CO_2 Investigation Procedure

Materials

- Heat lamp station to which your group is assigned (shared with other groups)
- 2-L plastic water bottle
- Permanent marker
- 100-mL (or larger) graduated cylinder
- Thermometer
- Timer
- Water
- Fizzing tablets (if your group was assigned either low or high CO_2)
- 1-hole stopper
- Indirectly vented chemical splash goggles
- Nitrile gloves
- Non-latex apron

Procedure

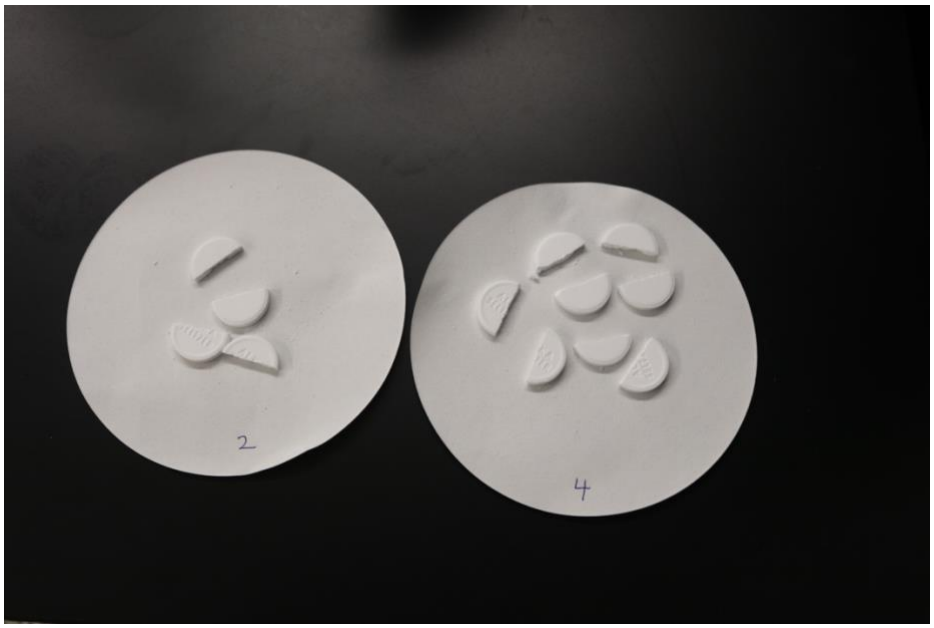
Before beginning, assign each person in your group one of the following roles:

- Materials manager – gathers the materials and labels the bottle with your designated experiment: Control, Low CO_2, or High CO_2.
- Setup manager – follows the procedures to set up the bottle for the designated experiment.
- Transporter – after the bottle is set up, monitors the temperature until it reaches equilibrium (does not change for at least 5 seconds) then transports it to the assigned heat lamp station.
- Timer – starts the timer once the bottle is placed near the heat lamp by the transporter then calls out the temperature of the bottle every 2 minutes.
- Recorder – records the time and temperature.

1. Bottle setup.
    a. Gather the materials and label the bottle as either "control," "low CO_2," or "high CO_2," so that it matches your group's assignment.
    b. Fill the bottle with 900 mL of water.

    c. Insert a thermometer through the hole in the stopper.
    d. Insert the stopper into the opening of the bottle.
    e. Adjust the position of the thermometer in the stopper as needed, so that it is hanging in the air above the water and not in the water.
2. If your group has the "control" bottle, skip to step 3. If your group has one of the other two bottles, do as follows:
    - "Low CO_2" Bottle
        a. Break two fizzing tablets in half.
        b. Remove the stopper with thermometer from the bottle.
        c. Drop the four pieces of tablets into the "Low CO_2" bottle and immediately reinsert the stopper with thermometer into the bottle's opening.
    - "High CO_2" Bottle
        a. Break four fizzing tablets in half.
        b. Remove the stopper with thermometer from the bottle.
        c. Drop the eight pieces of tablets into the "High CO_2" bottle and immediately

reinsert the stopper with thermometer into the bottle's opening.



3. Wait till the temperature in your bottle has stabilized.
4. Record the initial air temperature reading of your bottle in Celsius degrees (°C) in your data table.
5. Take your group's bottle to the designated heat lamp station and place it near the heat lamp so that the heat lamp is angled toward the bottom of the bottle and is at least 6 inches away from the bottle. Note: there may be bottles from other groups at the station.
6. Make sure the heat lamp at each station is positioned at the same angle and distance from that station's bottles. **This is extremely important because temperatures can vary greatly due simply to different positioning of the bottles.**
7. Once bottles from all assigned groups are at the station, ask the teacher to turn the heat lamp on.
8. Record the air temperature (°C) in your bottle at 2-minute intervals for 20 minutes. Also record any additional observations that you cannot put directly into the data table in the "Observations" section below the table.

9. Collect data from the other two stations by asking someone from each station to share their data with you. Record all of the results in the data table on your handout and include a title for the table.

Name: _____ Date: _____

Carbon Dioxide Investigation

Investigation Question:

Hypothesis: Complete the statement below.

If [the amount of carbon dioxide in the system] THEN the temperature of the system will [ ]

Reasoning 1:

How does matter (CO_2) flow into and out of the water bottle system, if at all?

Reasoning 2:

Where does the energy come from?

How does the energy get to the water bottle?

What does the energy do in the bottle if there is CO_2? If there is no CO_2?

Where does the energy go after getting into the water bottle? Is the answer different if CO_2 is present or absent?

Data Table Title:

When coming up with a title for a data table, describe the relationship you are keeping track of when collecting data.

Column goes top to bottom ↓

Row goes left to right →

Row setup considerations:

- When do you need to take measurements?

If you are looking for changes over time, how frequently will you take measurements?

Column setup considerations:

- What are you changing?
- What are you measuring?
- What units will you measure in?
- Will you track changes over time?

Will you need multiple data tables to track changes over time?

Observations:

Record any other observations that you cannot put directly into your data table.

Summarize Investigation Findings:

Look back at your hypothesis and the evidence you collected from the investigation. Summarize your findings by answering the following prompt and completing the provided sentence stems.

How did the increased carbon dioxide affect the temperature in the bottles?

In this investigation, the energy came from _____ as _____.

It went to _____.

This caused the particles to _____.

Then _____ (some/all) energy _____.

If not all energy flowed/transferred in the same way, what did the rest do?