

 **Activity 4.3.2 Take a Deep Breath****Purpose**

You have learned about cellular respiration where cells “burn” oxygen and glucose to produce energy and carbon dioxide (CO<sub>2</sub>). Have you wondered how CO<sub>2</sub> leaves the body? The simple answer is external respiration. Carbon dioxide has to get out of the cells and body to prevent a buildup and cells need more oxygen to continue producing energy. External respiration is how your body rids itself of the CO<sub>2</sub> produced in your cells and acquires more oxygen to fuel the cells. This exchange of gases occurs through the process of diffusion in your lungs where the alveoli and capillaries meet. How do you know there is CO<sub>2</sub> in the air you exhale?

A common method to determine the presence of particular substances is using indicators. When using an indicator solution, it changes color in the presence of the material that you are testing. Bromthymol blue (BTB) is an indicator that turns yellow in an acidic solution and blue in a basic solution. When carbon dioxide is suspended in water, it forms carbonic acid. BTB can be used to indicate the presence of carbon dioxide in water. Sodium hydroxide is a base used to neutralize the acidity.

When collecting data, scientists use visual indicators as well as measurements. Data collected using visual observations is called qualitative data while data that is measured is called quantitative data. What data will you collect while testing for CO<sub>2</sub>?

**Materials****Per group of four students:**

- 3 plastic cups
- Sodium Hydroxide 0.05M
- SEPUP tray
- 30ml graduated cup
- 2 straws
- Bottled water
- Bromthymol blue indicator

**Per pair of students:**

- One-gallon plastic bag
- Straw
- Stir stick
- Stop watch

**Per student:**

- Pencil
- *Agriscience Notebook*

**Procedure**

In this activity, you will observe the quantity of carbon dioxide (CO<sub>2</sub>) in the air you exhale. Your teacher will assign you to a group of four students for this lab activity. Within that group, find a partner to work with for Part Two of the lab.

**Part One – Testing for the Presence of Carbon Dioxide**

1. Add 5ml of water to each of the five large cups (A-E) of your SEPUP tray. Use the 30ml graduated cup to measure the water.
2. Add two drops of bromthmyol blue (BTB) to each cup and stir.
3. Record the initial color of each solution in Table 1 in *Activity 4.3.2 Student Worksheet*.

4. Use the dropper to bubble air in Cup B. Place the dropper in the solution and squeeze the bulb. Before releasing the bulb, remove the dropper from the solution. Repeat this for 15 seconds.
5. Record the final color of the solution of Cup B in Table 1
6. Add 3 drops of sodium hydroxide to Cup C.
7. Record the final color of the solution of Cup C in Table 1.
8. Have one person in your group unwrap a straw and place one end in Cup D. This person should take a deep breath and blow gently in the straw for 15 seconds. **Do not inhale through the straw.**
9. Record the final color of the solution of Cup D in Table 1.
10. Have one person in your group unwrap a straw and place one end in Cup E. This person should take a deep breath and blow gently in the straw for 15 seconds. **Do not inhale through the straw.**
11. Record the final color of the solution of Cup E in Table 1.
12. Answer the discussion questions in *Activity 4.3.2 Student Worksheet*.

### Part Two – Measuring Carbon Dioxide in Exhaled Breath

1. Working in your group, set up a control solution.
  - Measure 10ml of water using the 30ml graduated cup.
  - Add 3 drops of BTB to the graduated cup and stir.
  - Pour the BTB solution into a large plastic cup.
2. Divide into pairs of two.
3. With your partner, set up a bag of BTB solution.
  - Measure 10ml of water using the 30ml graduated cup.
  - Add 3 drops of BTB to the graduated cup and stir.
  - Pour the BTB solution into a 1 gallon plastic bag.
4. Carefully remove the air from the plastic bag by slowly flattening it. Be careful to avoid spilling any of the BTB solution out of the bag.
5. While keeping air out of the bag, place a straw in the opening of the bag.
6. Make an airtight seal around the straw by holding the opening of the bag firmly around the straw.
7. Determine if you or your partner will exhale into the bag.
8. That person will sit down, take a deep breath, and then inflate the plastic bag by blowing through the straw. Make sure the bag is fully inflated. **Do not inhale through the straw.**
9. When the bag is fully inflated, quickly pull the straw out while making sure to seal the opening of the bag as the straw is removed.
10. Holding the bag tightly closed, shake the bag vigorously 25 times.
11. Pour the BTB solution from the bag into a clean, empty plastic cup.
12. Record the color of the BTB solution in Line 1 of Table 2 in *Activity 4.3.2 Student Worksheet*.
13. Determine the quantity of carbon dioxide in the exhaled air using a simple titration to return the solution to neutral.
  - Add 1 drop of sodium hydroxide. Observe any changes and record in Line 1 of Table 2.
  - Gently stir the solution and wait 10 seconds.
  - Compare the color of your solution to the control solution.
  - If it is the same color as the control for 30 seconds, go to step 14.

- If the solution is not the same color as the control, add a second drop of sodium hydroxide, record in Table 2, and stir.
  - Compare to the control and repeat until your solution remains the same color as the control for 30 seconds.
14. Record the total number of drops of sodium hydroxide used to return your solution to neutral.
  15. Share your results with the rest of your group. Record their results in Line 2 of Table 2.
  16. Record your total on the class data table provided by your teacher.
  17. Calculate the class average by \_\_\_\_\_ and record in Line 3 of Table 2.
  18. Cleanup your lab area as instructed by your teacher.

## Conclusion

1. What can you conclude about the amount of carbon dioxide in the inhaled breath of animals? (HINT: Think about which solution in Table 1 that was similar to air an animal would inhale.)
  
2. Was the data collected in Part One qualitative or quantitative? Explain your answer.
  
3. Was the data collected in Part Two qualitative or quantitative? Explain your answer.
  
4. How did your results compare with the class average in Part Two? What are possible differences?

Name: \_\_\_\_\_

## Activity 4.3.2 Student Worksheet

**Table 1. Presence of Carbon Dioxide**

Cup	Initial BTB Color	Final BTB Color
A (control)		
B (air)		
C (sodium hydroxide)		
D (person 1, exhaled breath)		
E (person 2, exhaled breath)		

1. What was the purpose of the solution in Cup A?
  
2. Which of the solutions in Table 1 contained carbon dioxide? Support your answer with evidence from your results.

**Table 2. Carbon Dioxide in Exhaled Breath**

	Names	Final BTB Color	Drops of Sodium Hydroxide	Total Drops of Sodium Hydroxide
1				
2				
3	Class			