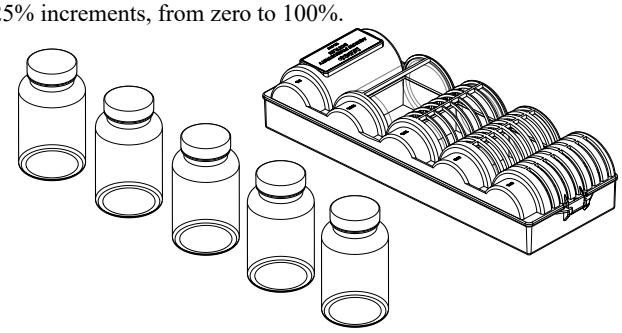
Aquatic Productivity Bottles

ME-6937

Introduction

The Aquatic Productivity Bottles rest in a rack that provides constant and reliable light control for quantitative aquatic productivity studies. The identical transparent bottles are designed to fit perfectly into each of the five rack positions. The custom design of the rack shields the bottles from light by blocking a fixed percentage of light in 25% increments, from zero to 100%.



During experiments, students fill the bottles with algae solution or pond water and then measure the dissolved oxygen concentration in the solution before and after incubation in fluorescent light. By comparing the dissolved oxygen concentrations in each solution, students learn about the relationship between light intensity, dissolved oxygen concentration, photosynthetic activity, and the primary productivity of aquatic ecosystems.

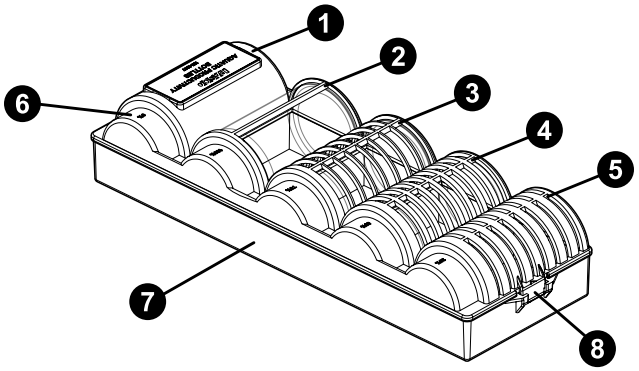
> **IMPORTANT:** Do NOT clean the bottles in an autoclave or dishwasher on a heated cycle. Doing so will cause the plastic of the bottles to warp, rending them unusable for the experiment. If you would like to replace the included bottles with dishwasher-safe glass bottles, see the product page for the dimensions of the bottle.

About the equipment

Included components:

- 5× plastic bottles
- Rack with lid

Rack features:



1. 0% light position
2. 100% light position
3. 75% light position
4. 50% light position
5. 25% light position
6. Lid
7. Rack
8. Latch

Compatible equipment

- PASPORT Optical Dissolved Oxygen Sensor (PS-2196) *or* Wireless Optical Dissolved Oxygen Sensor (PS-3246)
- Wireless Colorimeter and Turbidity Sensor (PS-3215)
- ezSample Snap Vials and other water quality testing equipment (EZ-2331 through EZ-2341)

Get the software

You can use the Aquatic Productivity Bottles with SPARKvue, PASCO Capstone, or Chemvue software. If you're not sure which to use, visit pasco.com/products/guides/software-comparison.

A browser-based version of SPARKvue is available for free on all platforms. We offer a free trial of SPARKvue and Capstone for Windows and Mac. To get the software, go to pasco.com/downloads or search for **SPARKvue** or **chemvue** in your device's app store.

If you have installed the software previously, check that you have the latest update:

SPARKvue: Main Menu > Check for Updates

PASCO Capstone: Help > Check for Updates

Chemvue: See the download page.

Sample Activity

Purpose: In this experiment, you will measure the effects of light intensity on the dissolved oxygen concentration and primary productivity of an algae solution.

