

Bubbles and Sensors: Two Datasets on Light and Photosynthesis

Learning target: I can graph and calculate from data on oxygen bubbles and carbon dioxide levels to show how light affects what a plant takes in and gives off, and explain why a plant in the dark still changes the air.

Data and graphing About 40 min Individual MS-LS1-6 · practice data analysis independent practice

Name

Date

Period

Directions

This sheet has two parts, each with a teaching dataset: the numbers were invented to be realistic, not measured in a real lab. Part A counts oxygen bubbles from a water plant at different distances from a lamp. Part B follows the carbon dioxide level inside sealed jars. Graph with a ruler, show every calculation, and put units on every number.

You will need: This worksheet, Pencil, Ruler, Calculator (optional)

Part A: Bubbles from a water plant

A student placed a sprig of elodea, a common aquarium plant, in a beaker of water with a pinch of baking soda (a source of dissolved carbon dioxide). He set a lamp at a measured distance, waited two minutes, and counted the bubbles rising from the cut stem in one minute. He repeated the count three times at each distance, then covered the beaker with a box and turned the lamp off for the last set. The water temperature stayed at 22 °C throughout.

Bubbles per minute from an elodea sprig at different lamp distances (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

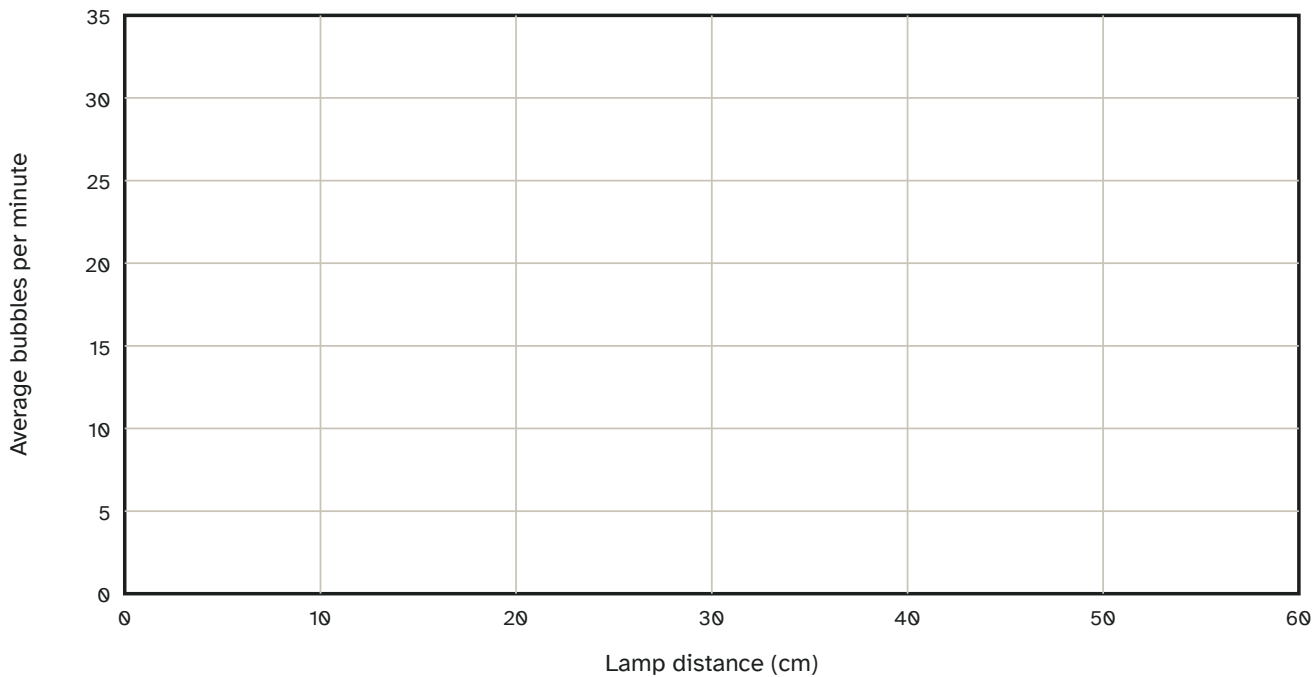
Lamp distance (cm)	Trial 1 (bubbles/min)	Trial 2 (bubbles/min)	Trial 3 (bubbles/min)
10	31	29	33
20	21	23	22
30	14	15	13
40	8	9	7
50	4	3	5
Dark (lamp off, box on)	0	0	0

Simulated data for teaching. Bubbles from a cut elodea stem in light are mostly oxygen.

1. Complete the table: add the three trials and divide by 3. Show one full calculation below the table.

Sum of three trials	Average (bubbles per minute)
10 cm	
20 cm	
30 cm	
40 cm	
50 cm	
Dark	

Average bubbles per minute versus lamp distance



2. Describe the shape of your graph. Is the drop in bubbles the same size for each 10 cm step, or does it change? Use two numbers from your table.

3. By what percent did the average bubble rate fall between 10 cm and 50 cm? Show the subtraction and the division.
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-
-
4. Use your graph to predict the average bubble rate at 15 cm and at 70 cm. Explain how you made each prediction.
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-
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5. In the dark the plant made zero bubbles. Does that mean the plant stopped doing everything? Explain what the zero does and does not tell you.
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-
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6. Counting bubbles is a quick way to measure oxygen, but not a perfect one. Give two reasons the count might not match the true amount of oxygen produced, and one way to improve the measurement.
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Part B: Carbon dioxide inside sealed jars

A second student put a leafy pothos cutting in each of two large sealed jars with a carbon dioxide sensor inside. Jar 1 sat under a bright lamp. Jar 2 sat inside a dark box. A third sealed jar, with a sensor but no plant, sat under the same lamp as Jar 1. All three started at 800 parts per million (ppm) of carbon dioxide; normal outdoor air is a little above 400 ppm. The sensors were read every 10 minutes.

