KEY

Biology Mid-Year Cornerstone Assessment: Part A. Experimental Design

Directions: Read the paragraph below and then respond to the questions.
Suzy's Biology classroom has two potted plants. At the beginning of the year, both plants were the same size. Now, Suzy notices that the plant on the teacher's desk, located farthest from the window, has not grown as much as the plant near the window. She decides she would like to know if distance from the light source affects the plant growth. Design an appropriate experiment to test the effect of light source distance on the rate of plant growth.

The following materials are available to you:

1. Bean seeds
2. Small pots
3. Potting soil
4. water
5. Lamps
6. Cardboard boxes
7. Ruler
8. Balance (scale for measuring mass)

1. State an appropriate **hypothesis**. Explain your reasoning.

If two plants are placed at different distances from a light source, the plant placed closer to the light source will demonstrate the greatest growth over time. Plant growth is dependent on a light source.

2. What should be the **independent variable** in the experiment? Explain your choice.

The independent variable is the distance from the light source. This is the manipulated variable.

3. What should be the **dependent variable** in your experiment? Explain your choice.

The dependent variable is the plant growth. This is what we are measuring and it depends on the distance from the light source.

4. Are there conditions that should **remain constant** in this experiment? Explain your answer, and give examples, if necessary.

Example of constants would be type of seed, type of pot, amount and type soil, amount and type of water, and the amount of light…etc. These things must stay constant to show that distance from the light source alone is responsible for changes in the dependent variable.

5. Is there a need for a **control group** in this experiment? Explain your answer, and identify the control, if necessary.

The control would be a lack of light. Although an established distance from the light is an appropriate comparison for the physically varied light source distances in the experiment, it is not a control group.

6. Describe the procedures you will use to carry out the experiment. List the steps below and the materials needed.

Take fifteen bean seeds and place them in fifteen pots with the same amount and type of potting soil and water. Place five of the bean plants 30 cm from the light source and the other five bean plants 120 cm from the light source. The remaining 5 bean plants will be placed in a dark closet as the experimental control.

Mark each of the pots in the following way:

30 cm from light (1-5)

120 cm from light (1-5)

Dark location (1-5)

Check all of the plants at the same time once a week. Record qualitative (color of plant) and quantitative (height of plant, number of leaves) observations.

List of materials:

Bean seeds
Small pots
Potting soil
water
Lamps
Ruler
Balance (scale for measuring mass)

Name:_____

7. Create a data table that can hold all the data you would gather through your experiment. Label rows and columns but do not include data.

Quantitative Table

Plant growth at varying distances from a light source over a four week period

Distance from light	Height of plant				Number of leaves			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
30 cm (1)								
30 cm (2)								
30 cm (3)								
30 cm (4)								
30 cm (5)								
120 cm (1)								
120 cm (2)								
120 cm (3)								
120 cm (4)								
120 cm (5)								
Dark Location (1)								
Dark Location (2)								
Dark Location (3)								
Dark Location (4)								
Dark Location (5)								

Name:_____

Qualitative observations

Color of plant over a four week period

	Observations			
30 cm (1)	Week 1	Week 2	Week 3	Week 4
30 cm (2)				
30 cm (3)				
30 cm (4)				
30 cm (5)				
120 cm (1)				
120 cm (2)				
120 cm (3)				
120 cm (4)				
120 cm (5)				
Dark Location (1)				
Dark Location (2)				
Dark Location (3)				
Dark Location (4)				
Dark Location (5)				

Name:_____

Biology Mid-Year Cornerstone Assessment: Part B. Data Analysis and Scientific Reasoning

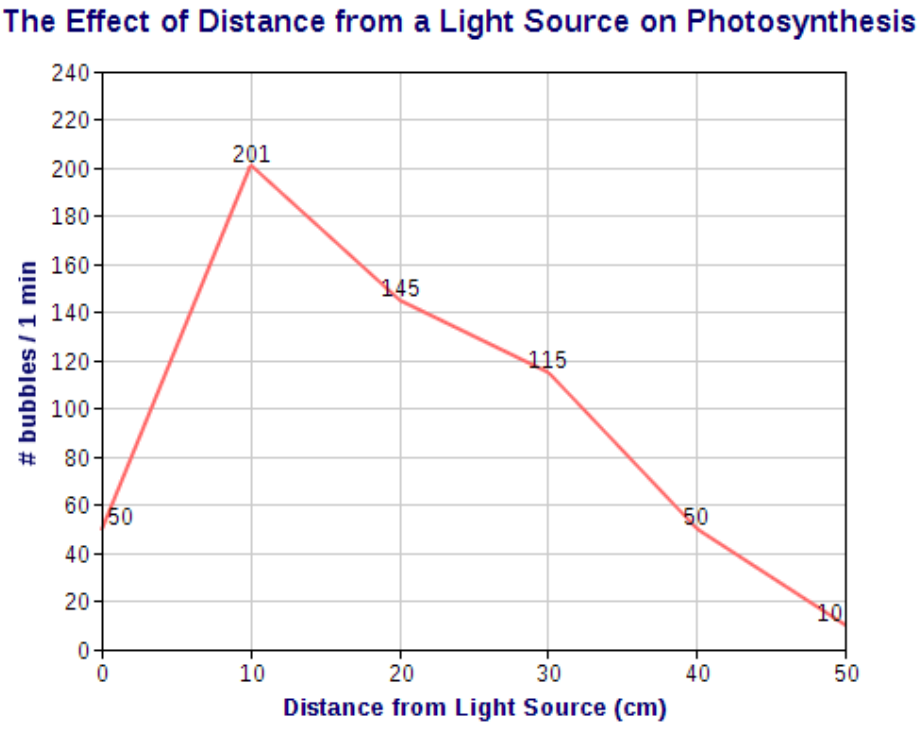
Directions: Review the data table below. Then, answer the questions that follow. The students believed that the rate of photosynthesis would decrease with an increased distance from the light source. Photosynthesis can be described by the following chemical reaction:

