LAB. MASS VS. VOLUME

AP PHYSICS II

Driving Question | Objective

How are mass and volume of singular materials related to each other?

Design and Conduct Your Experiment

It is your group's responsibility to design and conduct an experiment whose data will support your answer to the driving question above. Use the answers to the pre-lab questions below to help guide your experiment design. After you have answered the pre-lab questions, write an outline of the equipment setup and procedure you will use to collect data, identifying the steps in sequence and the points at which each piece of equipment will be used.

Suggested Materials and Equipment

Although you have the freedom to design your procedure using any reasonable equipment at your disposal, the following equipment is provided for your experimental setup. CIRCLE all equipment which you choose to use. The equipment which you select <u>must</u> be referenced during in your SETUP and/or PROCEDURE.

- Graduated Cylinder
- Moldable Clay
- Beaker
- Funnel
- Triple Beam Balance

Pre-Lab Questions

❷   1.   What kind of relationship do you believe mass will have with volume (linear, power, inverse, etc.)? Why do you believe this?

I believe that mass will have a linear relationship with volume. I believe this because by observing everyday objects, I have noticed that mass is linearly proportional to volume. I have not seen an object where increasing its mass would exponentially with volume, and I have not seen an object where its volume decreased as mass increased. Also, mass and volume can be related through the equation density = mass/ volume, which is a directly linear relationship between mass and volume,

❷   2.   How do you plan on measuring the volume of irregularly shaped clay?

I plan to measure the volume of irregularly shaped clay by measuring the volume of water displaced in a graduated cylinder after the object is placed in an initial volume of water. The final volume of water with the clay immersed in it minus the initial volume of water in the graduated cylinder is equal to the volume of the irregularly shaped clay.

❷   3.   It is always important to consider the origin (0,0) at the start of every experiment. Do you believe that this data point will be valid for the two provided variables of mass and volume? Why or why not?

Yes, because if we use a scale to weigh an object of zero volume (in other words, after placing nothing on a tarred scale), the scale will read a mass of zero grams.

Experimental Design

Your goal is to experimentally determine the relationships between the Mass and Volume of the clay. Use the responses to the pre-lab Questions to help finalize your procedure and your equipment configuration.

Once you are convinced that your procedure will accomplish the experiment's objectives, record your experimental setup and procedure in the following sections.

Setup

Draw and/or describe your experimental setup such that a third party could recreate the same setup in an attempt to reproduce your experiment.

Fill a graduated cylinder with 50 mL (0.00005 m^3) of water. Obtain a triple beam balance. Section off pieces of the moldable clay to create five balls of clay, each increasing in size. Make sure the largest clay ball is still smaller than the mouth of the graduated cylinder such that it can fit inside.
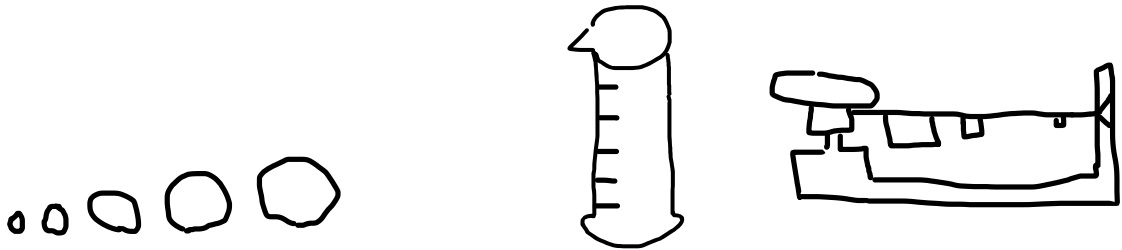
Procedure

Outline the procedure you will use in your experiment, listing all of the steps below. Your outline should be written such that a third party could follow the same procedure in an attempt to reproduce your experiment.

Record the mass of each of the clay balls by weighing each of them on the triple beam balance. Tilt the graduated cylinder filled with 50 mL (0.00005 m^3) of water at an angle and gently drop the smallest clay ball into the water. Subtract the final volume reading in the graduated cylinder from the initial volume reading of 50 mL (0.00005 m^3). Record this value, which is the volume of the clay ball. Repeat this process with each of the remaining balls.

