

Conservation of Mass in Chemical Reactions

Course: Chemistry (Grades 9–12) **Subject:** Science **Time:** ~50 min standard · ~90 min block **Work mode:** Independent · pencil only Science

Start Here

This is a **paper investigation**. You will study a diagram of a simple chemical reaction, read a short passage, and analyze a data table of masses using a pencil. You do **not** need a computer, a lab, or any materials besides this packet and a pencil. There are **no hazards** — nothing is measured on a real balance, mixed, or heated. Work by yourself and do your best thinking. You will do some arithmetic with masses (adding and subtracting grams); a **calculator is allowed**, but the numbers are chosen so you can do them by hand. Write in complete sentences where you are asked to explain. If a question is hard, skip it, keep going, and come back. Reading the passage quietly aloud to yourself is allowed and encouraged.

Start Notice & Wonder 5 min

Imagine sealing a fizzing tablet and water inside a capped bottle, then weighing the whole bottle before and after it fizzes.

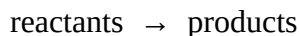
1When wood burns in a campfire, only a small pile of ash is left behind — it looks like most of the wood "disappeared." Write **one thing you notice** and **one thing you wonder** about where the rest of the wood's material went.

2If you sealed a fizzing tablet and water inside a **capped** bottle and weighed the whole bottle before and after it fizzed, do you think the total mass would go **up**, go **down**, or **stay the same**? Give your best first idea and say why.

Build Read the Science 8–12 min

The law of conservation of mass

In a chemical reaction, the starting substances are called **reactants** and the new substances that form are called **products**. We show a reaction with an arrow that means "produces" or "turns into":



The **law of conservation of mass** states that in a chemical reaction, **matter is never created or destroyed**. The atoms in the reactants are only **rearranged** into new combinations in the products. Because no atoms are added or lost, the **total mass of the reactants equals the total mass of the products**:

$$\text{total mass of reactants} = \text{total mass of products}$$

This is only guaranteed to be visible when the reaction happens in a **closed system** — a container that lets **no matter in or out** (like a sealed, capped bottle). In an **open system**, a gas product can **escape** into the air. The mass you can weigh in the container then seems to drop — but the "missing" mass left as gas. The atoms were **conserved**; they just floated away where the balance could not weigh them. Likewise, a reaction that pulls in a gas (such as burning metal combining with oxygen from the air) can seem to **gain** mass in an open container.

Balanced equations. Chemists write reactions as equations using formulas. A **coefficient** is the big number in front of a formula telling how many of that particle take part (for example, the **2** in **2 H₂O** means two water molecules). A **subscript** is the small low number inside a formula telling how many atoms of one element are in a single particle (the small **2** in H₂O means two hydrogen atoms per water molecule). An equation is **balanced** when there is the **same number of atoms of each element on both sides of the arrow**. A balanced equation is conservation of mass written in symbols.

Example — water forming from hydrogen and oxygen: $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$. Left side: 4 H atoms (2 molecules $\times$ 2 H) and 2 O atoms. Right side: 4 H atoms (2 molecules $\times$ 2 H) and 2 O atoms (2 molecules $\times$ 1 O). The atoms match on both sides, so it is balanced — the atoms were only rearranged.

Word Bank

reactant

a starting substance in a chemical reaction (written to the left of the arrow).

product

a new substance formed by a chemical reaction (written to the right of the arrow).

coefficient

the number in front of a formula that tells how many of that particle react (the 2 in $2 \text{H}_2\text{O}$).

conserved

kept the same total; not created or destroyed (atoms and total mass are conserved).

closed system

a container that lets no matter in or out, so all products stay and can be weighed.

