The Oxygen Gain

Use controlled measurements to determine a compound's empirical formula.

CHE.4.8 "Plan and conduct controlled scientific investigations to produce mathematical evidence of the empirical composition of a compound."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each measurement the investigation requires, circle two conditions kept the same, and number the calculation steps in order. These marks will help you connect the procedure to the formula.

What Did the Copper Gain?

1. A metal can gain mass when it combines with oxygen. To find the empirical formula of copper oxide, heat a weighed copper sample in a dry stream of excess oxygen using teacher-approved equipment. Wear goggles and follow the teacher's heating directions. Keep the oxygen flow and heating setup the same between trials so changing conditions do not affect the comparison.

2. First record the mass of the clean, dry crucible, then add copper and record the new mass. Heat the sample in flowing oxygen, let it cool in a dry environment, and weigh the crucible and product. Repeat heating, cooling, and weighing until two consecutive product masses agree. The recorded masses from one trial appear below.

MASSES FROM ONE COPPER-HEATING TRIAL

Measurement	Mass (g)
Empty crucible	24.000
Crucible with copper	24.635
Crucible with product, first heating	24.790
Crucible with product, second heating	24.795
Crucible with product, third heating	24.795

3. Subtract the crucible mass to find the copper and final product masses. Their difference is oxygen gained, if no solid escaped. Divide each element's mass by its molar mass: 63.5 g/mol for copper and 16.0 g/mol for oxygen. Divide both mole amounts by the smaller amount to get the simplest whole-number ratio.

2 ANSWER WITH EVIDENCE

Use the passage

1. Using the recorded masses, calculate the starting mass of copper, the final mass of product, and the mass of oxygen gained.

2. Why should you use the final product mass instead of the mass after the first heating?

3. Convert the copper and oxygen masses to moles. What simplest mole ratio and empirical formula do the results support?

4. Name two conditions to keep the same between trials. What would happen to the calculated oxygen gain if some solid escaped?

3 YOUR TURN

Your own words

Under your teacher's supervision, conduct a new copper-heating trial in the approved dry, excess-oxygen setup, recording the empty crucible, crucible with copper, and two matching final masses. Name two controlled conditions and show the mass and mole calculations that support your empirical formula.

The Oxygen Gain

PART 1 · READ AND MARK

Underline each measurement the investigation requires, circle two conditions kept the same, and number the calculation steps in order. These marks will help you connect the procedure to the formula. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Using the recorded masses, calculate the starting mass of copper, the final mass of product, and the mass of oxygen gained.	**Copper: 24.635 − 24.000 = 0.635 g. Product: 24.795 − 24.000 = 0.795 g. Oxygen: 0.795 − 0.635 = 0.160 g.**
2	Why should you use the final product mass instead of the mass after the first heating?	**The second and third product masses match at 24.795 g, while the first is lower. The matching masses show that further heating did not change the measured mass.**
3	Convert the copper and oxygen masses to moles. What simplest mole ratio and empirical formula do the results support?	**Copper: 0.635 ÷ 63.5 = 0.0100 mol. Oxygen: 0.160 ÷ 16.0 = 0.0100 mol. Cu:O = 1:1, so the formula is CuO.**
4	Name two conditions to keep the same between trials. What would happen to the calculated oxygen gain if some solid escaped?	**Keep the oxygen flow and heating setup the same. Escaping solid would make the measured product mass, and therefore the calculated oxygen gain, too low.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Empty crucible: 22.000 g. Crucible with copper: 22.508 g. The two final masses were 22.636 g and 22.636 g. I kept the oxygen flow and heating setup the same. Copper mass = 22.508 − 22.000 = 0.508 g. Product mass = 22.636 − 22.000 = 0.636 g. Oxygen mass = 0.636 − 0.508 = 0.128 g. Copper: 0.508 ÷ 63.5 = 0.00800 mol. Oxygen: 0.128 ÷ 16.0 = 0.00800 mol. The mole ratio is 1:1, so the empirical formula is CuO.

For the new trial, accept results based on the student's own recorded masses and correct calculations, even if measurement error produces a ratio slightly different from 1:1. The trial requires teacher supervision and approved oxygen-flow equipment.