

Using equations to find masses and yields

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

Name: _____ Date: _____ Class: _____

These twenty problems train the full chain of reacting-mass calculations: relative formula masses, mole ratios, limiting reactants, percentage yield and concentration. They start with one-step conversions and finish with multi-step problems that combine several ideas. The set suits GCSE, IGCSE, O Level and Class 9-10 students. Work in moles first, show every step and check each answer for a sensible size.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-7, GCSE C3

Problem 1 Reading mole ratios (easy)

Ammonia forms by $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$.

1. State the mole ratio $\text{N}_2 : \text{H}_2 : \text{NH}_3$.
2. Calculate the moles of hydrogen needed to react with 4 mol of nitrogen.
3. Calculate the moles of ammonia formed from 4 mol of nitrogen.

Problem 2 Relative formula masses (easy)

Use Ar: Ca = 40, C = 12, O = 16, Na = 23, S = 32, Al = 27.

1. Calculate the relative formula mass of CaCO_3 .
2. Calculate it for Na_2SO_4 .
3. Calculate it for Al_2O_3 .

Problem 3 Units of concentration (easy)

1. Convert 250 cm^3 to dm^3 .
2. Calculate the concentration of a solution containing 0.50 mol of potassium hydroxide in 2.0 dm^3 .
3. Calculate the moles of solute in 250 cm^3 of a 0.80 mol/dm^3 solution.

Problem 4 A simple yield (easy)

Emma in Leeds makes a salt. The equation predicts 4.5 g, but she collects 3.6 g.

1. State what 4.5 g is called.
2. Calculate her percentage yield.
3. Another student has a 65% yield from a theoretical 8.0 g. Calculate the actual mass.

Problem 5 Hydrogen from magnesium (easy)

$\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$. Aarav drops 2.4 g of magnesium into excess acid (Ar: Mg = 24, H = 1).

1. Calculate the moles of magnesium.
2. State the moles of hydrogen formed.
3. Calculate the mass of hydrogen.

Problem 6 Mass of iron(III) oxide (easy)

Rust is mainly Fe_2O_3 (Ar: Fe = 56, O = 16).

1. Calculate the molar mass of Fe_2O_3 .
2. Calculate the mass of 0.25 mol of Fe_2O_3 .
3. Calculate the moles in 80 g of Fe_2O_3 .

Problem 7 Oxygen from potassium chlorate (medium)

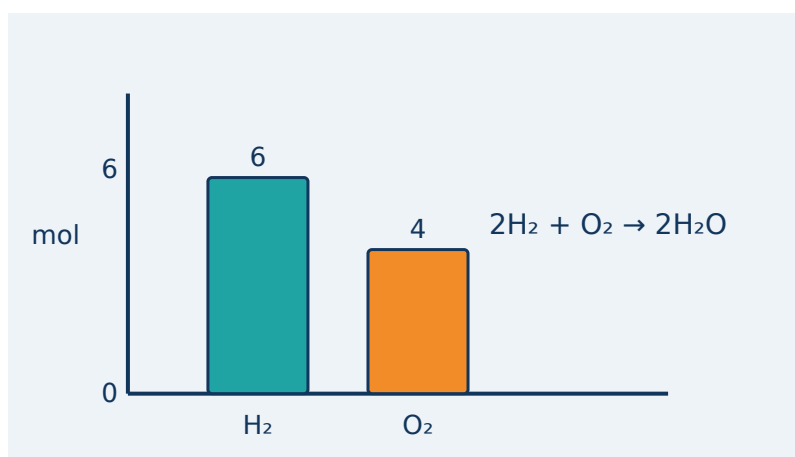
Wanjiru heats 12.25 g of potassium chlorate: $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$ (Ar: K = 39, Cl = 35.5, O = 16).

1. Calculate the molar mass of KClO_3 .
2. Calculate the moles heated.
3. Calculate the mass of oxygen released.

Problem 8 Which gas runs out? (medium)

Hydrogen burns in oxygen: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$. The bar chart shows the amounts available.

1. Identify the limiting reactant.
2. Calculate the moles of water formed.
3. Calculate the moles of the excess reactant left over.



Amounts available at the start.

Problem 9 Burning methane (medium)

Diego in Texas burns 8.0 g of methane on a camp stove: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ (Ar: C =

12, H = 1, O = 16).

1. Calculate the moles of methane.
2. Calculate the mass of carbon dioxide formed.
3. Calculate the mass of water formed.

Problem 10 Salt water for an aquarium (medium)

Mei in Singapore dissolves 5.85 g of sodium chloride and makes the volume up to 500 cm³ (Ar: Na = 23, Cl = 35.5).

1. Calculate the moles of NaCl.
2. Calculate the concentration in mol/dm³.
3. Calculate the concentration in g/dm³.

Problem 11 Weighing copper sulfate (medium)

A teacher needs 250 cm³ of 0.100 mol/dm³ copper(II) sulfate, CuSO₄ (Ar: Cu = 63.5, S = 32, O = 16).

1. Calculate the moles of CuSO₄ required.
2. Calculate the molar mass of CuSO₄.
3. Calculate the mass to weigh out.

Problem 12 Silver chloride precipitate (medium)

AgNO₃ + NaCl → AgCl + NaNO₃. Bilal in Lahore uses 3.40 g of silver nitrate with excess sodium chloride and collects 2.58 g of dry silver chloride (Ar: Ag = 108, N = 14, O = 16, Cl = 35.5).