Data and Graphical Analysis

Perform your experiment and record all relevant data. Present your data below in a form that best suits the experiment format (ex: data table), such that a third party can understand your experimental results in an attempt to reproduce them.

	x-variable	y-variable
Trial	Volume (m^3)	Mass(kg)
1	0.0000006	0.0004
2	0.0000009	0.0012
3	0.0000022	0.0029
4	0.0000024	0.0040
5	0.0000045	0.0069

mass vs. volume

$m = 1644.5V - 0.0004$
$R^2 = 0.986$

Mass (kg) vs. Volume (m^3)
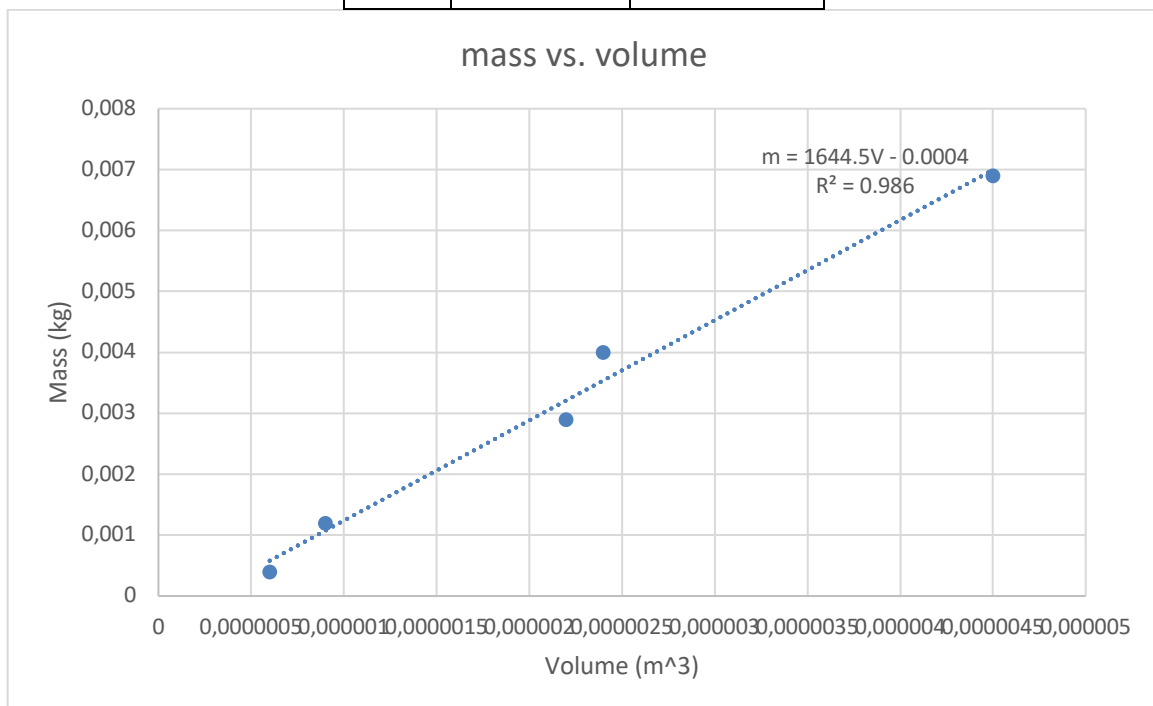
Screenshot in case graph does not load

You will need a screenshot of this completed graph for the Lab Quiz

Post-Lab Questions

❷ 1. Based on your data and graph. What type of relationship exists between Mass and Volume (linear, power, root, etc.)? Record the appropriate equation generated via your experiment as well as your r^2 value.

> The relationship between mass and volume is linear. The equation is m = 1644.5V + 4E-04, which shows that mass and volume are linearly proportional, and the r^2 value is 0.986.

❷ 2. Using the equation generated by <u>your data</u>, what would be the mass of a lump of clay which has a volume of 1 M³? Is this an interpolation or extrapolation of your data? Show the calculation.

> We can use our linear regression equation to predict what the mass of a lump would be if it had a volume of 1 M^3.
> m= 1644.5(1 M^3) + 0.0004
> m= 1644.5004 kg
>
> Since 1 M^3 is outside of our tested range of values, this would be an extrapolation of our data.

❷ 3. What were some sources of unpreventable error in your laboratory design? Do not use the phrase "human error," but rather indicate specific limitations which you can identify.

> The triple beam balance is only precise up to the tenth of a gram, so there are limitations on the accuracy of our mass readings. Similarly, we can only measure volume up to a certain precision because of the intervals on the graduated cylinder. Therefore, we cannot be sure that our readings were precise.

❷ 4. If you were able to perform this experiment again with no limitation of equipment, why type of equipment would you use to attempt to minimize error?

> A digital scale with great decimal precision would allow us to get more precise mass readings, and a more precise graduated cylinder would help us get more precise volume readings.

Please save this document as a PDF and submit. After submission, please complete the post-lab quiz.