Reacting masses and collected yield

Teacher / technician

YEAR 10 / LESSON 43 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Staff preparation and answer guidance. Keep separate from student sheets. Live small-scale collected-CO_2 measurement plus original mass/yield practice. Apparent collected yield is not a direct assay of chemical conversion.

Coverage and delivery

1.28–1.30: amount calculations, reacting masses and percentage yield. Gas-volume conversion is supplied as a measurement aid, not assumed prior knowledge.

Allow about 60 minutes. Follow the student sequence and use the answers to check reasoning.

Requisition • class of 30, working in 15 pairs

Item	Per pair / setup	Class total
Booklet / calculator	1 per learner	30 sets
Syringe/flask/stand/cylinder/balance access	1 checked set per pair	15 sets
Eye protection / tray	1 protector each; 1 tray per pair	30 protectors; 15 trays
Marble / 0.5 mol dm^{-3} HCl	0.20 g + 10.0 cm^3 per run	8 g marble; 375 cm^3 acid incl. spare

Immediate safety

Wear eye protection; avoid acid splashes and report them immediately. Keep the syringe plunger free and tubing unobstructed. Stop if apparatus sticks or pressurises; call the teacher. Handle glassware carefully. No flames or heating.

Preparation and delivery

Read alongside the student method

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1. For 15 pairs and two runs per pair, supply 8 g marble including spare and 375 cm^3 of 0.5 mol dm^{-3} HCl. Each run is about 0.20 g chips with 10.0 cm^3 acid; use actual recorded mass in calculations. No 5 g marble setup is retained.

2. Check the capacity calculation: 0.20 g pure $CaCO_3$ is 0.0020 mol and consumes 0.0040 mol HCl, less than the supplied 0.0050 mol. Maximum CO_2 is about 48 cm^3, giving margin in a 100 cm^3 syringe. The old 5 g / 20 cm^3 acid recipe is not this method.

3. Staff trial the chip size and check free syringe travel, tubing and gas-tight joints. Record room conditions; the 24 dm^3 mol^{-1} conversion is approximate. Do not force a sticking plunger or continue with a blocked outlet.

4. Allow 10 minutes calculations, 20 collection/repeats, 20 yield/evaluation and 10 cleanup. If reaction is incomplete at lesson end, retain honest partial data; do not call that the final yield.

5. This measures apparent collected-gas yield, influenced by collection losses, CO_2 dissolution and purity. The Mg/MgO data are a separate invented practice question, not a measured combustion experiment. No metal burning is included.

Close of lesson

• After reaction stops, staff direct collection/disposal of dilute mixtures and leftover chips. Rinse equipment as instructed; return dry apparatus and wash hands.

Check before teaching

Check the cards, reference data and quantities against this requisition. Keep the staff answer guide separate until the checking stage. Supplied numerical practice datasets are labelled examples; they are not class measurements.

Answers and teaching notes

Expected explanations • do not give as experimental observations

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• 0.20/100 = 0.0020 mol $CaCO_3$ gives at most 0.0020 mol CO_2 = 0.088 g ≈ 48 cm^3. Required HCl is 0.0040 mol; 0.0050 mol is available, so pure $CaCO_3$ is limiting.

• For each run: theoretical mass = actual marble mass × 44/100, assuming pure $CaCO_3$. Collected mass ≈ measured cm^3/24 000 × 44. Divide collected by theoretical mass and multiply by 100; use actual measurements.

• 2Mg + O_2 → 2MgO. Theoretical MgO = (8.0/24)×40 = 13.33… g. Percentage yield = 12.0/13.33… ×100 = 90%.

• Coefficients give mole/particle ratios. Convert moles to masses using each substance's molar mass; equal coefficients do not usually mean equal masses.

• Gas can escape before bunging or through leaks, remain in apparatus, or dissolve in the liquid. These collection effects do not necessarily mean the chemical reaction failed to finish.

• Warm gas, inaccurate mass/volume readings or an unsuitable molar-volume/purity assumption can give an apparent value above 100%. Improve sealing/timing, use measured temperature/pressure, allow cooling and repeat; do not report more than theoretical pure product as a real chemical gain.

References and provenance

Pearson Chemistry specification

RSC teaching marble/acid rate investigations

Prepared 22 November 2026. Original wording, tables and questions. Sources inform the concepts and technique; the lesson scope and classroom quantities are explicitly described here. No laboratory trial or final school risk approval is claimed.