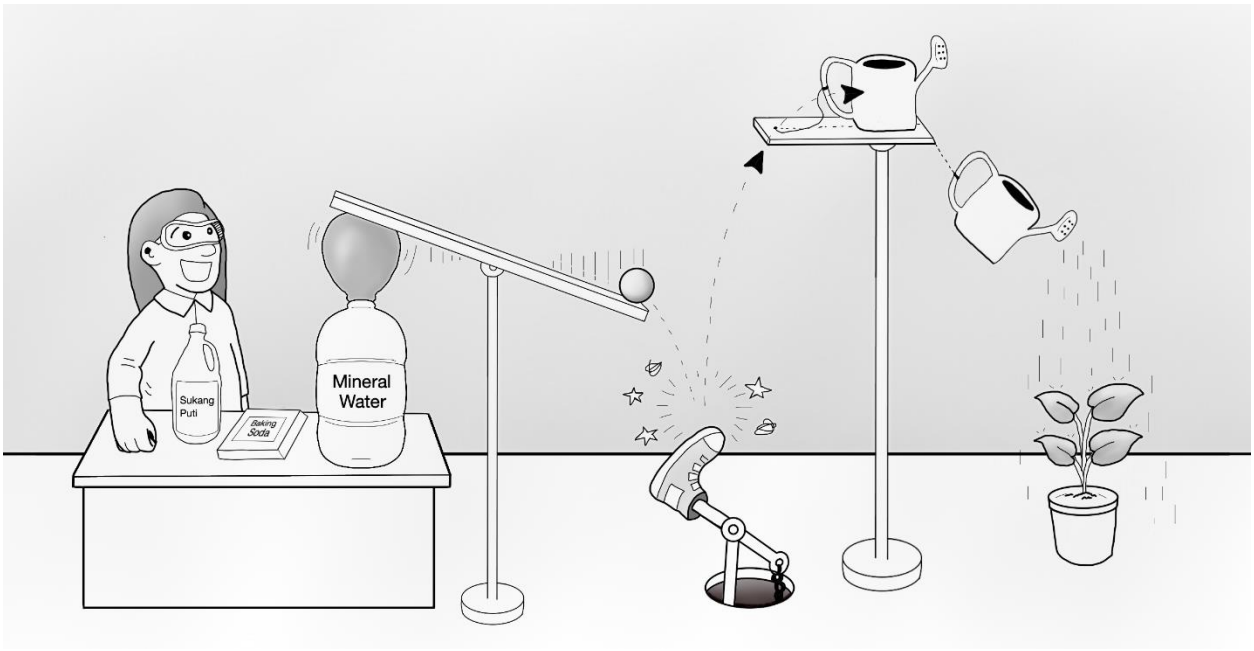


Adopted from Active Chemistry (2020) modified by Le Grande O. Dolino

What do you think?

Imagine that you are making bibingka for dessert. At the same time, your friend across town is also making bibingka.

- **Suppose some of your ingredients are not the same as those of your friend. Can you and your friend produce identical bibingka desserts? How?**
- **Suppose you and your friend both have identical sets of ingredients. Could you produce bibingka that are completely different from those that your friend produces? How?**

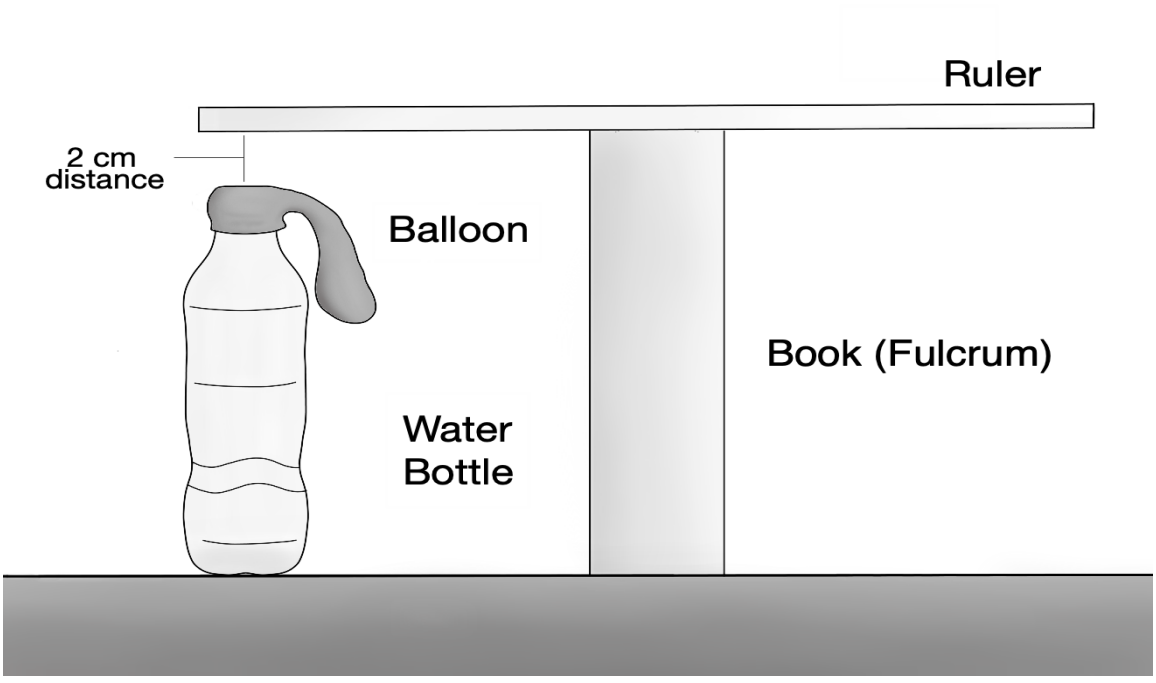
The *What do you think?* Questions are meant to get you thinking about what you already know or think you know. Don't worry about being right or wrong. Discussing what you think you know is an important step in learning.

