Family edition

Reaction Lab: Lid On, Lid Off

Ages 11-14 · about 45 minutes, in one sitting

Your child does the baking soda and vinegar lab in Reaction Lab, sealed in a bag and then in an open cup, and finds out why the open cup gets lighter even though matter is never destroyed.

What you need

- A computer or Chromebook with a current browser.
- The lesson link: mytekdev.com/try/reactionlab?lesson=lid-on-lid-off&ref=fam-reactionlab-3. No account, no email and nothing to install.
- If you want to try it for real: a zip bag, a small cup of vinegar, a spoonful of baking soda, and a kitchen scale.

Before you start: try it once yourself

Open mytekdev.com/try/reactionlab?lesson=lid-on-lid-off&ref=fam-reactionlab-3. A short guide opens over the app on the zip bag lab: a sealed bag on a kitchen scale reading 152.4 g, with a magnifier beside it.

1. **Sealed.** `Tip the cup`. The vinegar spills onto the baking soda, it foams, the bag puffs up, and the scale holds at 152.4 g. Drag the magnifier over the bag to see the particles.
2. **Open.** Press `Make it an open cup` and tip again. Carbon dioxide bubbles away and the reading falls to 151.4 g.
3. **Particles.** Press `Particles`. With the lid off, a balanced reaction ends with the carbon dioxide escaping up the neck; the scale drops by its mass and the molecules wait above the flask under "Left the flask".

> A real sealed bag that puffs up a lot can read a few tenths of a gram low: the bigger bag pushes aside more air, and the air lifts it a little, like a balloon. A capped plastic bottle does not puff up and shows no change. The app tells children this after the sealed run.

The ideas, in plain words

Baking soda (sodium bicarbonate) and vinegar (acetic acid) make sodium acetate, water and carbon dioxide gas. In a closed system the carbon dioxide stays and the mass holds. In an open one it leaves, and the scale drops by its mass. Nothing is destroyed: the atoms are in the room.

Children often believe gases have no mass, especially gases they cannot see. Showing the gas as molecules that keep their mass when they leave is the point of the particle view. The research the app was built from found that open systems are the part children understand least, even after teaching.

The real lab works with a spoonful of baking soda and a small cup of vinegar; the carbon dioxide from a spoonful weighs about a gram, so the scale needs to read tenths of a gram.

Do it together

1. Open mytekdev.com/try/reactionlab?lesson=lid-on-lid-off&ref=fam-reactionlab-3 together. A short guide opens over the app with the zip bag on a scale. Write down the reading, then press `Tip the cup`.

   > **You'll know it worked when:** The bag puffs up and the scale stays at 152.4 g.

2. Press `Make it an open cup`, and tip it again.

   > **You'll know it worked when:** The reading drops to 151.4 g.

3. Ask: where did that gram go? Then press `Particles`, and press `React` with the lid off.

   > **If you get stuck:** If the equation is not balanced, add molecules with the + buttons first.
   >
   > **You'll know it worked when:** Your child can point to the carbon dioxide molecules that left through the top.

4. Press `Put the lid on`, and press `React` again.

   > **You'll know it worked when:** The scale holds, and your child can say why the lid made the difference.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Why did the sealed bag puff up?
- Where did the gram from the open cup go?
- You cannot see carbon dioxide. How do you know it has mass?
- Is the open cup a closed system or an open one?
- Why might a real sealed bag read a little lower than it should?

> The second question is the real test: the answer is "into the air of the room", not "it was used up".

For younger and older kids

Younger: For a younger child, do the bag sealed and open and talk about the fizz.

Older: For a teenager, try burning methane with the lid off and compare the drop with the gases that left.

Keep going

- Burning methane with the lid off: the carbon dioxide and the hot water vapor both leave. Compare the drop with the masses.
- Work out why a puffed-up bag reads a little low, and design a container that would not.
- Find a reaction on the shelf where taking the lid off changes nothing, and say why.

Bring it into other subjects

- Math: the open cup lost 1.0 g. Carbon dioxide is 44 mass units a molecule. Which reactant was used up first, and how do you know?
- Earth science: where does the carbon dioxide from a campfire go, and what takes it back out of the air?
- English: write a lab report for the sealed bag and the open cup, with a claim, evidence and reasoning.
- Engineering: design a container for the lab that will not puff up, and say why it gives a truer reading.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Reaction Lab: Lid On, Lid Off
SUBJECTS	Physical science
TIME	45 minutes
WHAT WE DID	Compared a baking soda and vinegar reaction in a sealed bag and an open cup, and used a particle model to explain why the open cup lost mass.
SKILLS PRACTICED	Open and closed systems; Gases have mass; Conservation of mass

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/reactionlab?lesson=lid-on-lid-off

Essential question: If mass is never destroyed, why does the scale go down when the cup is open?

Warm-up: An open can of soda sits out all day. Would it weigh less by evening? Why?

_____

1. **Vocabulary.** Closed system, open system, gas, carbon dioxide, conservation of mass: write each in your own words.

2. **The data table.** Sealed bag: before _____ g, after _____ g, change _____. Open cup: before _____ g, after _____ g, change _____. Particles, lid off: before _____, after _____, molecules that left _____.

3. **The magnifier.** What I saw inside the bag: _____.

1. Where did the mass from the open cup go?

2. Why might a real sealed bag that puffs up read a little lower than it should?

Quick check

Name: _____

1. Baking soda and vinegar react in a sealed bag on a scale. The reading after is: (A) lower (B) the same (C) higher

2. The same reaction in an open cup reads lower after because: (A) matter was destroyed (B) a gas left the cup (C) the vinegar dried up

3. Does carbon dioxide gas have mass? Use the lab to explain.

Answers

QUESTION	ANSWER	WHY
1	B	A closed system: the carbon dioxide stays in the bag.
2	B	The carbon dioxide escaped into the room. Matter is not destroyed.
3	Yes	When it left the open cup, the scale went down by its mass. A yes with the lab as evidence is a full answer; yes alone is half.

If your state or umbrella school asks, this lesson covers NGSS MS-PS1-5, NGSS MS-PS1-2.

Terms of use

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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