Geometry: Measurement

FANTASTIC JURASSIC

Gro-Beasts are small animal figurines that are made from a polymer (sodium polyacrylate). Your responsibilities include completing a Gro-Beast lab in which a Gro-Beast will be observed over a period of 5 days. Changes in length, height, width, perimeter, area, mass, volume, and density will be recorded over the 5-day period, and the results graphed and evaluated. Note that this means you will have to measure them 6 times, day 0 to day 5.

Objective:

Demonstrate skills in working with measurement, ratios and proportion, linear graphs, intercepts, and slope.

Materials:

The following is a list of materials needed to complete the Gro-Beast Lab.

Gro-Beast
Plastic Bag or Tupperware type container
Overflow Device using 2 liter pop bottle (optional: for determining the volume).
Balance (for determining mass)
String (for measuring perimeter)
Metric Rulers (for measuring length, height, and width
COLD water (hot water will dissolve the Gro-Beast!)
Graduated cylinder (for measuring volume)
Graph Paper (provided in the packet)

Tasks:

- Complete the Gro-Beast lab worksheets. Be sure to record the changes in your Gro-Beast over the course of 5 consecutive days. Day 0 measurements should be the values before the dinosaurs are put in the water bag to start growing. Each day the measurements must be taken and recorded.

- Neatly sketch the six graphs on the papers provided. Be sure to label the appropriate axes and calculate the slopes for the graph in the space provided.

- Answer a set of questions based on the data you have collected.

Gro-Beast Lab
Procedure

1. Trace your Gro-Beast on the graph paper provided.

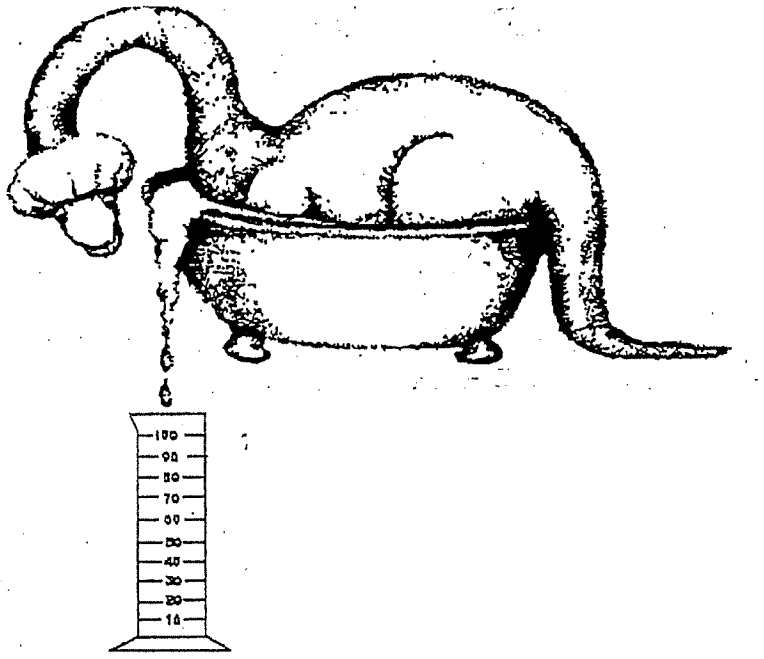
2. Measure the **length** of your Gro-Beast to the nearest centimeter and record it in the data table.

3. Measure and record the **height** of your Gro-Beast.

4. Measure and record the **width**.

5. The distance around the outside of an object is known as its **perimeter**. To measure the perimeter, take a piece of string or wire and place it on the outline of your Gro-Beast on your graph paper. How much string did it take to cover the outline of the Gro-Beast? Record this in the perimeter row of your data table.

6. **Area** is the amount of space an object takes up on a flat surface (in two dimensions). Measure this by counting the squares that one side of the Gro-Beast covers on the graph paper. (This is actually called a cross-sectional area.) You may need to estimate and add any partially covered squares.



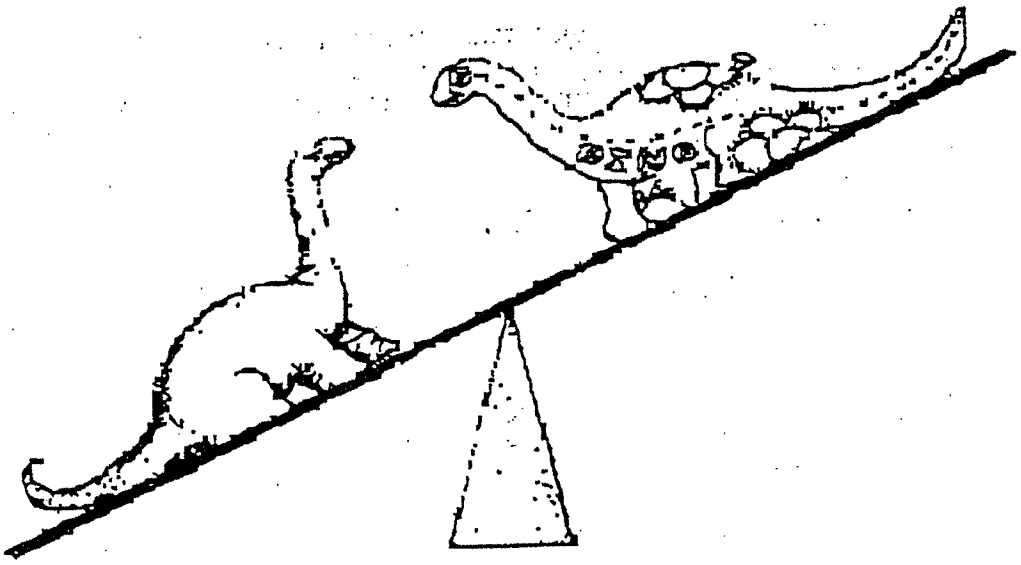
7. **Volume** is the amount of space that an object takes up in three dimensions. You can observe this when you sit down in a full bathtub and water spills out over the sides. The volume that spills out is the same as the volume of your body. Using an overflow can or a graduated cylinder, you can determine the total volume of your Gro-Beast and record it on your data table.