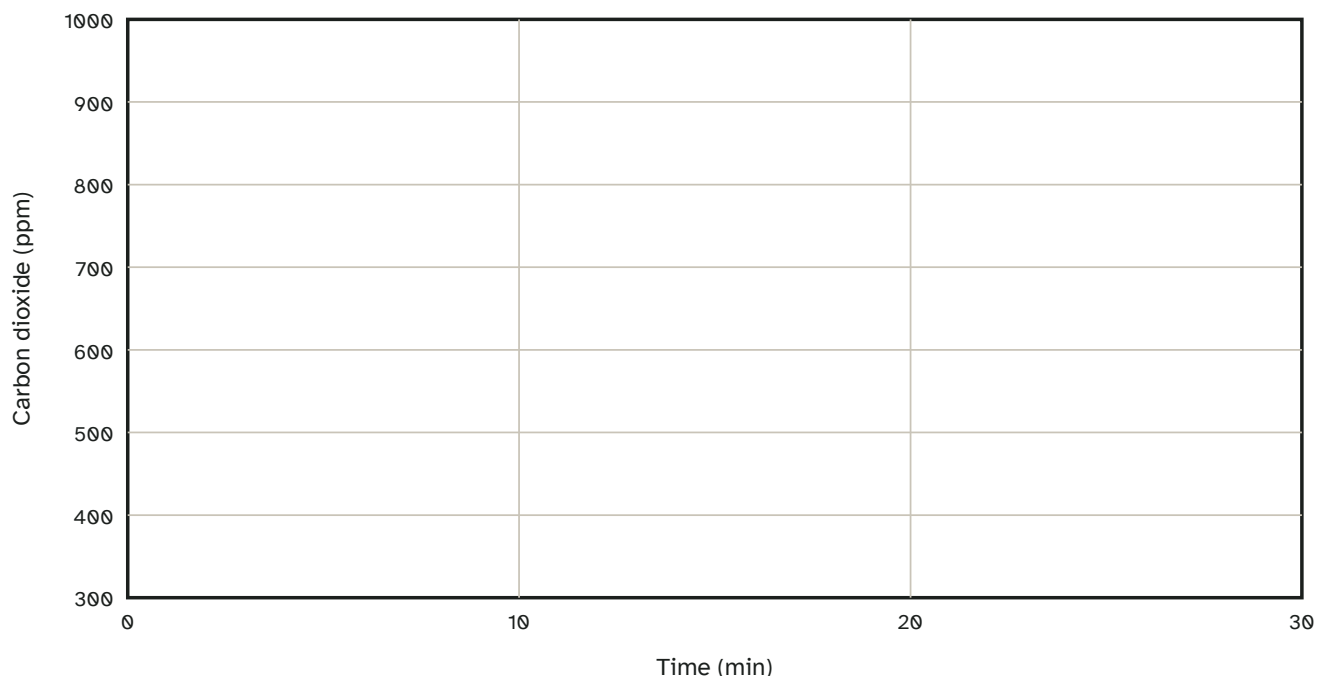
Carbon dioxide level in three sealed jars (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Time (min)	Jar 1: plant in light (ppm)	Jar 2: plant in dark (ppm)	Jar 3: no plant, in light (ppm)
0	800	800	800
10	650	860	800
20	500	920	801
30	350	980	800

Simulated data for teaching. ppm = parts per million. Realistic for a leafy cutting in a 4 liter jar.

Carbon dioxide level versus time in three sealed jars



7. Calculate the rate of change of carbon dioxide for each jar in ppm per minute over the 30 minutes. Use a minus sign for a falling level. Show your work for all three.

8. What is Jar 3 for? What would it have meant if Jar 3's level had also fallen?

9. Explain the results of Jar 1 and Jar 2 together. Your explanation must say what the plant is doing with carbon dioxide in the light and what it is doing in the dark, and must use the idea that a plant's cells use sugar for energy at all times.

10. Suppose the plant releases carbon dioxide from using its own sugar at the same rate in the light as in the dark. Use the Jar 2 rate to estimate how fast photosynthesis in Jar 1 was actually **removing** carbon dioxide. Show your reasoning and explain why the sensor in Jar 1 does not show this number directly.

11. Look back at the air plant kept in a dark cabinet in Worksheet 1, which lost mass. Use the Part B results to explain where that lost mass went.

Rates in two steps

A rate of change is 'how much it changed' divided by 'how long it took.' Step 1: subtract the starting value from the ending value (ending – starting). If the result is negative, the level fell. Step 2: divide by the time, 30 minutes. Write the unit as ppm per minute. Example with made-up numbers: $(500 - 740) \div 30 = -240 \div 30 = -8$ ppm per minute, so the level fell 8 ppm every minute.

When does the jar stop changing?

If Jar 1 kept falling at the same rate, it would reach 0 ppm after about 53 minutes. In reality the fall slows and then stops at a low level that is not zero. Propose two reasons the rate would slow as carbon dioxide gets scarce, and sketch what the Jar 1 line would look like over 90 minutes. Then explain why Jar 2's rise would also slow eventually, even in the dark.