

Gasping for Air

Concepts

- Analyzing the rate of oxygen use
- Differences in rate of cellular respiration

Overview

By comparing the metabolic rates of a plant with an animal, students will see how the rate of cellular respiration differs by analyzing the rate of oxygen use.

Materials

- TI-84 Plus

Introduction

Almost everybody knows that plants are able to make their own food through the process of photosynthesis. During photosynthesis, while the plant produces its own food, carbon dioxide (CO_2) is taken in and oxygen (O_2) is released. It's important to remember, however, that the plant is making food for itself, and it needs to use the food it makes. Food is broken down using the process of cellular respiration—and this occurs in animals AND in plants.

During cellular respiration, O_2 is used and CO_2 is released. One way you can measure the rate of cellular respiration in an organism is by measuring how much oxygen is used up in an enclosed space by that organism. In the table below are data that represent the results of an experiment measuring the use of oxygen by a plant and an animal of nearly equal masses. After you enter the data into your calculator, you will graph the data and compare the use of oxygen by the organisms.

Time (min)	% Oxygen in chamber (animal)	% Oxygen in chamber (plant)
0	19.81	19.85
5	16.38	17.97
10	15.38	17.80
15	14.49	17.67
20	13.63	17.50
25	12.87	17.37
30	12.21	17.27
35	11.48	17.14
40	10.69	17.04
45	9.86	16.87
50	9.03	16.77
55	8.27	16.64
60	7.54	16.48

Procedure

1. Enter the data into L1, L2 and L3 of your calculator, but make sure your lists are cleared first.
 - Press **[2nd] [+] [4]**. This will place the command ClrAllLists onto the Home Screen.
 - Press **[ENTER]**, and your screen will say “Done.”
2. Graph the data in L1 and L2 (oxygen consumption in the animal over time).
 - Press **[2nd] [Y=] [ENTER]**.
 - Make sure this plot is turned “On”. If it is, ‘on’ will be highlighted.
 - If this plot is ‘Off’, move the cursor to ‘On,’ and press **[ENTER]**.
 - The rest of your selections should look like Figure 1.
3. Return the cursor to the top of the screen, and use the **[▶]** arrow to move to Plot2. Press **[ENTER]**.
4. Graph the data in L1 and L3 (oxygen consumption in the plant over time).
 - Move the cursor down to the Ylist: position.
 - Press **[2nd] [3]**.
 - Move the cursor down to Mark:, press the **[▶]** key once, and press **[ENTER]**.
 - Make sure your screen looks like Figure 2.
5. Now you will set the window to view a graph of the data.
 - Press the **[WINDOW]** key, and make the settings look like Figure 3.
 - What is the independent variable (X) in this graph?
 - What is the dependent variable (Y) in this graph?
6. Draw your graph in the space below, making sure you put in a title and label the axes.

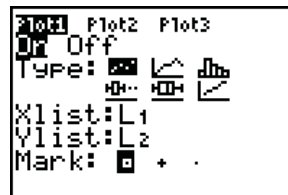


Figure 1

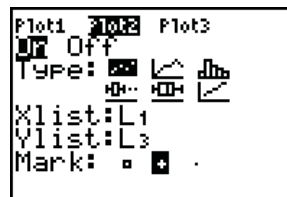


Figure 2

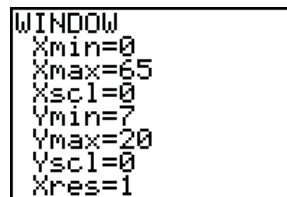


Figure 3

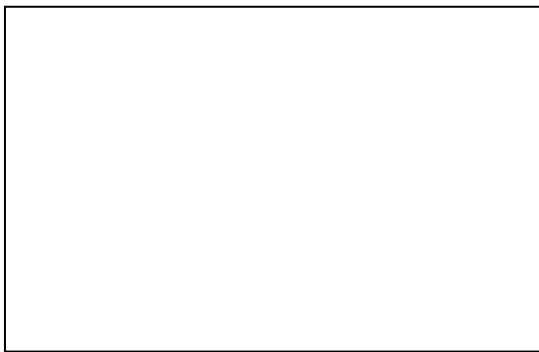
You will now ask the calculator to build mathematical models for the data in this experiment.

7. Press **[STAT]** **[▶]** **[4]**.
 - The calculator to build an “linear regression” (best-fit line) for the data in L1 and L2.
8. Press the following keys: **[2nd]** **[1]** **[,]** **[2nd]** **[2]** **[,]** **[VARS]** **[▶]** **[ENTER]** **[ENTER]**.
 - Your screen should match Figure 4.
9. Now press **[ENTER]**, and you will see the numerical data pertaining to the best-fit line for the oxygen consumption by the animal in the experiment.
 - The value we are most interested in here is “a”, which is the slope of the best-fit line. This indicates the rate of oxygen consumption as percent oxygen in the chamber over time. The number is negative because the amount of oxygen in the chamber is decreasing as time goes on.
 - What is the slope of your best-fit line for the animal data?
 - What is the label that should be applied to this value?
10. Next, ask the calculator to build a linear regression for the data in L1 and L3. Rather than go through all of the key strokes again, take this shortcut:
 - Press **[2nd]** **[ENTER]**. This will take you back to the last operation you performed on the calculator, which was to calculate the linear regression for the animal data.
 - All you need to do is press the **[◀]** key until the cursor is blinking on “L2”. With the cursor there, simply type in **[2nd]** **[3]** then **[▶]** **[▶]** so that you are at the end of the command line.
 - Press **[ENTER]**, and the numerical data for the plant’s best-fit line will be displayed.
 - Is the oxygen in the plant’s chamber increasing or decreasing? How can you tell?
 - What is the slope of your best-fit line for the plant data? Include the appropriate label!
11. Press **[GRAPH]**, and you will see the data displayed with the linear regression (best-fit) mathematical model drawn in for each of the two plots.
12. In the graph you drew earlier, draw in the best-fit lines.

Figure 4

Questions

1. Which consumed oxygen at a faster rate, the animal or the plant? How can you tell?
2. Why would you have expected your answer to #1 even before you looked at the data?
3. Describe another way that you could measure the rate of cellular respiration.
4. What would you expect to happen if you repeated the experiment with a larger chamber and the same plant and the animal? Why?
5. What would you expect to happen if you performed the experiment with a smaller chamber? Why?
6. What would you expect to happen if you did the experiment and wrapped the plant's chamber so that no light could strike the plant?
7. In the space below, draw a graph representing the levels of CO₂ in the chambers over time. Your graph should have two plots on it. Make sure you title and label the graph.



8. Predict what would happen if you let the experiment run for another 60 minutes.