8. The amount of matter that an object has is known as its **mass**. Things that have a lot of matter are heavier than objects with less matter. Determine the mass of your Gro-Beast by weighing it on a balance.

9. **Density** is an object's mass divided by its volume.

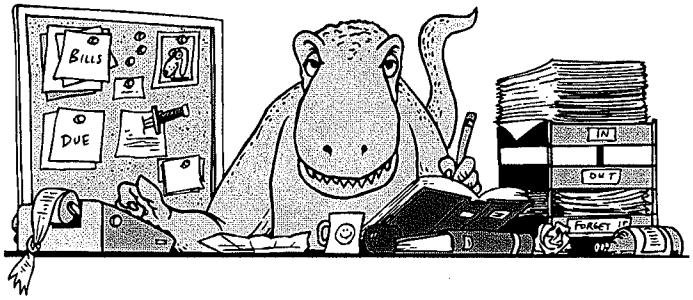
Density = Mass ÷ Volume

Density is a difficult concept for some people to understand. However, you probably already understand how to apply this concept. A dense object will be heavier than an object of equal size that is less dense. Which of the following dinosaurs is more dense?



10. Divide the mass of your Gro-Beast by its volume and record it on your data table.

11. Water has a density of 1 gram per milliliter (g/ml). Is your Gro-Beast more or less dense than water? Once again, you can check your answer by putting your Gro-Beast in some water. If it sinks it is denser than water. If it floats it is less dense.

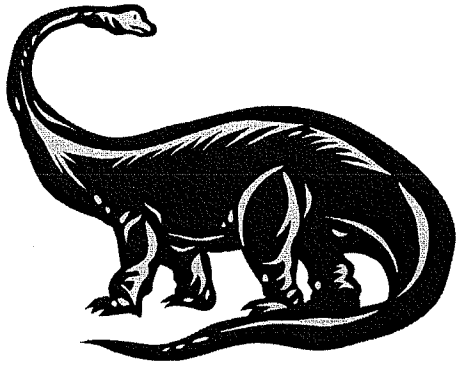


Gro-Beast Lab
Measuring and Graphing the Physical Changes of A Growing Toy Dinosaur

In this lab you will investigate how the physical measurements of length, height, width, perimeter, area, volume, mass, and density are related. Being able to use these forms of measurement is on the essential to making accurate observations of the world around us. For example, the relationship between an animal's **surface area** and **volume** changes, as an animal becomes larger. These physical measurements in turn have an effect **metabolism** of the animal. Animals that have a lot of volume such as whales or polar bears lose heat more slowly and have slower rates of **metabolism** than smaller animals. Small animals such as mice or hummingbirds that have more surface area to volume have much faster heartbeats and rates of metabolism. Remember that density is mass divided by volume.

Your dinosaur Gro-Beast will grow when you place it in water. You will measure, record, and graph the changes that occur over the next several days. It is important that you measure accurately.

	Day 0	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Length						
Width						
Height						
Perimeter						
Area						
Mass						
Volume						
Density						



THE QUESTIONS:

1. By reading the calculated slopes on the graphs of length, width, height, and perimeter describe the slope values.
   a. Is the slope decreasing or increasing?
   b. What are the units for the slope?
   c. Do the slope values change from day zero to day five?

2. Do the measurements of length, width, height and perimeter increase at the same rate?
   a. How do you measure the rate?
   b. On what days is the rate of growth the greatest? The least?
   c. Why does the rate of growth change?
   d. Of the length, width, height and perimeter measurements, which overall slope is steepest? Why do you think this is so?

3. For the perimeter graph consider the intercepts.
   a. What is the y-intercept?
   b. What is the meaning of the y-intercept in this graph? (Think of this in real-world terms as applies to the Gro-Beast.)
   c. Is there an x-intercept?
   d. Would the x-intercept have any real meaning in the graph in this context? Why or why not?

4. For the graph of area describe the slope.
   a. What are the units for the slope?
   b. How many times larger in area does your Gro-Beast get from start to finish?

5. For the graph of mass describe the slope.
   a. What are the units for the slope?
   b. From your calculations, how many times its own weight can this material absorb?
   c. In what other ways might this material be useful? (Besides entertaining students???)