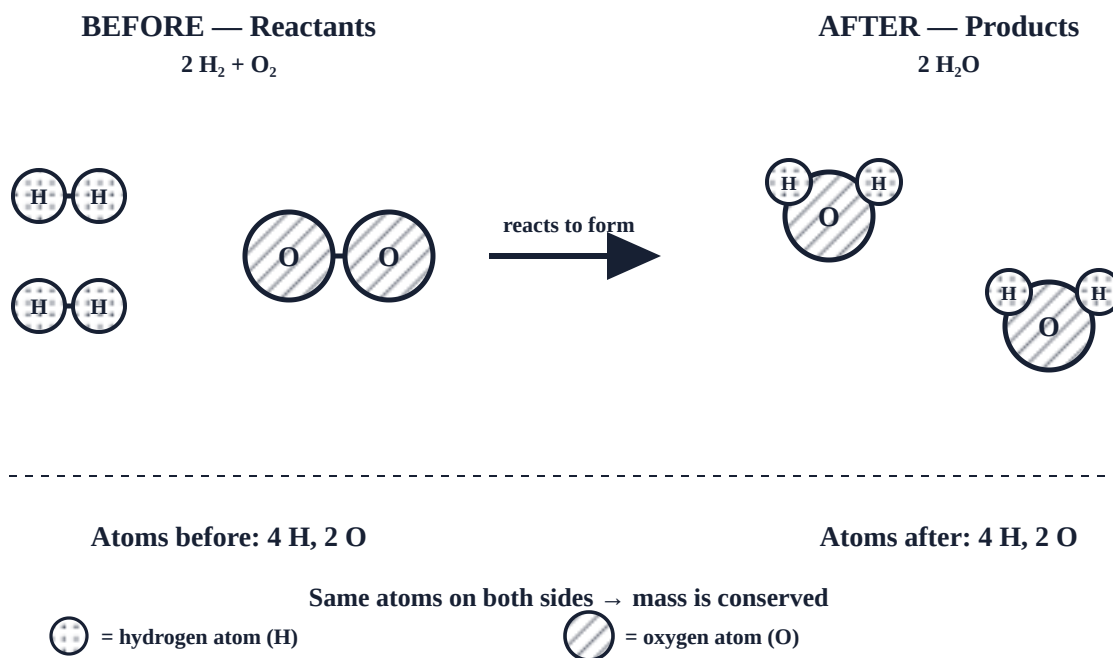


Figure 1. Particle diagram of $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$. **Before** the arrow: two hydrogen molecules (dotted) and one oxygen molecule (hatched) — **4 H and 2 O atoms**. **After** the arrow: two water molecules — still **4 H and 2 O atoms**. The atoms are only **rearranged** into new molecules; none are created or destroyed, so mass is **conserved**. Patterns and labels — not color — carry the meaning, so the figure reads clearly in grayscale.

3Using Figure 1, count and record the number of **hydrogen (H)** atoms and **oxygen (O)** atoms on the **before** side and on the **after** side. In one sentence, state whether the atoms were conserved and how the diagram shows it.

Apply Use the Data 20–25 min

Table 1 gives the measured masses (in grams) for three reactions. Two happen in a **closed** system (sealed flask); one happens in an **open** beaker where a gas can escape. Study it, then answer. (These are original numbers for this packet.)

Table 1. Masses of reactants and products for three reactions (grams). A dash (—) means the value was not recorded. (Original data.)

Reaction	System	Reactant A (g)	Reactant B (g)	Product(s) recovered (g)
1	Closed (sealed flask)	12.0	8.0	20.0
2	Closed (sealed flask)	15.0	—	40.0
3	Open (beaker, gas escapes)	50.0	0.0	34.0 (solid left in beaker)

4Check conservation (closed system). For **Reaction 1**, add the two reactant masses and compare the total with the product mass recovered. Show your work. Was mass conserved? Explain in one sentence how you can tell.

5Find the missing mass. In **Reaction 2** (a closed system), the mass of **Reactant B** was not recorded. Use the law of conservation of mass to find it. Show your work.

5a. Write the conservation equation in words: mass of A + mass of B = total mass of products.