Required materials

- Aquatic Productivity Bottles and rack
- Wireless Optical Dissolved Oxygen Sensor (PS-3246)
- PASCO Capstone, SPARKvue, or Chemvue data collection software
- Algae solution or pond water
- Test tube rack
- Sterile disposable pipet
- Large sterile container, with a volume at least 1 L larger than the amount of water you will be using (see **Teacher preparation**)
- Alga-Gro® concentrate
- Wax pencil
- Sticker or marker
- Fluorescent light source
- Wash bottle
- Paper towels

Teacher preparation

- Prepare at least 1500 mL of algae culture for each group.
  - If you buy your algae from a biological supply company, immediately remove it from the container when it arrives. Remove the test tube from the container, place it in a test tube rack, and remove the cap. Use a disposable pipet to squirt air bubbles into the test tube and then place the algae in a cool place with indirect light until ready to culture.
  - When you are ready to make the culture, place 1 L of distilled water into the large sterile container for each group. Mix all of the algae with the distilled water and 20 mL of Alga-Gro® concentrate for each group. (For example, if you have 8 groups, you should use a total of 8 L of water and 160 mL of Alga-Gro®.) Stir to mix. Place the algae in a cool place in direct light until ready to use.
  - If you do not have access to an algae culture, you can instead use local pond water. In this case, no culturing is necessary. Dissolved oxygen data will vary greatly depending on the algae source. Pond water may have a higher level of heterotrophic and decomposing organisms than pure algae culture. These organisms consume oxygen through respiration and may affect your results.

- To prevent students from mixing up their bottles of algae after incubation, the bottom of each bottle should be labeled. To save time, you can label the bottles prior to the lab. With a wax pencil, sticker, or marker, write a percentage of light (either 0%, 25%, 50%, 75%, or 100%) on the bottom of each bottle that will be exposed to that percentage.
- Set up a light source for incubation of the Aquatic Productivity Bottles. Place the bottles far enough from the light source that they will *not* be heated. To ensure the bottles are not heated, place your hand where you want the bottles to sit while the light source is active and verify that you do not feel any warmth from the light. Alternatively, you can create a heat sink by placing a large, clear vessel of water between the light source and the bottles.

Procedure

Day 1:

1. Obtain approximately 1500 mL of algae culture.
2. Start a new experiment in PASCO Capstone, SPARKvue, or Chemvue.
3. Connect your Wireless Optical Dissolved Oxygen Sensor to the software, then calibrate the sensor. For more information on this, see the manual for the sensor and the PASCO Capstone, SPARKvue, or Chemvue online help.
4. Create a digits display to measure the concentration of dissolved oxygen.
5. Begin monitoring data, then remove the rubber boot from the sensor's probe and carefully insert the probe tip into the culture. The tip of the probe should be immersed in the culture, but the probe should *not* be touching the bottom of the beaker.
6. Gently swirl the probe in the culture until the measurement of dissolved oxygen concentration stabilizes. Once the value is stable, record this value as **Initial Dissolved Oxygen (mg/L)** on each row of Table 1.
7. Rinse the tip of the probe with the wash bottle and place the rubber boot back over the probe.
8. If your teacher has not already done so, label the bottoms of each of your five Aquatic Productivity Bottles with a percentage of light (0%, 25%, 50%, 75%, and 100%).
9. Fill each of the bottles by immersing them one at a time in the large vessel of algae culture. While each bottle is submerged, shake it to ensure that all air bubbles have left the bottle, then place the cap on the bottle while it is still submerged. Remove the capped bottles from the algae culture and dry the bottle's exterior with a paper towel.
10. Once all five bottles are filled, remove the lid of the rack by pressing *in* on the latches at both ends, then place the bottles into the matching rack chambers. Make sure you have placed each bottle in the appropriate chamber!
11. Replace the lid on the rack, then place the rack with the bottles in the incubation area under a fluorescent light. Allow the bottles to sit undisturbed for 24 hours.