Record your ideas about these questions in your *Chemistry log* (notebook). Be prepared to discuss your responses with your small group and the class.

Explore/Investigate

Often, there are many ways to achieve a goal. In this investigation, you will compare different ways of arriving at a product. You will also learn how to make decisions about which way is best. Lastly, you will consider if a change in circumstances might make you choose a different method.

1. Carbon dioxide (CO_2) is a gas at room temperature. You will examine two different methods of generating CO_2 gas. The gas you generate will then have to blow up a balloon that will tip a lever. (This can be a ruler.)
2. You will set up an apparatus and practice making the level/ruler tip up from a distance of about 2 cm.



Adopted from Active Chemistry (2020) modified by Le Grande O. Dolino

As you practice making CO_2 gas using your group's method, make observations about the changes that happen using the CO_2 production method. You will want to record the following:

a) The time it takes to generate the gas
b) The approximate volume of gas made. (You could measure the circumference of the balloon.)
c) The approximate mass of the starting materials (how many tablespoons were used).
d) You will also make other observations during the experiment.
e) You will need to decide the amount of each substrate (material) to use. Make sure you record quantitative data. (Quantitative data are measurements that involve numbers, such as the size of the balloon and the amount of starting materials necessary.) You need to record qualitative data as well. (These are observations of what happens.)

Method 1

Starting materials: Sodium bicarbonate and acetic acid

Sodium bicarbonate is also known as baking soda. Sodium bicarbonate is represented by the chemical formula $NaHCO_3$. A chemical formula shows how many atoms or ions of an element are needed to combine with the other elements in the compound. The formula for sodium bicarbonate shows that one sodium ion, one hydrogen atom, one carbon atom, and three oxygen atoms bond together to make sodium bicarbonate, $NaHCO_3$. Acetic acid, $HC_2H_3O_2$, is the ingredient that gives vinegar its characteristic odor. Acetic acid is present in vinegar in low concentration (or amount) at about 5%. The majority of vinegar is

water. For your tests, please use white vinegar. The reaction that occurs between sodium bicarbonate and acetic acid is

$$NaHCO_3(s) + HC_2H_3O_2(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(l) + CO_2(g)$$

sodium bicarbonate	acetic acid	sodium acetate	water	carbon dioxide

The symbol (g) indicates that the substance is a gas, (s) indicates a solid, and (l) indicates a liquid. The symbol (aq) shows that the substance is dissolved in water. Note that the equation is **balanced**. The total numbers of each element (Na, H, C, O) are identical before and after the reaction.

Method 2

Starting materials: Calcium carbonate and acetic acid

Calcium carbonate, $CaCO_3$, is the principal component of limestone, chalk, and eggshell. We already know acetic acid from Method 1. The reaction that occurs between calcium carbonate and acetic acid is

$$CaCO_3(s) + 2HC_2H_3O_2(aq) \rightarrow Ca(C_2H_3O_2)_2(aq) + H_2O(l) + CO_2(g)$$

calcium carbonate	acetic acid	calcium acetate	water	carbon dioxide

Note that the equation is balanced. The total numbers of each element (Ca, C, O, H) are identical before and after the reaction.

Once you are done and before you put the reaction aside,

Remove the balloon and quickly insert a long lighted candle into the bottle. The flame part of the candle should be placed inside first. **Be careful and ask for assistance from an adult to handle the fire.**

a) Observe what happens to the candle and record your observations.
b) According to the chemical reactions, carbon dioxide (CO_2) is a product for Methods 1 and 2. Carbon dioxide can extinguish fires in high concentrations. It is also heavier than air. If CO_2 gas is present, the flame should go out immediately. Does the test confirm that there is CO_2?
c) In your log, record any additional properties that you observed.

Control: get an empty bottle and do the same thing as above.

a) Observe what happens to the candle and record your observations.
b) What do you think happened in this bottle?
c) In your log, record any additional properties that you observed.

IF YOU CANNOT DO THE ABOVE METHODS GO TO

Method 1: https://www.youtube.com/watch?v=5mCcFzcCIvE

Method 2: https://youtu.be/LXnfx5q87Y0

Data Table (copy in notebook)

	Trial 1	Trial 2	Trial 3	Trial 4
Time it takes to generate the gas				
Volume of gas (measure balloon circumference)				
Mass of starting material				
Volume of acetic acid				
Descriptive observations				
Describe observations Qualitative test for CO_2				