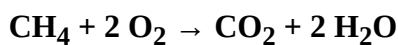
5b. Substitute the known masses and solve for the mass of Reactant B. Show the subtraction.

6Explain the open system. In **Reaction 3**, 50.0 g of solid reactant was heated in an **open** beaker, and only 34.0 g of solid was left afterward. A student says, "Mass was destroyed — the law is broken."

6a. Calculate how many grams "went missing" from the beaker. Show your work.

6b. Explain what really happened to that mass and why the law of conservation of mass was **not** broken. Use the word **gas** in your answer.

7Count atoms to check a balance. Look at the equation below. Count the atoms of each element on each side and decide whether it is **balanced** (same number of each element on both sides).



Fill in the atom counts:

Element	Atoms on LEFT (reactants)	Atoms on RIGHT (products)	Balanced? (yes/no)
Carbon (C)			
Hydrogen (H)			
Oxygen (O)			

Is the whole equation balanced? Circle: **YES** / **NO**

8Observation vs. inference. Write **O** if the statement is an observation (a value read directly from Table 1) or **I** if it is an inference (a conclusion you reason out).

___ a) In Reaction 3, 34.0 g of solid was left in the beaker.

___ b) In Reaction 3, 16.0 g of gas escaped into the air.

___ c) In Reaction 1, the recovered product mass was 20.0 g.

___ d) Reaction 2 must have taken in 25.0 g of Reactant B for mass to be conserved.

9Closed vs. open — which is fair? In 2–3 sentences, explain why a **closed system** is the fair way to test whether mass is conserved, and why an **open system** can fool you into thinking mass was lost or gained. Use the

words **reactant**, **product**, and **gas**.

Explain Claim–Evidence–Reasoning 7–10 min

Question 10. A student combines the two reactants of **Reaction 1** inside a sealed flask and measures 20.0 g of product. Using the data in Table 1, write a **claim** answering *whether mass was conserved in Reaction 1*, support it with **two pieces of evidence** (specific masses from Table 1), then explain your **reasoning** using the law of conservation of mass and the idea of atoms being rearranged.

Sentence stems you may use: "Mass was / was not conserved in Reaction 1 because..." · "One piece of evidence is... (from Table 1)." · "A second piece of evidence is..." · "This shows mass was conserved because the atoms were..."

Claim

Evidence (two pieces, with masses)

Reasoning

Close ACE Wrap-Up 5 min

Articulate

Explain the **law of conservation of mass** in your own words, as if teaching a friend.

Connect

Point to one row of Table 1 that shows mass being conserved (or seeming to change). Name the numbers.

Extend

Give a **new** everyday example (not in this packet) where a gas escaping or being taken in makes mass *seem* to change, and say what really happens to the atoms.

Continue Early Finisher & Block Extension optional · block ~+30 min

If you finish early (no new materials needed):

Design your own conservation problem. On the back of this page, invent a reaction in a sealed flask. Choose masses for two reactants and one product so that mass is conserved, but leave **one** mass blank. Write the words "reactants → products," then trade the missing value with an imaginary partner and show how the law of conservation of mass lets you solve for the blank.

Block-period extension — balance a simple equation with coefficients:

The equation for hydrogen gas burning to form water is $__ \text{H}_2 + __ \text{O}_2 \rightarrow __ \text{H}_2\text{O}$. It is not balanced yet. Fill in whole-number **coefficients** (the big numbers in front) so the equation has the **same number of H atoms and the same number of O atoms on both sides**. Make a small atom-count table for H and O to prove your answer is balanced. Then, in one sentence, explain how a balanced equation is another way of showing the law of conservation of mass.

Turn in: Hand in this whole packet with your name, class period, and date filled in. Make sure questions 1–10 and the ACE box are answered. The early-finisher problem and the block-period balancing task are optional but turn them in too if you did them.

HS_CHEM_ConservationMass_01 — Conservation of Mass in Chemical Reactions Student Packet