Day 2:

1. After 24 hours have passed, retrieve your bottles, return them to your lab stations, and remove the rack lid.
2. Connect your Wireless Optical Dissolved Oxygen Sensor to the data collection software, calibrate the sensor again if needed, and set up a digits display to measure the concentration of dissolved oxygen.
3. Place several paper towels onto the lab table.
4. Remove the 100% bottle from the rack, place it onto the paper towels, and carefully remove the cap.
5. Begin monitoring data, then remove the rubber boot from the sensor's probe and carefully insert the probe tip into the bottle. The tip of the probe should be immersed in the culture, but the probe should *not* be touching the bottom of the beaker.
6. Gently swirl the probe in the culture until the measurement of dissolved oxygen concentration stabilizes. Try not to introduce any air bubbles into the algae solution during the data collection process.
7. Once the value is stable, record this value under **Final Dissolved Oxygen (mg/L)** in the appropriate row of Table 1.
8. Rinse the sensor's probe using the wash bottle.
9. Repeat Steps 4 through 8 for the remaining four bottles, recording each of their final dissolved oxygen measurements in Table 1.
10. Once you have obtained all measurements, rinse the tip of the probe with the wash bottle one more time, then place the rubber boot back over the probe.

Data analysis

1. Calculate the respiration rate *R* for your group's algae solution and record it in all rows of Table 1. Since there was no photosynthetic activity in the bottle that received no light (0% bottle), *R* is equal to the total amount of dissolved oxygen consumed in that bottle. In other words:

$$R = (\text{Initial dissolved oxygen concentration}) - (\text{Final dissolved oxygen concentration of 0\% bottle})$$

2. Calculate the net primary productivity (*NPP*) of the algae in each bottle using the equation below. Record these values in Table 1.

$$NPP = (\text{Final dissolved oxygen of bottle}) - (\text{Initial dissolved oxygen of bottle})$$

3. Calculate the gross primary productivity (*GPP*) of the algae in each bottle using the equation below. Record these values in Table 1.

$$GPP = (NPP \text{ of bottle}) + R$$

Table 1

Light Intensity (%)	Initial Dissolved Oxygen (mg/L)	Final Dissolved Oxygen (mg/L)	Respiration Rate (mg/L)	Net Primary Productivity (mg/L)	Gross Primary Productivity (mg/L)
0%					
25%					
50%					
75%					
100%					

Sample data

The following images depict a sample data set, including a data table and plots of both *NPP* and *GPP* versus light intensity. Note that your values may differ significantly depending on your algae source.

Figure 1: Sample data for Table 1.

	Set	Set	Set	Set	Set	Set
	Light Intensity (%)	Initial Dissolved Oxygen (mg/L)	Final Dissolved Oxygen (mg/L)	Respiration Rate (mg/L)	Net Primary Productivity (mg/L)	Gross Primary Productivity (mg/L)
1	0	8.9	8.8	0.1	-0.1	0.0
2	25	8.9	9.0	0.1	0.1	0.2
3	50	8.9	9.2	0.1	0.3	0.4
4	75	8.9	9.5	0.1	0.6	0.7
5	100	8.9	9.7	0.1	0.8	0.9

Figure 2: Net Primary Productivity (mg/L) vs. Light Intensity (%) for sample data.

