. A technician has a 250 g reel.

1. Calculate the mass of copper in the reel.
2. Calculate the mass of tin in the reel.

Problem 12 Spot the errors (medium)

Ifeanyi writes about metals:

1. Metals conduct electricity because positive ions flow through them.
2. The sea of electrons makes a metal negatively charged.

3. An alloy is a compound of a metal with oxygen.
4. Correct each statement.

Problem 13 Heat along a spoon (medium)

A metal spoon left in hot soup soon feels hot at the handle.

1. Explain how thermal energy travels along the spoon.
2. Explain why a wooden spoon stays cooler.

Problem 14 Cables for pylons (medium)

Copper has a density of 8.96 g/cm^3 and a relative conductivity of 100. Aluminium has a density of 2.70 g/cm^3 and a relative conductivity of 61. Overhead power lines are usually made of aluminium.

1. Calculate relative conductivity divided by density for each metal.
2. Calculate how many times better aluminium is by this measure.
3. Suggest why aluminium cables are suitable for pylons.

Problem 15 Drawing copper into wire (medium)

Copper is ductile. A cylinder of copper with a volume of 12.0 cm^3 is drawn into a wire with a cross-sectional area of 0.0020 cm^2 .

1. Explain at particle level why copper can be drawn into a wire without breaking.
2. Calculate the length of the wire in centimetres, using $\text{volume} = \text{area} \times \text{length}$.
3. Convert your answer to metres.

Problem 16 Carbon in steel (hard)

A steel rail has a mass of 1500 kg and contains 0.80 % carbon by mass.

1. Calculate the mass of carbon in the rail.
2. Calculate the mass of iron, assuming the rest is iron.
3. Explain why adding carbon makes iron harder.

Problem 17 Conduction in solids (hard)

Metals conduct electricity when solid. Solid sodium chloride does not, but molten sodium chloride does.

1. Explain why a solid metal conducts.
2. Explain why solid sodium chloride does not conduct.
3. Explain why molten sodium chloride conducts.
4. State what carries charge in each case.

Problem 18 Planning a hardness comparison (hard)

Mei wants to compare the hardness of pure copper and brass.

1. State a prediction and explain it.
2. Describe a method that gives a numerical result, with one control variable.
3. State one risk and one precaution.

Problem 19 Choosing an aircraft metal (hard)

Aircraft builders prefer duralumin (aluminium with about 4 % copper) to pure aluminium.

1. Calculate the mass of copper in 2500 kg of duralumin containing 4.0 % copper.
2. Explain why duralumin is stronger than pure aluminium.
3. Suggest why aircraft makers do not use steel instead.

Problem 20 Heating a copper wire (hard)

Chiamaka measures a copper wire connected to a 1.5 V cell. Its resistance is 1.00 Ω at 20 °C and 1.31 Ω at 100 °C.

1. Calculate the current at each temperature using $I = V \div R$.
2. Calculate the percentage increase in resistance.
3. Explain at particle level why the resistance rises when the metal is hotter.