6. For the graph of volume, describe the slope.
   a. What are the units for the slope?

7. If your Gro-Beast was a real animal would its metabolism be getting faster or slower? Explain your answer based on the graph of the volume and the information given to you at the introduction to the table of data.

8. For the graph of density, describe the slope.
   a. What are the units for the slope?
   b. Water has a density of 1 gram per milliliter (g/ml). Initially is your Gro-Beast more or less dense than water? Does the answer to this question change over the course of your measurements? **(You can check your answer by putting your Gro-Beast in some water. If it sinks it ism ore dense than water. If it floats it is less dense.)**
   c. Is the density measurement closer to the density of water at the beginning or at the end of the project? Why is this true?
   d. How does the graph of density demonstrate what is happening to the composition of the dinosaur over the course of the project?

9. a. The values of the following ratios should be calculated.

$$\frac{\text{Length of Gro-Beast after day 4}}{\text{Length of original Gro-Beast}}$$

$$\frac{\text{Area of Gro-Beast after day 4}}{\text{Area of original Gro-Beast}}$$

$$\frac{\text{Volume of Gro-Beast after day 4}}{\text{Volume of original Gro-Beast}}$$

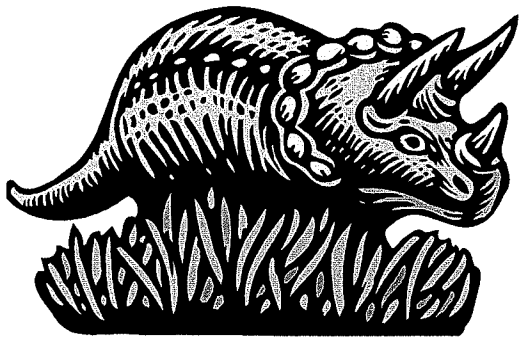
b. The second of these in theory should be the square of the first. The third should be the cube of the first. How do your three ratios compare to the theoretical values?

10. If you were to carry this experiment on for another day, what you predict the length, area, and volume would be? Describe how you calculated your predicted values (or show your calculations).

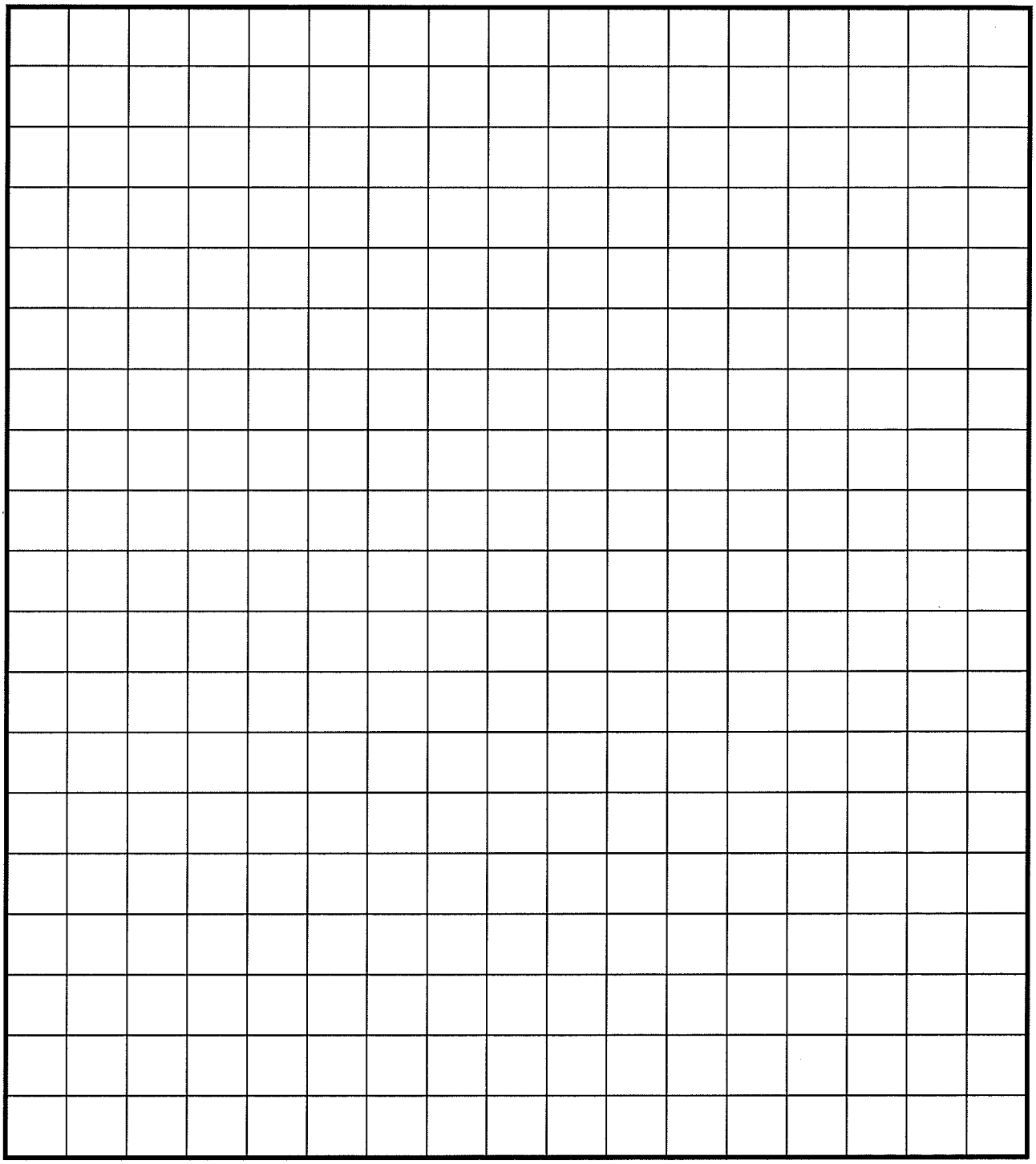
Overall Assessment:

