Experiment 1: Measurement of Variables

Units of Measurement

1. Obtain the balance apparatus (meter stick with holes, small cup with holes, hanger, paper clips, and small binder clip), and assemble it so that the meter stick is centered on the hanger.

2. If the meter stick doesn't balance, use the small binder clip to add weight to one side. Explain how you decide when the apparatus is "balanced."

3. Obtain two objects labeled "A" and "B", and either set of hanging masses (wing nuts or lock washers—these will be the "units" of mass for this lab, like grams or pounds).

4. Place paper clip "hangers" in the holes at or near the far ends of the meter stick, equally spaced. Hang OBJECT A from one of the clips. Place one type of unit mass (e.g., lock washers) on the other clip until it balances. What is the mass of OBJECT A in terms this unit of mass? (For instance, the mass of OBJECT A might be "10 lock washers") Note: You may use ½ units if it isn't clear which whole unit is closer.

OBJECT A: _____

5. Remove OBJECT A and replace it with OBJECT B. Use the same type of unit mass. What is the mass of OBJECT B?

OBJECT B: _____

6. Repeat step 4, but this time use the second type of unit mass. What is the mass of OBJECT A this time?

OBJECT A: _____

7. Based on the previous 3 measurements, see if you can calculate the mass of OBJECT B in term of this second type of unit mass. Describe or show your reasoning:

Hypothesis for mass of OBJECT B: _____

8. Now measure the mass of OBJECT B in terms of the second type of unit mass.

Actual mass of OBJECT B: _____

9. Compare your hypothetical and measured mass for OBJECT B. Were they close? Do you think the hypothesis is verified or refuted?

10. Add your data to the class data report.

11. Looking at the entire class data, compare the masses of A and B for both types of hanging masses. What can you conclude about the relative weights of A and B? Does the conclusion depend on the mass unit used?

12. Suppose another lab group has two different objects, C and D. Object C balances with 12 units on the other side of the balance, and object D balances with 15 units (of the same type).

    a. What can you say about the masses of C and D?

    b. What are the limitations in what you know about the masses of the objects?

Proportionality

1. Collect the following materials

graduated cylinder	eyedropper
aluminum and copper rods	paper towel
aluminum shot	balance
container of water	plastic cups

2. Prediction: The two metal rods are identical in size and shape, but they have different masses. If both are placed into the same amount of water in identical graduated cylinders, how will the resulting water levels compare?
    a. higher for the heavier metal cylinder
    b. higher for the lighter metal cylinder
    c. same level

3. Pour 50 milliliters of water in the graduated cylinder, then slide the aluminum cylinder into the water. What is its volume? Repeat for the copper cylinder. Check your answer in part 2.

4. Now measure the *mass* of the aluminum rod using the equipment from part one and the fact that 1 milliliter of water has a mass of 1 gram.

    Mass of cylinder_____ (in grams)

