Biology Year-of End Cornerstone Assessment: Part A – Experimental Design

Directions: Read the paragraph below and respond to questions 1 - 7.

Alex's biology class is studying the effect of salinity (amount of salt) of water on the behavior of aquatic organisms. Specifically, the students want to investigate the effect of salinity on the rate of movement in *Artemia*. *Artemia*, commonly known as brine shrimp, are small aquatic crustaceans that live in high saline aquatic environments. Although *Artemia* are small, they can easily be seen with the naked eye (without a microscope). Design an appropriate experiment to test the effect of salinity on the rate of movement of *Artemia* by responding to questions 1 through 7. The rate of movement is determined by how far *Artemia* travel over time.

The following materials are available for use in your experimental design:

• *Artemia* – unlimited supply • Petri dishes to hold *Artemia* • 0% saline solution • 10% saline solution • 20% saline solution • 30% saline solution • 40% saline solution	• Timer • Paper and pencil • Marker (black) • Grid paper that fits under petri dishes (2mm x 2mm grids marked off that can be seen through the petri dish) • Graduated cylinder 10ml

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

   If the salinity of the solution the *Artemia* are placed in is increased from 0% to 40%, then the rate of movement will be highest at the higher salinity levels. Since Artemia live in saline environments, their rate of movement will be highest at higher saline levels because their life processes are adapted to the higher levels of salt.
   *Accept any appropriate hypotheses as long as it is supported with reasoning. Some students may (correctly) predict the Artemia will have higher rates of movement in environments they are not adapted to.

2. What is the **independent variable** in your experimental design? Explain your choice.

   The independent variable is the salinity of the solution. This is the manipulated variable.

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

   The dependent variable is the rate of movement of the *Artemia* (squares per second or chosen unit).

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

   Examples of constants should be the same amount of water, the same number of *Artemia* in the petri dish, the same amount of timing of movement, the same water source (pH, minerals, etc.), the same temperature of the water, the same method of counting the squares crossed, etc. The student should explain that the change in salinity alone is affecting the rate of movement and other variables need to be controlled.

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

   There is no need for a control since varying levels of salinity are being compared to each other. Although, the natural salinity preferred by the *Artemia* could be considered the control. Some students may state the level of the highest rate of movement could be used as the control.

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

   Steps:

   1. Place 10 ml of 0% salinity solution in a petri dish and add 10 brine shrimp. (identify a stated volume of solution with *Artemia* or exact number of *Artemia* to be added).
   2. Repeat the above procedure with each of the salinity solutions (10%, 20%, 30%, 40%). Mark each dish to identify the salinity of the solution.
   3. Place the petri dish contain the *Artemia* with 0% salinity on top of the grid sheet and chose one *Artemia* to follow and count how many squares it crosses in a 20 second period of time (or chosen appropriate amount of time). Repeat this for 4 trials in order to calculate the average rater of movement. *Students should understand that multiple trials should be taken to get an average rate of movement.
   4. Repeat the above procedure with each of the salinity solutions (10%, 20%, 30%, 40%).
   5. Record your results in a data table. Students should also note that qualitative observations are important as well.

   Materials needed: salinity solutions (any used and amount), petri dish (number used), 10 ml graduated cylinder, *Artemia* (number needed), Marker, pen and pencil, grid paper (2mm x 2mm), timer *materials will vary depending on experimental design.

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

The Effect of Salinity of Solution on the Rate of Movement of *Artemia*

Salinity of Solution (%)	**Rate of Movement (squares per second)**	**Observations (qualitative)**
0		
10		
20		
30		
40		

Biology Year-End Cornerstone Assessment: Part B – Data Analysis and Scientific Reasoning

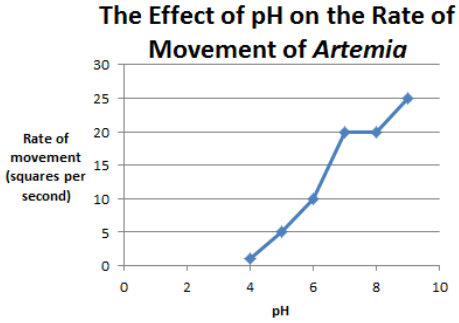
Directions: Review the information and data table presented below. Answer questions 1 through 11 that follow the information.

