Core practical: empirical formula

Student activity • core practical

YEAR 10 / LESSON 46 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

Can measured mass changes reveal an empirical formula?

Heat a small piece of magnesium in a lidded crucible, then use the measured mass gain to estimate the oxygen-to-magnesium ratio. Keep your actual data even when the ratio is imperfect.

Equipment

- Eye protection; crucible with fitted lid, pipeclay triangle, tripod, Bunsen and heat-resistant mat
- Crucible tongs; balance reading to 0.01 g or better; timer
- Teacher-issued cleaned magnesium ribbon, 5–10 cm per pair, no more than 0.20 g

Wear eye protection. Burning magnesium gives intense light: keep the lid over vigorous burning and do not stare at it. Treat all apparatus as hot; use tongs and a heat-resistant mat. Keep flammables away; avoid smoke/dust and never weigh hot apparatus.

Course coverage: Shared core: 1.31–1.33 and practical 1.36. This lesson covers magnesium combustion and formula calculations; water, hydrates and reduction need separate coverage.

Plan, model or apparatus sketch

Draw the crucible, lid, triangle, tripod and burner; label the safety features.

Method and reasoning

Read the whole sequence before starting

YEAR 10 / LESSON 46 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

1. Wear eye protection, secure hair and clear the bench. Practise lifting the cool lid with tongs. The teacher checks the stable tripod/triangle, gas tubing and dry crucible.

2. Weigh the cool dry crucible with its lid (m_1). Add the cleaned ribbon, loosely coiled, replace the lid and reweigh (m_2). Record actual masses and balance resolution.

3. Place the lidded crucible on the triangle. Heat gently at first, then more strongly under teacher supervision. Keep the lid covering the contents during bright burning; never look directly at burning magnesium.

4. When vigorous burning has subsided, use tongs to briefly raise the lid a little to admit air, then replace it. Continue heating as directed; avoid losing smoke or solid. Do not poke the product or add liquid.

5. Turn off the burner. Leave the crucible on a heat-resistant surface to cool fully; handle with tongs. Never put a hot crucible on the balance. Weigh the cool crucible, lid and product (m_3).

6. Repeat heating, complete cooling and weighing. Keep each reading until two successive cool masses agree within 0.01 g using a 0.01 g balance, or the teacher's stated tolerance for another balance.

7. Use the accepted final cool mass: magnesium mass = $m_2 - m_1$; oxygen mass gain = $m_3 - m_2$. Divide by 24 and 16 respectively, then divide both amounts by the smaller value. Discuss uncertainty before selecting a whole-number ratio.

Cleanup

- Turn off gas; leave apparatus in the designated cooling area.
- Staff collect cooled residues and supervise cleaning; wash hands.

Record your evidence

Blank spaces are for your own work

YEAR 10 / LESSON 46 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Reference and task data

Use A_r(Mg) = 24 and A_r(O) = 16. Constant mass means successive cooled readings agree within the stated tolerance; it does not prove complete purity. Separate invented practice: m_1 = 24.30 g, m_2 = 24.42 g, final m_3 = 24.50 g. Do not copy these into your experimental table.

Measurement	Mass / g	Notes
Crucible + lid, m_1		
Crucible + lid + Mg, m_2		
After heating/cooling 1		
After heating/cooling 2		
After heating/cooling 3		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 10 / LESSON 46 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

1. Use your own masses to calculate the amounts of Mg and O and their simplest ratio.

2. Calculate the empirical formula from the separate invented practice readings.

3. Explain why the lid is used and why it must occasionally be lifted slightly.

4. Explain the need to cool before weighing and to repeat the heating/cooling cycle.

5. Predict how lost oxide or incomplete reaction affects the inferred oxygen amount; identify another limitation.

6. Explain empirical versus molecular formula. A molecular compound has empirical formula CH_2O and $M_r = 180$: find its molecular formula.