Light + $6CO_2$ + 6 H_2O -> Glucose + $6O_2$

The data collected from *Elodea*, an aquatic plant, is listed below:

Distance from light source (cm)	# bubbles/1 min
0 cm	50
10 cm	201
20 cm	145
30 cm	115
40 cm	50
50 cm	10

1. Using the grid below, create a line graph from these data.



2. What is your **independent variable**? Explain your choice.

The independent variable is the distance from the light source. This is the manipulated variable.

3. What is the **dependent variable**? Explain your choice.

The dependent variable is the number of bubbles produced. This is what we are measuring and it depends on the distance from the light source.

4. At what distance from the light source was bubble production the greatest?

10 cm

5. How many bubbles would you predict would be seen 60 cm from the light source? Explain your reasoning.

Zero bubbles would be present at 60 cm from the light source. The graph showed that bubble production was decreasing incrementally with every 10 cm move from the light source. The last reading was ten bubbles per minute at 50 cm.

6. The bubbles are what type of gas? Why is bubble production a good measurement of rate of photosynthesis?

The bubbles are oxygen. Oxygen production is a good measure of the rate of photosynthesis because oxygen is a product of photosynthesis.

7. What conclusion(s) can be made based on these results?

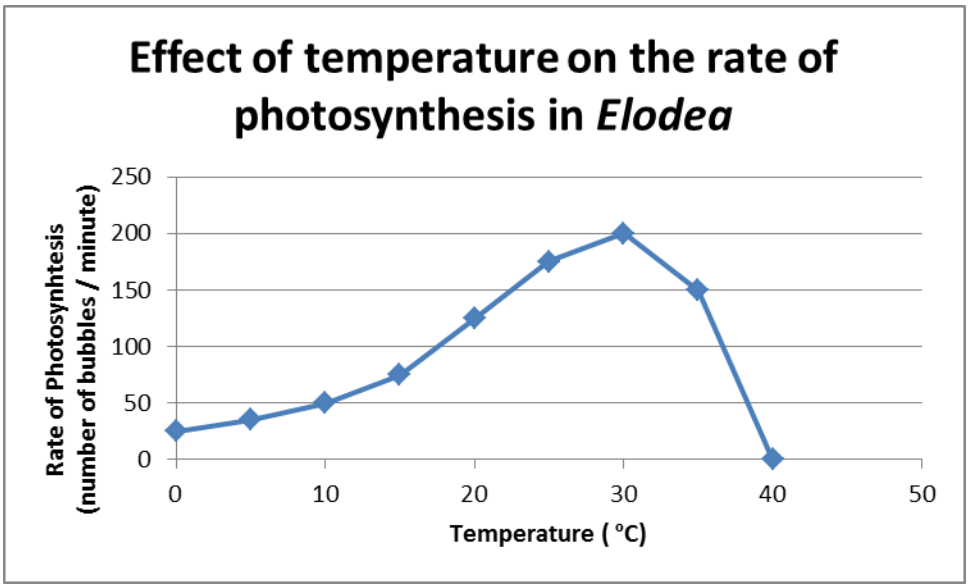
Elodea photosynthesizes best at a distance of 10 cm from a light source.

8. Describe a way in which this experiment can be improved or expanded to further explore the effect of distance from light source on photosynthetic rate?

Modify the plant type, modify the type of light source, or modify the environment.

Name:_____

Use the following graph to answer questions 9 and 10.



9. At what temperature does Elodea photosynthesize the best?

Elodea photosynthesizes best at 30 ^{o}C producing 200 oxygen bubbles per minute.

10. If most plants exhibit a similar response to temperature as the Elodea, explain what happens to Virginia plants in the autumn and winter months? Use the graph above to explain your answer.

According to the graph, as the temperature decreases the oxygen bubble production decreases indicating a slowing in photosynthesis. In the autumn and winter months plants in Virginia will experience colder temperatures and the chemical reaction will slow down. Many plants will be dormant until the temperatures rise to a level that allow a sufficient amount of photosynthesis to occur.