Activity: Dissolving carbon dioxide in water

Determine the effects of dissolving carbon dioxide (CO_2) in water.

Materials

- Three 60 mL syringes, no needle (two of the syringes should have long, non-Luer lock tip)
- Permanent marker
- Cotton ball
- 100 mL beaker
- 50 mL tap water
- Hotplate
- Thermometer
- Teaspoon
- 1 teaspoon table sugar
- 2 mL dry yeast
- Two 3" pieces rubber tubing
- Tubing clamp
- Small beaker or cup
- Indicator solution
- Plastic pipette

Procedure

Fig. 1. Diagram of syringes used in activity.

1. Remove the plunger from one 60 mL syringe. With the permanent marker, label this Syringe A. **Syringe A will be the gas production syringe** (See Fig. 1)**.** Pull a small piece of cotton off of the cotton ball and push it into the bottom of this syringe to form a plug. The plug should be loose enough to let liquids and gases pass through, but small solid particles should be unable to pass.

2. In a 100 mL beaker, heat 20 mL of water on a hotplate so that it is lukewarm (~35°C) . If the water gets too hot, add some room temperature water.

3. Add 1 teaspoon of table sugar to the warm water.

4. Into the plugged Syringe A, add enough yeast to cover the bottom of the syringe, approximately up to the 2 mL mark. Gently push the plunger back into the syringe until it almost touches the yeast.

5. Secure a 3-inch piece of rubber tubing to Syringe A.

6. Gently draw 10 mL of warm sugar water into Syringe A. Clamp the tubing. Allow the formation of about 20 mL of gas. This may take up to 15 minutes.

7. While the yeast are producing gas, prepare the **gas collection syringe.** Label another 60 mL syringe as Syringe B (see Fig. 1). Into the bottom of this syringe, push a small amount of cotton to form a plug, just as you did with Syringe A. The plug should be loose enough to let gases pass through.

8. Label the last 60 mL syringe Syringe C. This will be the **test solution syringe** (see Fig. 1).

9. Add just over 10 mL of tap water to a beaker. Add a few drops of indicator solution. Draw this solution into Syringe C. Try not to get any gas into this syringe. If you do, point the tip of the syringe upwards, gently tap the syringe to loosen bubbles, and slowly push the gas out. Put a piece of rubber tubing on the tip of Syringe C.

10. When 20 mL of gas has been produced in Syringe A, join Syringe A to Syringe B.
    a. Unclamp the tubing of Syringe A. Use the tubing to connect the two syringes.
    b. Gently push the gas from Syringe A to Syringe B. You may have to pull on the plunger of Syringe B at the same time you push on the plunger of Syringe A.
    c. When you have drawn out all of the gas from Syringe A, clamp the tubing.

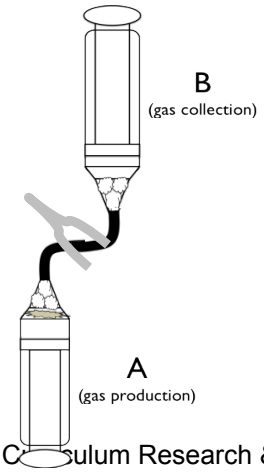

Fig. 2. Diagram of Procedure Step 11.

11. Hold Syringe B with the plunger pointing downward, as in Fig. 2. It should still be attached to Syringe A via a clamped tube.

a. Remove Syringe A from Syringe B, leaving the tubing attached to Syringe B.
b. Quickly attach Syringe C to Syringe B using the clamped tubing.

12. Rotate the syringes, so Syringe B is on the bottom and Syringe C is on the top, as in Fig. 3 . Unclamp the tubing connecting Syringe B and C. Very slowly, one bubble at a time, push the gas from Syringe B into the liquid in Syringe C. Record your observations.

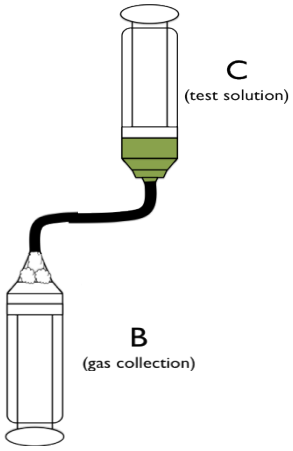

Fig. 3. Diagram of Procedure Step 12.

Optional Procedure

Materials

- Two 60 mL syringes, no needle
- Permanent marker
- 50 mL tap water
- One 3" piece rubber tubing
- Small beaker or cup
- Indicator solution

Procedure

1. Set up one more gas collection syringe (like Syringe B above) and one more test solution syringe (like Syringe C above).

2. Draw about 20 mL of air into the gas collection syringe.

3. Connect the two syringes with a piece of rubber tubing.

4. Very slowly, one bubble at a time, push the gas from gas collection syringe into the liquid in the test solution syringe. Record your observations.

Activity Questions

1. Yeast produces carbon dioxide (CO_2) gas as a byproduct of its metabolism, through the process of respiration.
    a. What happens as CO_2 is added to water?
    b. If you did the optional procedure: How does adding CO_2 gas to water compare to adding air to water?

2. Does CO_2 dissolve in the water? What is your evidence?

3. How does this system model what happens in the environment? How is it different?

4. In this activity, you used tap water, rather than distilled water (pH of 7). What is the pH of tap water? Why do you think it differs from distilled water?

5. Based on what you know about various pH indicators, which other pH indicators could you have used for this activity? Why?