Your grade will be based on the quality and correctness of the following:

Data Collection Sheet
Traces of Area
Graphs and Slope Calculation
Answers to Questions

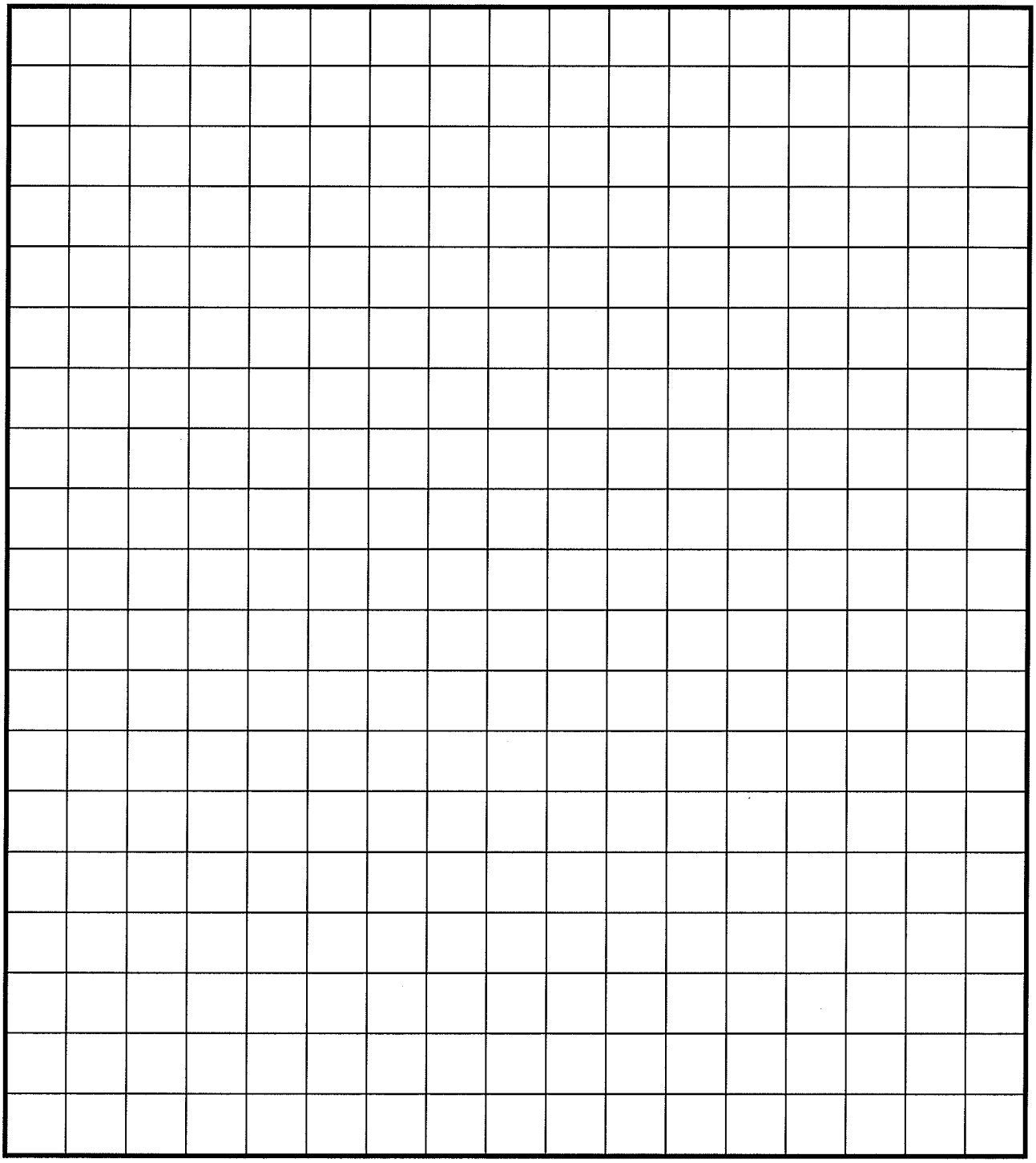


TRACES OF AREA



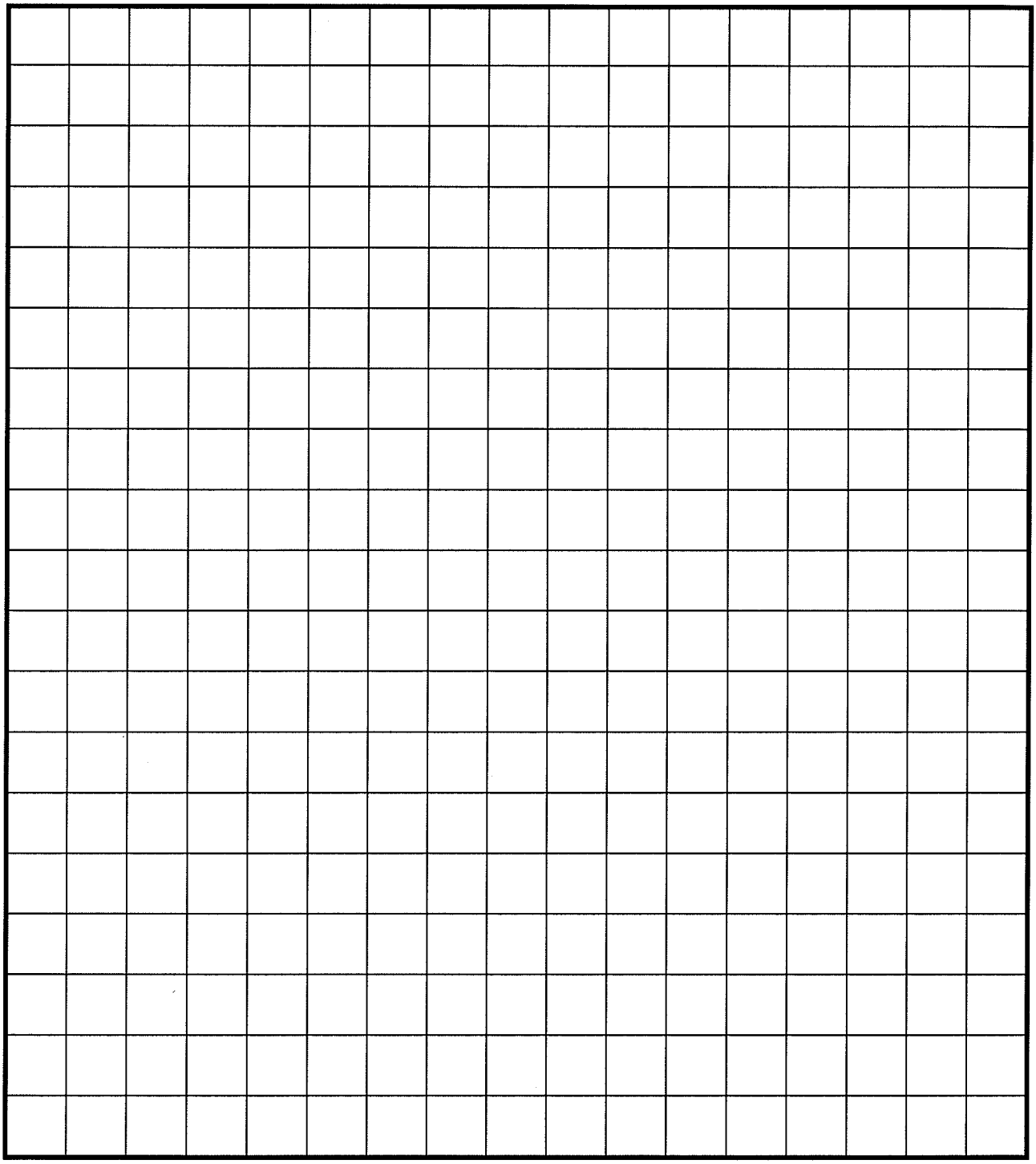
(Each square is 1 cm^2.)

