

# Density CER Activity – Teacher Instructions

Before class:

- Teacher will prepare solid blocks of wood, foam, or other materials that allow students to measure volume in terms of length, width, and height. (If you use wood, cut it small enough to use on your digital balance. I cut mine too large and the balance says ERROR. Oops!)
- Teacher will prepare irregular shaped objects, such as metal bolts, screws, turnings, etc. that allow students to measure volume in terms of final – initial displacement.
- Teacher will prepare various liquids that will allow students to measure total volume based on addition of more liquid.
- Teacher will supply students with digital balances, graduated cylinders, rulers, and either small beakers with pipettes or wash bottles with squirt spouts.
- Students should record 5 trials for each type of material.

During class:

- Write the following on the board:  $Slope = \frac{rise}{run} = \frac{y}{x}$      $Density = \frac{mass}{volume}$
- Explain that one equation relates to the other. So mass belongs on the y-axis and volume belongs on the x-axis.
- When you calculate the slope of the line you will be calculating the density of the material.
- Next write the following on the board: (See **Mass and Volume Data Tables** PDF to shine on board.)

## Solid Blocks

Dry Mass = grams

Volume =  $l \times w \times h = cm^3$

## Irregular Shapes

Dry Mass = grams

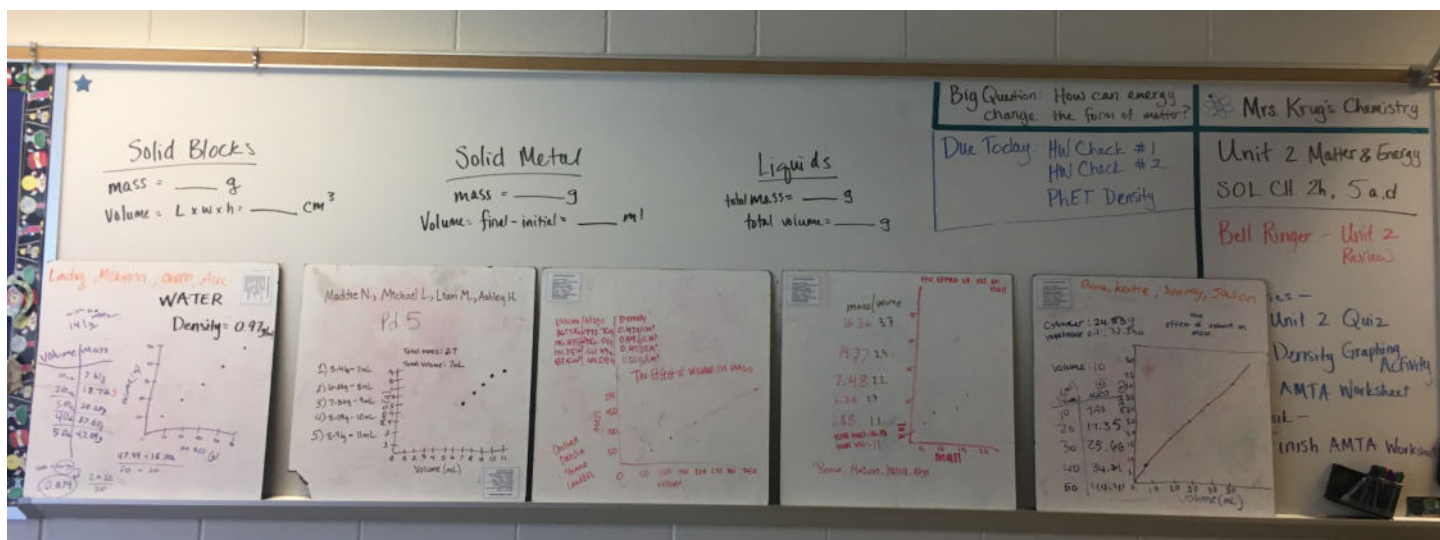
Volume = final – initial = ml

## Liquids

Total Mass = grams

Total Volume = ml

- Explain that students need to create a data table and graph on their white boards. Then they should calculate the density of their material and write it on the whiteboard. When students are done have them prop up their boards so that everyone can see the results. The image below is an example from one of my classes.



If assistance is needed...

- Explain that students should measure length, width, and height of solid blocks in centimeters.
- Explain that students should not add too much water or not enough water when doing displacement.
- Explain that total mass and total volume means to add some liquid, record current mass and volume, then to add more liquid and record the new mass and volume.
- Ask what units mass uses. (grams) Ask what units volume uses. (cm<sup>3</sup> or ml) Then ask what property of matter is measured using grams/cm<sup>3</sup> or grams/ml. (Density) To find density use the slope formula...
- $slope = \frac{y_2 - y_1}{x_2 - x_1}$  so  $Density = \frac{mass_2 - mass_1}{volume_2 - volume_1}$

CER Questions:

- What happened when the number of particles (mass) in their matter increased?
- What happened when the amount of space (volume) increased?
- Did the number of particles and amount of space increase at the same rate?
- Did it matter whether volume was measured in cm<sup>3</sup> or ml?
- What type of relationship exists when the trend aims upward?
- Can two objects have the same mass but different volume?
- Can two objects have the same volume but different mass?
- How will having more mass or more volume affect the density?
- Refer to the type of matter as the system. Ask if the type of system matters when determining density? Ask students to explain reasoning.
- Ask student what the density of water is. Many of them understand sink and float but not in relationship to the specific gravity.
- Notice the y-intercept for the liquid graph. If the students included the graduated cylinder's mass, their y-intercept will not cross at (0,0). Explain that the y-intercept occurs when X = 0. X=0 means there is NO Volume of liquid. If this is the case, ask how can there be \_\_\_\_\_ grams of matter when there is NO liquid?
- Draw a trend line to show density of water on each graph, then ask...
  - Which substances will sink? How do you know?
  - Which substances will float? How do you know?

Follow Up Assignments:

#### **AMTA Density, Mass, and Volume Worksheets - (do not post answer key online!!!)**

- College prep may need help getting started. Show how to do #1, #4 a, b, c, and #5 titanium.
- I deleted AMTA code off the bottom because students were using it to find answers online.

#### **PhET Density Simulation**

- Just make sure students have clicked on "My Box" and "Custom".
- May need to explain that volume of object is found by completely submerging object and recording volume by displacement.
- College Prep and Honors are both capable of following directions on the worksheet on their own.