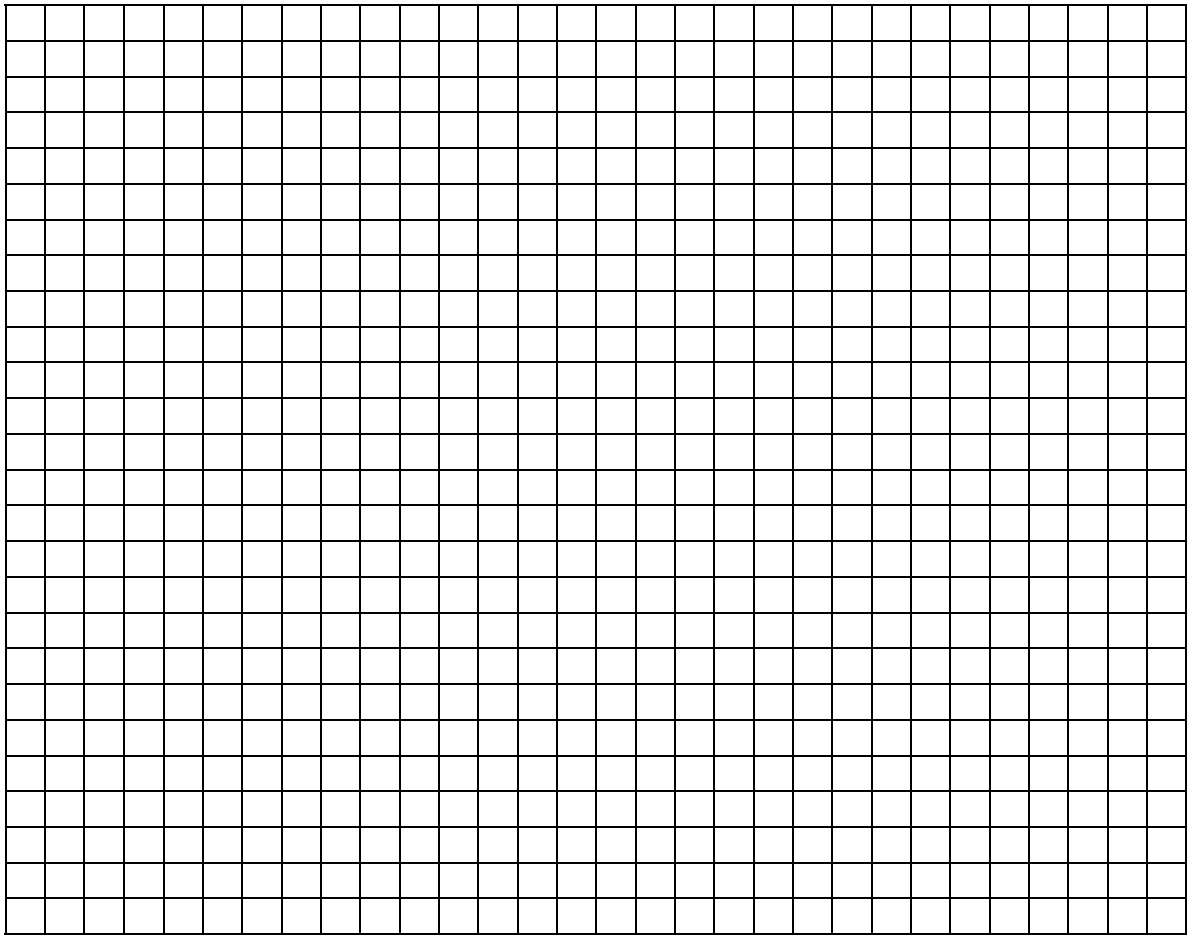
5. Measure out an equal mass of aluminum shot. Slide it into the water to find the volume.

   Mass of shot _____ Volume of shot _____

6. Select various amounts of the same shot material (very roughly, 1/4x, 1/2x, 1.5x, 2x, 2.5x or similar). Find 4-5 other masses and volumes for these samples of shot. (These data pairs will be used to make a graph).

Sample:	1	2	3	4	5
Mass:					
Volume:					

7. Make a graph of your data. Put mass on the horizontal axis and volume on the vertical axis. By logic, what volume corresponds to zero mass? Use this as another data point. Review the rules for graphing in the introductory section of the lab manual).



8. Are the volume and mass measurements proportional? Explain.

10. Describe the graph produced by two measurements that are proportional (Hint: it has *two* features):

    1. _____

    2. _____

11. Describe how you can tell whether two measurements are proportional without using a graph?

Experiment 1: Post-Lab Exercise

State your ideas as clearly as possible.

1. Which 2 of the following sets of numbers are proportional? Explain how you know.

Set 1	Set 2	Set 3	Set 4
4 16	4 2	10 15	4 8
5 20	9 3	6 9	6 10
7 28	25 5	4 6	8 12

2. Sometimes children are introduced to measurement of distance using units like "hands" or "book lengths" instead of standard units. Name an advantage and a disadvantage for this practice, and explain why you would or would not recommend it.

3. Imagine the following scenario:

   You have 2 identical containers.
   The first is filled exactly ½ -way with water.
   The other is filled exactly ½-way with sand.
   You pour the sand into the water.

   Prediction
   Is the container full? Explain.

4. The numbers below show the movement of a beetle crawling across a sidewalk.

distance (centimeters)	**time** (seconds)
0	0
6	2
12	4
15	5
27	9

a) Are the numbers proportional? _____

b) How do you know?

_____

c) Graph the beetle data. (Remember the tips for figures, from the lab manual p. 6-8.)