LENGTH HEIGHT WIDTH



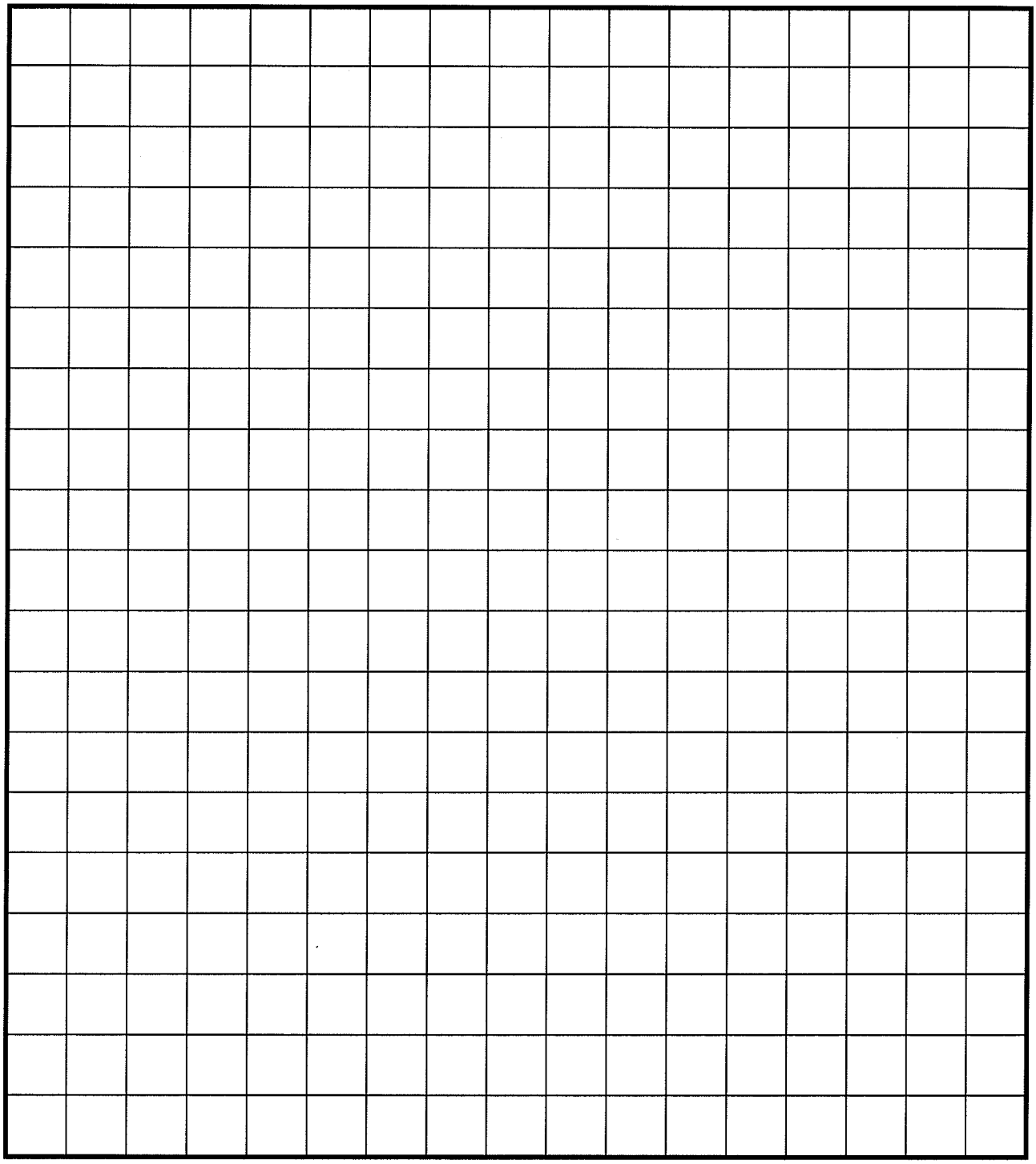
Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

PERIMETER



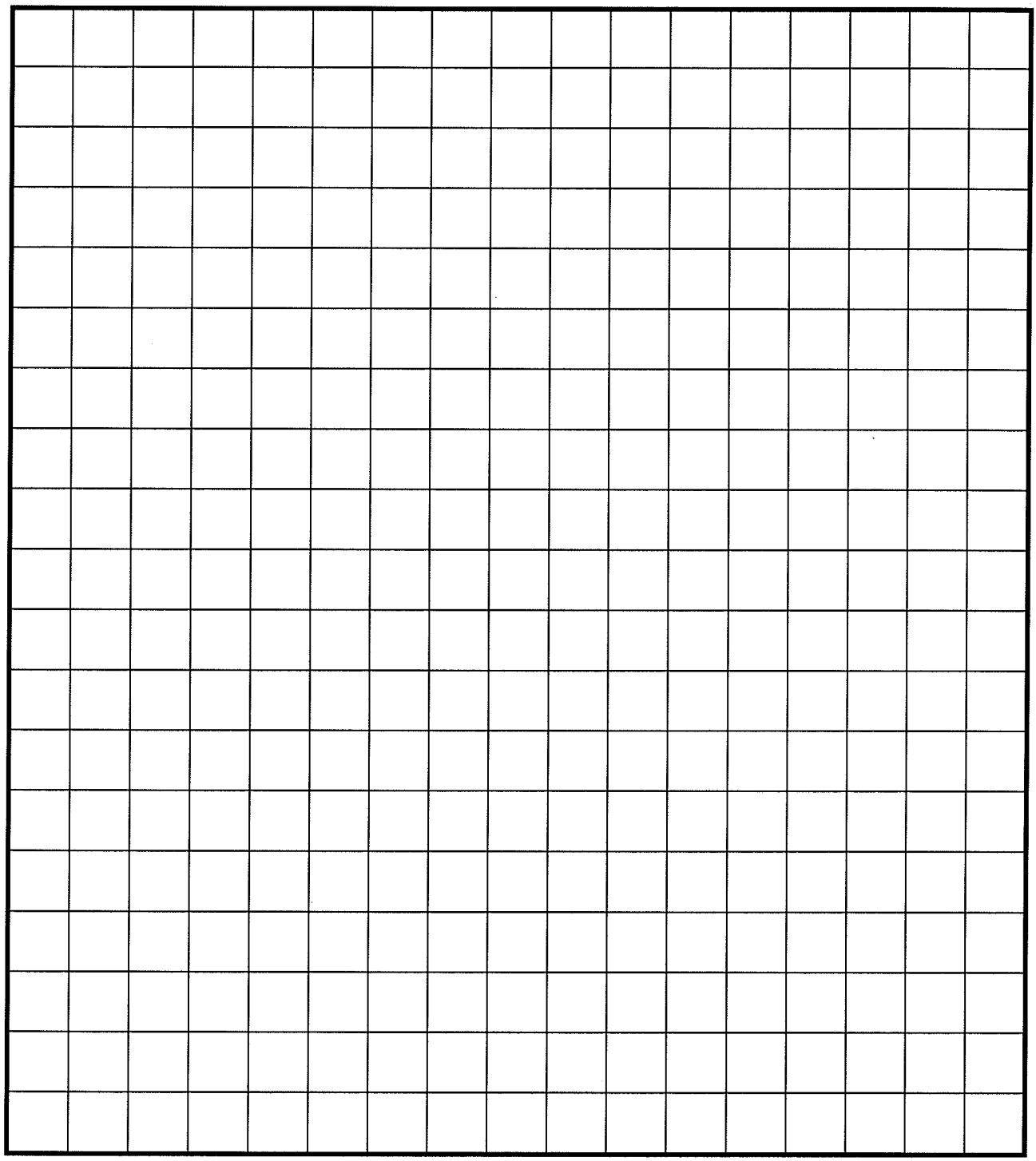
Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