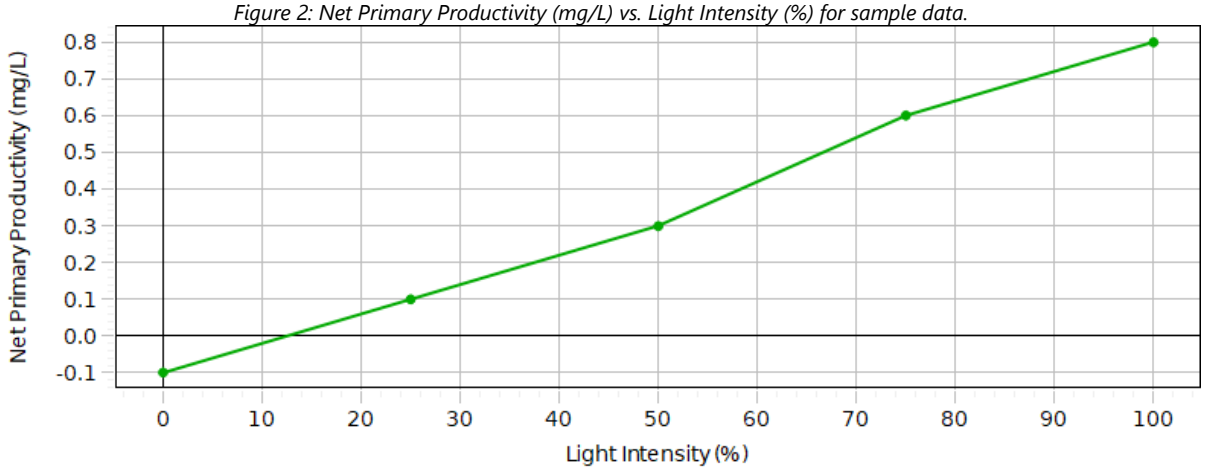
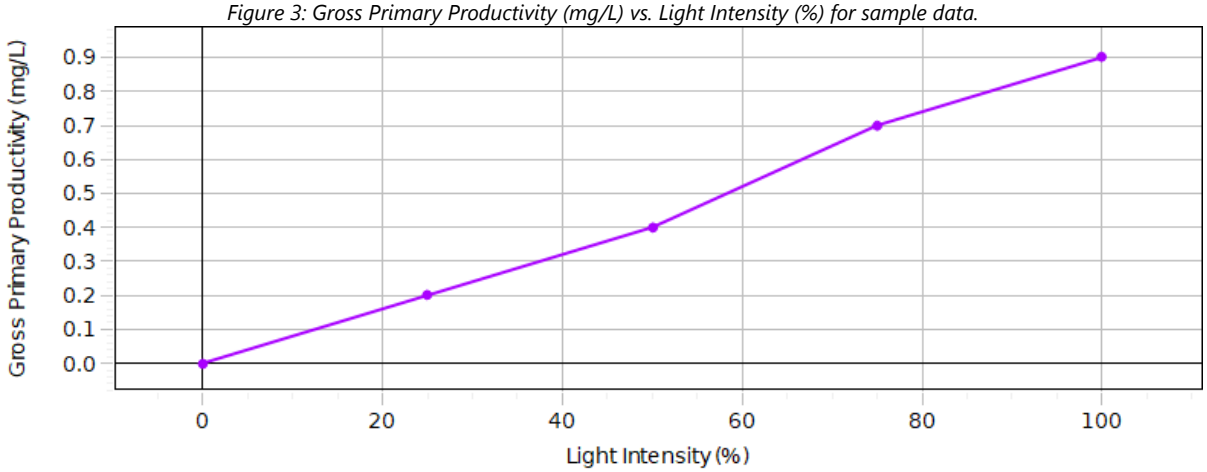


Figure 3: Gross Primary Productivity (mg/L) vs. Light Intensity (%) for sample data.



Software help

The SPARKvue, PASCO Capstone, and Chemvue Help provide information on how to use this product with the software. You can access the help from within the software or online.

SPARKvue

Software: Main Menu > Help

Online: help.pasco.com/sparkvue

PASCO Capstone

Software: Help > PASCO Capstone Help

Online: help.pasco.com/capstone

Chemvue

Software: Main Menu > Help

Online: help.pasco.com/chemvue

Specifications and accessories

Visit the product page at pasco.com/product/ME-6937 to view the specifications and explore accessories. You can also download experiment files and support documents from the product page.

Technical support

Need more help? Our knowledgeable and friendly Technical Support staff is ready to answer your questions or walk you through any issues.

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