CO_2 and Mass

Cost – in Dollars (not counting basic lab supplies and technology equipment if necessary):
$ -- 0-25
$$ -- 25-50
$$$ -- 50-100
$$$$ -- OVER 100

Background: Many students believe that gases like carbon dioxide (CO_2) do not have mass. The fact is that atmospheric gases like CO_2 have a tremendous amount of mass if you consider how much there is of them in our atmosphere. In this activity, students will use baking soda and vinegar to produce CO_2 and trap it in a balloon. After puncturing the balloon, students will notice that mass has been lost.

Chemical Formulas:
$NaHCO_3 + HCH_3CO_2 \longrightarrow CO_2\,(g) + H_2O + NaCH_3CO_2$

Sodium bicarbonate + acetic acid $\longrightarrow$ carbon dioxide + water + sodium acetate

Goal: Students will determine if CO_2 has mass.

Objectives: Students will …
- Identify that CO_2 has mass
- Use chemistry to determine the mass of CO_2

Materials (per lab group):
- 1 - 125ml flask
- 1 large 12-inch balloon (Amazon.com)
- 1 pin (or scissors)
- 1 micro spoon spatula
- 1 small funnel
- 30g of baking soda
- 60ml of vinegar
- 2-100 ml beakers
- Triple beam balance or digital scale
- Plastic tray
- Safety glasses for each student
- CO_2 and Mass – Data Sheet for each student

Time Required: 45-60 minutes

Procedure:
PREP

- Gather all of the necessary lab materials and run a test lab to be certain of safety procedures.
- Give each group one lab set-up.
- Explain that they will be creating CO_2 in class and using these gasses to examine mass.

PROCEDURE

- Review safety procedures with the students.
- Divide students into groups of 4.
- Hand out the CO_2 and Mass – Lab Procedure and CO_2 and Mass – Data Sheets and review.
- Have students write their hypothesis on the CO_2 and Mass-Data Sheet before starting the lab.
- Allow students to complete the lab as they follow steps on their procedure sheets.
- Remind students to fill Table 1 on the CO_2 and Mass – Data Sheet.
- Review clean up procedures with students and give them time to complete a thorough clean-up of their lab stations.
- Allow time to complete the CO_2 and Mass – Data Sheet and review together if time allows.

Assessment:

- Completed lab procedures
- Completed CO_2 and Mass – Data Sheet

CO_2 and Mass – Teacher Answer Key

Name: _____ Date: _____

Hypothesis: Does CO_2 have mass?

_____

_____

TABLE 1

Mass of flask and balloon before reaction (grams)	Mass of flask and balloon after reaction (grams)	Mass of flask and balloon after gas has escaped (grams)	Mass of gas (CO_2) (grams)

Respond to the following:

1. Does the gas carbon dioxide have mass? Give proof for your answer.
   Yes, carbon dioxide does have mass. When the balloon popped and the gas escaped, the mass decreased.

2. During the reaction between the baking soda and vinegar, was any mass lost? Explain your answer.
   No, mass was not lost. In order to determine the mass of a gas in a flexible container, the buoyant force of air needs to be considered. The scale is not really measuring the mass of the flask and its contents. The scale measures the force of the flask and its contents that are pressing down on it. The mass of the flask is the downward force of gravity and has not changed since its mass has not changed. The upward buoyant force of the air on the flask has increased since its volume has increased. The increase in buoyant force causes the downward force on the scale to decrease.

3. What is the term for the effect that the combined weight of all the gasses in our atmosphere has on us?
   The term that is used is atmospheric pressure.

4. What other types of chemical reactions produce CO_2 (give at least four)?
   Four other types of reactions that produce carbon dioxide are; cellular respiration, fermentation of ethanol, the manufacture of ammonia, and the burning of fossil fuels, such as coal, gas and oil.

CO_2 and Mass – Lab Procedure Student Sheets

Materials:

- 1 - 125ml flask
- 1 large 12-inch balloon
- 1 pin (or scissors)
- 1 micro spoon spatula
- 1 small funnel
- 30g of baking soda
- 60ml of vinegar
- 2-100 ml beakers
- Triple beam balance or similar scale
- Plastic tray
- Safety glasses

Procedure:

1. Be sure to wear your safety glasses!
2. Double check that you have the correct materials at your lab station.
3. Write your hypothesis on the CO_2 and Mass-Data Sheet.
4. Place the 100 ml beaker in the plastic tray and place it on the scale. Zero the scale by holding down the on button.
5. Use the scale to measure 30g of baking soda in the 100 ml beaker.
6. Place the 30g of baking soda into the balloon using the micro spoon spatula and a funnel.
7. Use the second 100 ml beaker to measure 60 ml of vinegar, and then pour the vinegar into the 125ml flask.
8. Carefully attach the balloon to the mouth of the flask keeping the balloon containing the baking soda to the side of the flask (be careful not to mix the baking soda with the vinegar).
9. Place only the plastic tray on the scale and zero the scale by holding down the on button.
10. Place the 125ml flask and balloon setup in the plastic tray that is on the scale. Find its mass and record this mass in Table 1 on the CO_2 and Mass – Data Sheet.
11. Hold on tight to the balloon and lift it up, mixing the baking soda and vinegar together allowing the two materials to mix and inflate the balloon.
12. Find the mass of the inflated balloon and the flask and record in the second column in Table 1 on the CO_2 and Mass – Data Sheet.
13. Puncture the balloon and let the gas escape.
14. Find the mass of the deflated balloon and flask and record it in the third column in Table 1 on the CO_2 and Mass – Data Sheet.
15. Determine the mass of the gas and record in the last column in Table 1 on the CO_2 and Mass – Data Sheet.
16. Clean up your lab station according to your instructor's directions and answer the questions on the CO_2 and Mass – Data Sheet.

CO_2 and Mass – Data Sheet

Name: _____ Date: _____

Hypothesis: Does CO_2 have mass?

TABLE 1

Mass of flask and balloon before reaction (grams)	Mass of flask and balloon after reaction (grams)	Mass of flask and balloon after gas has escaped (grams)	Mass of gas (CO_2) (grams)

Respond to the following:

1. Does the gas carbon dioxide have mass? Give proof for your answer.

2. During the reaction between the baking soda and vinegar, was any mass lost? Explain your answer.

3. What is the term for the affect that the combined weight of all the gasses in our atmosphere has on us?

4. What other types of chemical reactions produce CO_2 (give at least four)?