AREA



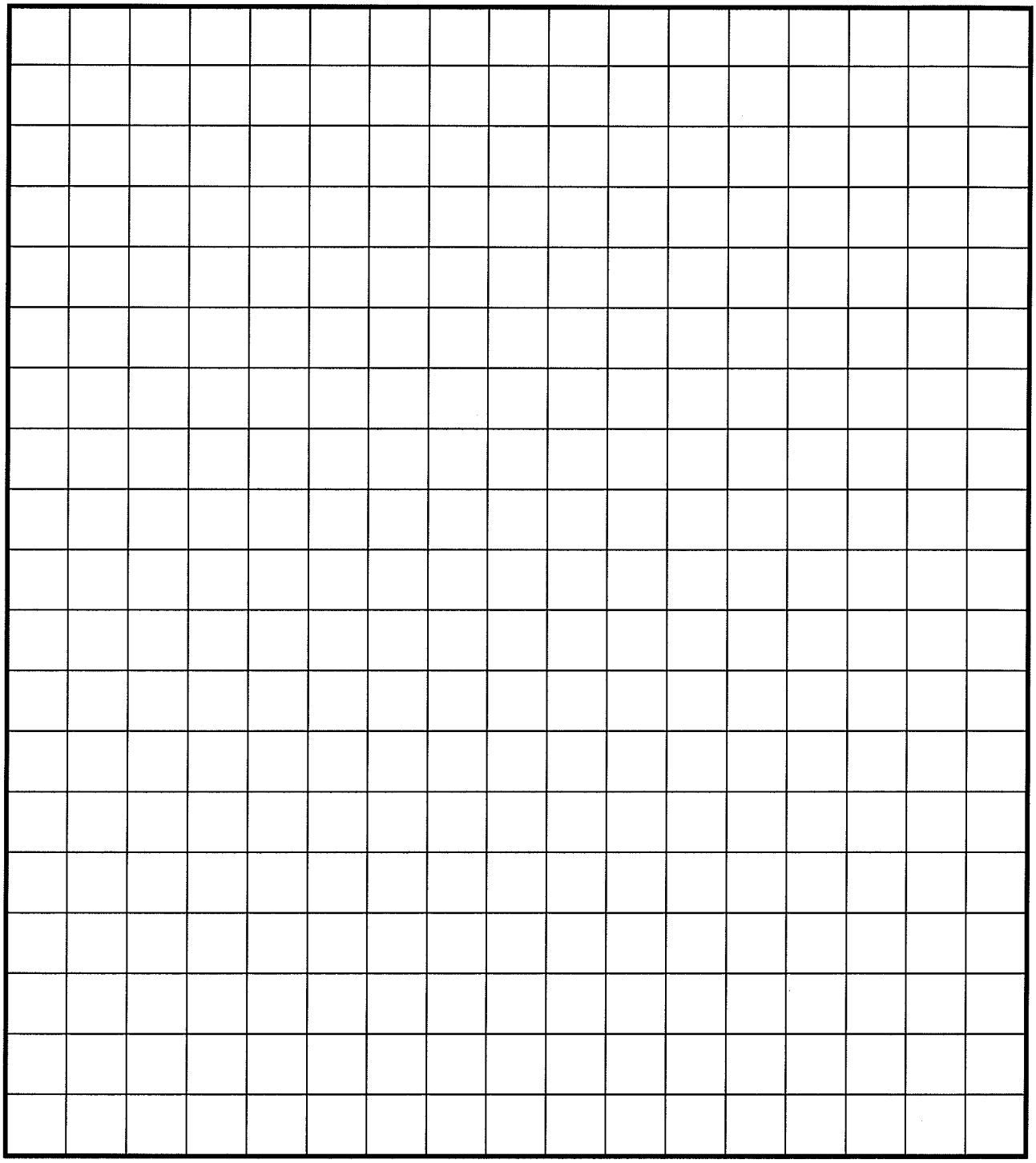
Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

