

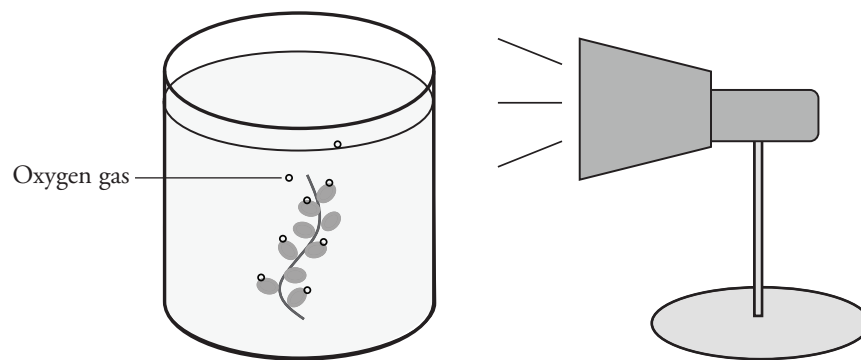
Experimental Variables

What is measured during a controlled experiment?

Why?

When scientists set out to do an experiment, they first think about the variables that may affect the outcome of the experiment. A **variable** is any condition that may cause a change in the system being studied. Some variables are measured quantitatively, like temperature, mass or height. Other variables are recorded in a qualitative manner, like color, texture or species. The most important factor is that the scientist runs a **controlled experiment**. In a controlled experiment, only one variable is changed to ensure that the effect of only that one variable can be measured.

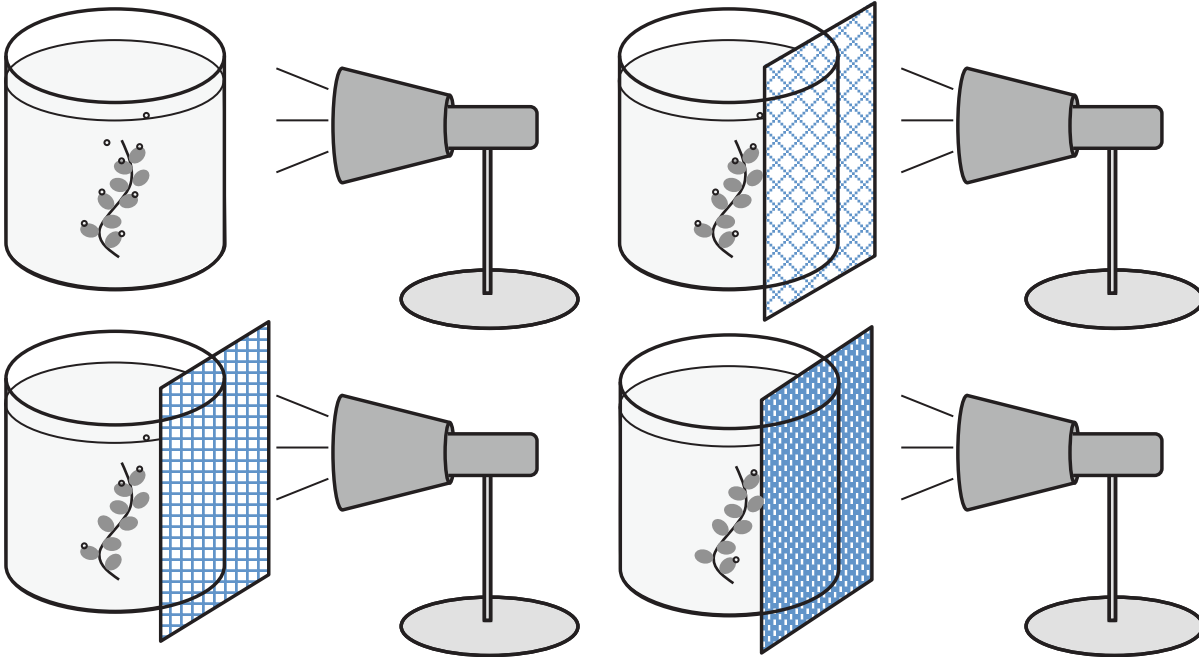
Model 1 – Photosynthesis in an Aquatic Plant



1. The diagram in Model 1 illustrates a clipping of an aquatic plant in water.
 - a. What process is occurring in the plant's cells to produce the gas in the bubbles that appear?
 - b. What gas is the plant producing?
 - c. What source of energy is the plant using to conduct the process recorded in part *a*?
2. Depending on the environment the plant is in, more or less gas may be produced. Suggest a method for measuring the rate of gas production from the aquatic plant in Model 1.
3. With your group, create a list of environmental factors that may affect the rate of gas production in the aquatic plant in Model 1. These factors could become variables in an experiment.



Model 2 – Aquatic Plant Experiment



4. Examine the four trials shown in Model 2. Identify several conditions in the experiment that are the same in each trial.
5. Describe the one condition that has been varied among the four trials in Model 2.
6. How does the condition described in Question 5 appear to affect the rate of gas production by the aquatic plant? Provide specific evidence from Model 2 to support your answer.

Model 3 – Aquatic Plant Data

	Length of clipping (cm)	Number of leaves on clipping	Lamp power (watts)	Percentage of light from lamp that reaches the plant	Number of oxygen bubbles formed in 10 minutes
A	12		40	100%	
B	12		40	75%	
C	12		40	50%	
D	12		40	25%	

7. Refer to the diagrams in Model 2 to complete the data table in Model 3.
8. The column headings in Model 3 each describe a variable in the experiment.
 - a. What variable was purposefully changed in the experiment?
 - b. What variable changed as a result of changing the variable listed in part *a*?
 - c. What variable(s) in the Model 3 data table remained constant among all the trials?

Read This!

When designing an experiment, you need to consider three types of variables. The **independent variable** is changed by the experimenter in the design of the experiment. This variable is sometimes called the “manipulated variable.” The **dependent variable** is what changes as a result of the change in the independent variable. This variable is sometimes called the “responding variable.” In some cases more than one dependent variable is considered. The third category of variables is **controlled variables**. These are variables that you think may change the outcome of the experiment, but since they are not being studied, they need to be kept constant in each trial.



9. Identify the independent, dependent, and controlled variables for the experiment that produced the data in Model 3.

Independent

Dependent

Controlled

Read This!

A well-written research question states the independent and dependent variables in the experiment. For example, a student investigated the effect of soil pH on the number of strawberries produced by a strawberry plant. Her research question was “How does the pH of soil affect the number of strawberries produced by a strawberry plant?”



10. Write a research question, using the format suggested in the *Read This!* box, for the experiment in Model 2.

11. A student wonders, “Does the moisture content in soil affect how far a worm can dig?” Identify the variables that are being considered in this experiment and the variables that need to be controlled.

Independent

Dependent

Controlled

Extension Questions

12. Scientists may design an experiment with a **control group**, which is a set of organisms or samples that do not receive the treatment (the independent variable) that is being tested. Scientists can then compare normal changes in organisms or samples with those that may have occurred because of the treatment. The idea of a control group is not the same as a controlled variable. Suppose a scientist is doing an experiment to determine the effect of an all-organic diet on the occurrence of cancer in rats.

a. What variables should the scientist control in the experiment?

b. Describe the control group for this experiment.

c. Why is it important for a scientist to use a control group when working with organisms in an experiment?