1. Calculate the moles of AgNO₃.
2. Calculate the theoretical yield of AgCl.
3. Calculate the percentage yield.

Problem 13 Why is the yield low? (medium)

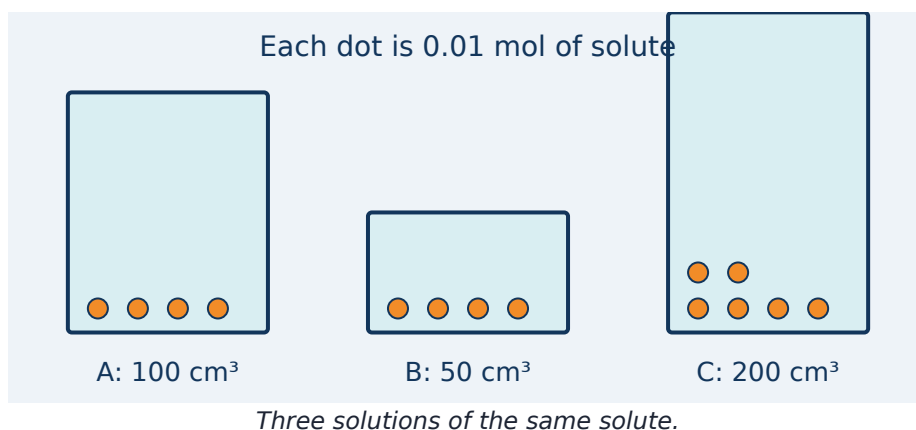
A student obtains 72% yield from a theoretical yield of 15.0 g.

1. Calculate the actual yield.
2. Explain two reasons why a yield below 100% is expected.
3. Explain why a yield of 104% suggests a mistake.

Problem 14 Which solution is strongest? (medium)

Each dot represents 0.01 mol of dissolved solute.

1. Calculate the concentration of solutions A, B and C.
2. Rank them from most to least concentrated.
3. State how much water must be added to B to match A.



Problem 15 Three trials, one mean (medium)

A class targets 5.00 g of product. Three groups collect 3.85 g, 4.10 g and 3.95 g.

1. Calculate each percentage yield.
2. Calculate the mean percentage yield.
3. Suggest why the groups did not get identical results.

Problem 16 Precipitating chalk (hard)

$\text{Na}_2\text{CO}_3 + \text{CaCl}_2 \rightarrow \text{CaCO}_3 + 2\text{NaCl}$. Chiamaka mixes 25.0 cm³ of 0.40 mol/dm³ sodium carbonate with 50.0 cm³ of 0.30 mol/dm³ calcium chloride (Ar: Ca = 40, C = 12, O = 16).

1. Calculate the moles of each reactant.
2. Identify the limiting reactant.
3. Calculate the mass of calcium carbonate formed and the moles of calcium chloride left.

Problem 17 Spot the error (hard)

$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$. Ravi reacts 10 g of calcium carbonate with 100 cm³ of 1.0 mol/dm³ hydrochloric acid. He writes: "0.10 mol of marble needs 0.10 mol of acid, so all the marble dissolves and 0.10 mol of CO₂ forms."

1. Identify his mistake.
2. Calculate the moles of CO₂ that really form.
3. Calculate the mass of CO₂ (Ar: C = 12, O = 16) and the mass of marble left.

Problem 18 Roasting zinc ore (hard)

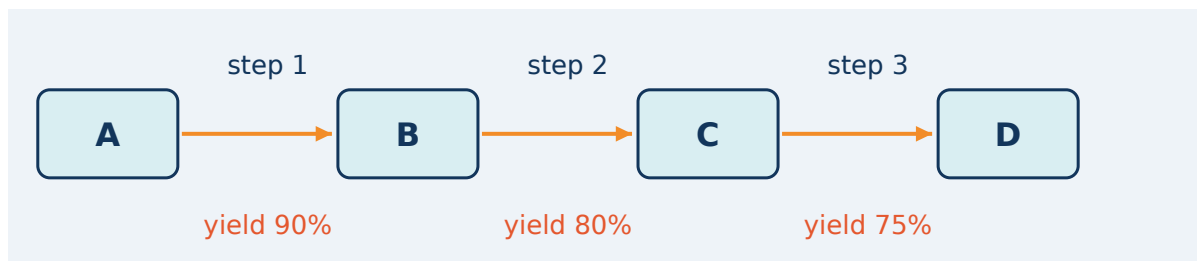
$2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$. A metals worker roasts 4.85 g of zinc sulfide and collects 3.24 g of zinc oxide (Ar: Zn = 65, S = 32, O = 16).

1. Calculate the theoretical yield of zinc oxide.
2. Calculate the percentage yield.
3. Calculate the mass of oxygen consumed and the mass of sulfur dioxide that would form at 100% yield.

Problem 19 Yield through three steps (hard)

A chemist converts A into D in three steps. Each step has a 1 : 1 mole ratio and the yield of each step is shown.

1. Calculate the overall percentage yield.
2. Starting with 0.500 mol of A, calculate the moles of D.
3. Calculate the moles of A needed to make 0.270 mol of D.



A three-step synthesis; every arrow is a 1 : 1 mole ratio.

Problem 20 Lead iodide precipitate (hard)

$\text{Pb}(\text{NO}_3)_2 + 2\text{KI} \rightarrow \text{PbI}_2 + 2\text{KNO}_3$. Mix 50.0 cm³ of 0.100 mol/dm³ lead nitrate with 50.0 cm³ of 0.150 mol/dm³ potassium iodide. The dry solid weighs 1.40 g (Ar: Pb = 207, I = 127).

1. Identify the limiting reactant.
2. Calculate the theoretical yield of PbI₂.
3. Calculate the percentage yield and the concentration of lead nitrate left in the 100 cm³ mixture.