An experiment was set up to test the effect of changing pH concentrations on the rate of movement of *Artemia. Artemia* move more when they are in an environment similar to their natural habitat. Students hypothesized that the higher pH levels would increase the rate of movement of the *Artemia*. The students placed the *Artemia* in petri dishes with 2 mm x 2 mm grids marked off on the bottom of the dishes. The students calculated how fast the *Artemia* traveled in each pH (4-9) solution by counting the number of squares the *Artemia* crossed per second of timing.

The data collected from their experiment is presented below:

pH of Water	Rate of Movement of *Artemia* (squares per second)
4	1
5	5
6	10
7	20
8	20
9	25

1. Using the grid below, create a line graph based on the above data.



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

The independent variable was the pH of the solution.

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

The dependent variable was the rate of movement of the *Artemia*.

4. At what pH level(s) did the *Artemia* exhibit the highest rate of movement?

   The highest rate of movement was seen at a pH level of 9.

5. What do you think would happen to the rate of movement if the *Artemia* were placed in a solution with a pH of 10? Explain your reasoning.

   The rate of movement would continue to slow down. The trends in the increasing pH levels show that higher pH levels slow the rate of movement. Exact predicted rates of movement may be included.

6. What do you think would happen to the rate of movement if the *Artemia* were placed in a solution with a pH of 3? Explain your reasoning.

   The rate of movement would continue to slow down. The trends in the decreasing pH levels show that lower pH levels slow the rate of movement. Exact predicted rates of movement may be included.

7. What conclusion(s) can you make based on the results (data) from the experiment?

   The data suggests that Artemia prefer to be in solution with a pH level between 7 – 9. This must be the pH level of their normal habitat.

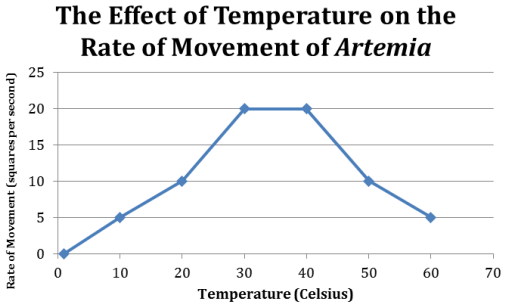
8. Describe a way in which this experiment could be improved to further explore the effect of the pH of solution on the rate of movement of the *Artemia*.

   This experiment could be improved by adding a greater range of the pH levels. More trials could also improve the validity of the data. Some students may also suggest testing pH levels on other organisms.

9. Describe what happens to the rate of movement of the *Artemia* as the pH of the solution they are placed in changes.

   The rate of movement is very slow at low pH levels and they increases as the pH level increases. The rate of movement is the slowest at pH of 4 and highest at a pH of 9.

The graph below shows the effect of temperature on the rate of movement of *Artemia*.



10. At what temperature(s) did the *Artemia* move the fastest?

They moved the fastest at 30 and 40 degrees.

11. Why do you think the rate of movement of an organism changes when the temperature of their environment changes?

Lower temperatures slow the rates of all reactions so movement will slow. At very cold temperatures organisms could die due to lack of motion at all. Most organisms carry out life processes at higher temperatures that are ideal for cellular / organism functions. Very hot temperatures limit movement because molecules (enzymes) start to fall apart and cannot support life. Some organisms slow their movement at high temperatures in order to conserve energy and speed up movement at cooler temperatures to generate heat. All organisms have an optimal temperature for survival. *Accept reasonable explanations.