VOLUME



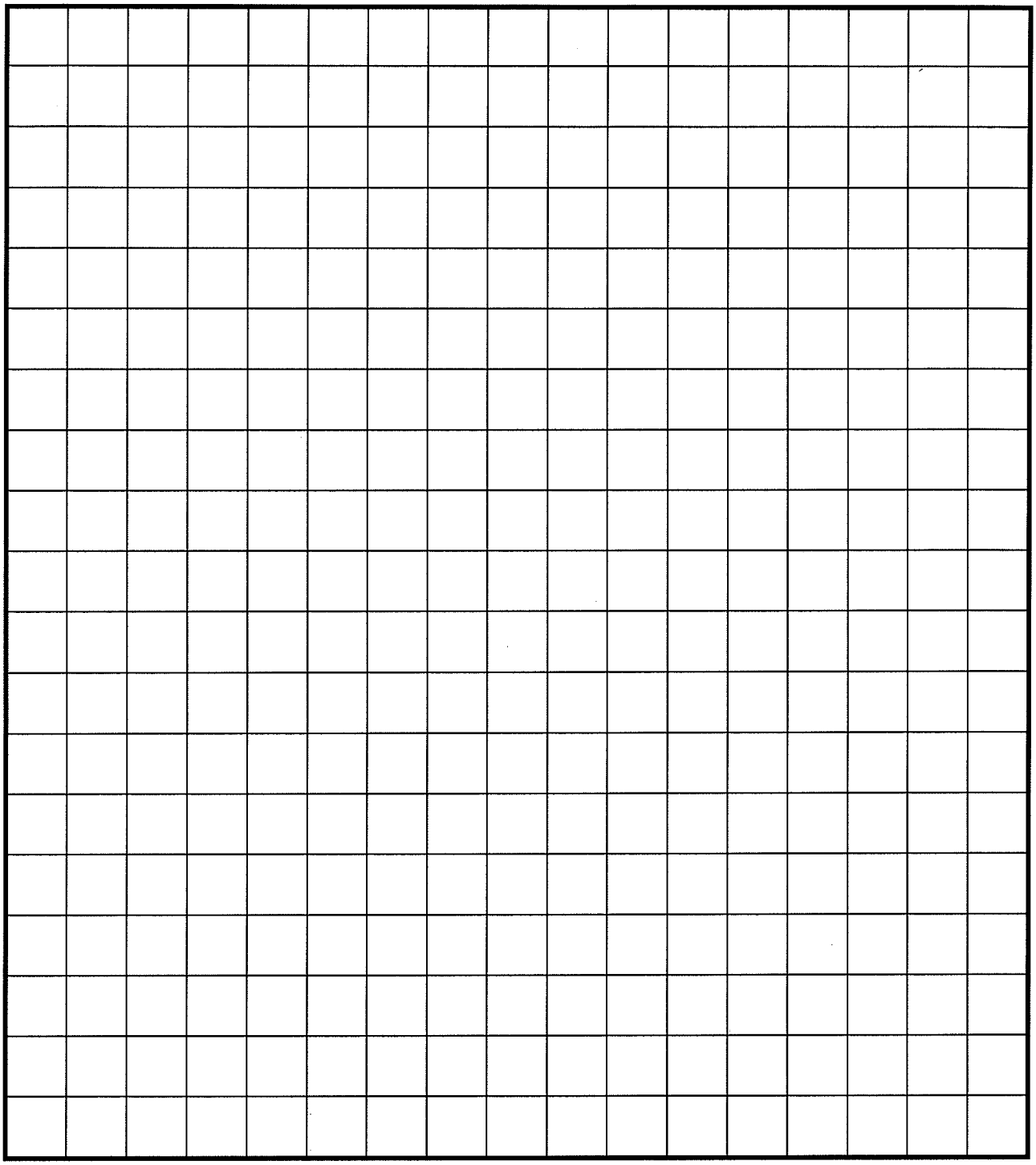
Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

MASS



Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

DENSITY



Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

Day interval	Day 0 – 1	Day 1 – 2	Day 2 – 3	Day 3 – 4	Day 4 - 5
Slope (with units)					

ASSESSMENT RUBRIC

Concept	Points Possible	Your Points
Lab:		
Collecting data for 5 days (including calculating density units must be included)	10	_____
Graph #1 (Areas traced on the same sheet for all 6 measurements)	5	_____
Graph #2 (Length/width/height)	10	_____
Graph #3 (Perimeter)	5	_____
Graph #4 (Area)	5	_____
Graph #5 (Volume)	5	_____
Graph #6 (Mass)	5	_____
Graph #7 (Density)	5	_____
Lab subtotal:	**50**	_____
Questions:		
1. Length, width, height, and perimeter discussion of slopes	5	_____
2. Rate of growth discussion	5	_____
3. Perimeter intercepts discussion	5	_____
4. Area discussion	5	_____
5. Mass discussion	5	_____
6. Volume discussion	5	_____
7. Metabolism discussion	5	_____
8. Density discussion	5	_____
9. Ratio calculations (actual calculations vs. theoretical calculations)	5	_____
10. Prediction for height, area, and volume	5	_____
TOTAL POINTS	100	_____

Turn in your data after Day 5

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
Length						
Width						
Height						
Perimeter						
Area						
Mass						
Volume						
Density