1

Sample Lab

Mass vs. Volume (Density Lab)

Technically, DV comes first. But either order is accepted for credit. Give the lab either an IV/DV title or a common title.

2

Rubric #2 is not found in any particular place in the lab. The following are the requirements for #2:
-Lab must be in the correct order. Follow this form as a guide for the order.
-The lab must be neat, legible, and representative of an AP student.

3

Purpose: To determine the mathematical and graphical relationship between mass and volume.

4

IV: Volume (cm^3)

Units on IV and DV needed for full credit.

DV: Mass (g)

The purpose is always the same. Just make sure to use the correct variables at the end. Switching the order of "mathematical" and "graphical" is OK. Also switching the order of the variables is OK.

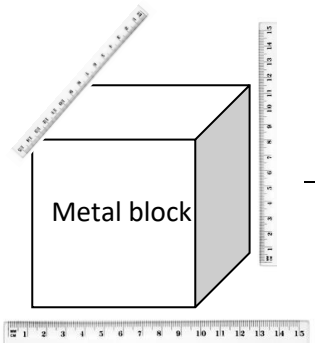
5

Equipment:
Ruler
6 Blocks
Triple beam balance

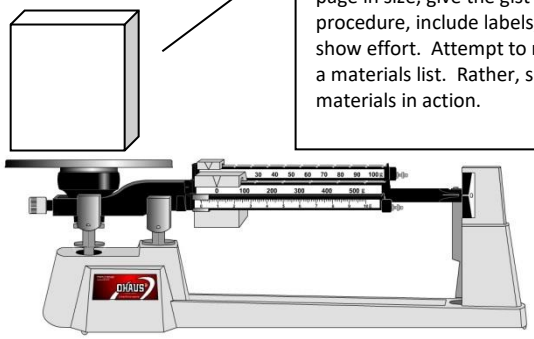
6

All equipment needed must be listed. Simple materials such as lab book, calculator, and pencil are not needed unless they played a special part in the lab. The equipment list and diagram can not be used for the same credit.

Diagram:



Volume: ruler



Mass: triple beam balance

The diagram must be at least 1/3 of a page in size, give the gist of the lab procedure, include labels, and must show effort. Attempt to not just draw a materials list. Rather, show the materials in action.

Procedure:

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- Measure length, width, and height of the iron block in centimeters with the ruler.
- Calculate the volume of the block in cm^3.
- Tare triple beam balance to zero.
- Place block on the triple beam balance and measure the mass in grams.
- Repeat steps 1-4 for three trials.
- Repeat steps 1-5 with the remaining five blocks.

The general rule for a procedure is that it could be passed to an educated stranger with no experience in the class and they could reproduce the entire lab from the procedures and diagram alone.

DO NOT include these in the procedures:
-Get materials
-Record data
-Do lab
-Make data table
-Do calculations
-Make graph
-Analyze data
-Clean up
-Any reference to the instructor

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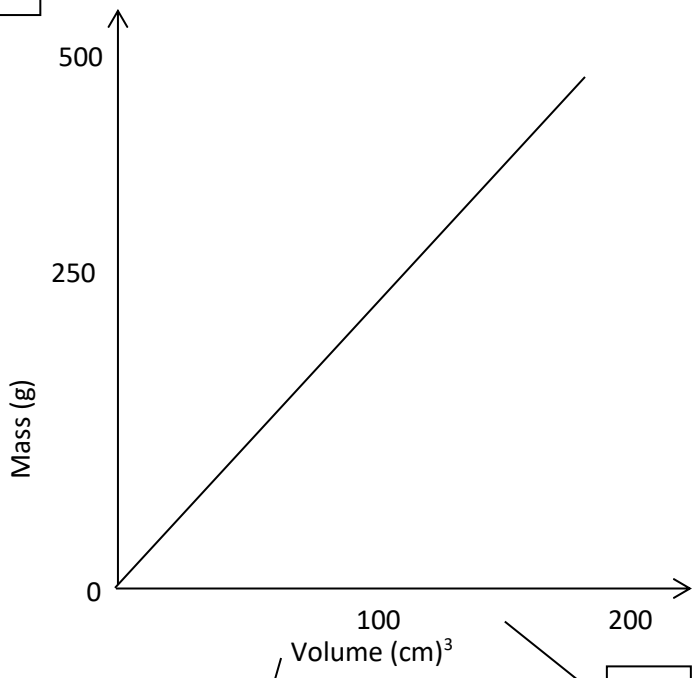

To obtain the best graph possible, make sure the largest value is at least 10-times greater than the smallest value. Otherwise, it can be difficult to determine if the line is curved or linear.

Graphs should be large enough to be clear and pronounced. Use common sense: a lab with one graph should be larger, a lab with 4 graphs should make them smaller to conserve space.

If your graph is incorrect, include a correct graph as well and note which is which.

Both axes must have correct labels, units, and incrementing.

9

This is copied from the square piece of paper with the written relationships. Fill in X and Y with your variables and units.

10

As volume increases, mass increases proportionally. Mass is directly proportional to volume.

11

As mass (g) increases by 2.316 (g), volume $(cm)^3$ increases by 1 $(cm)^3$.

The written relationship and the physical meaning of the slope must either be written on the graph sketch itself or on the page housing the graph sketch.

This number will always be "1" because the slope is always a value over 1.

<u>Additional graphs may be required</u>

under the following circumstances:

- Lab Extensions
- Multi-part Labs
- Linearized Graphs

Lab Notes

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Suggestions for lab notes is found in the lab notes examples guide

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General Equation

$$mass(g) = 2.32\frac{g}{(cm^3)} \cdot volume\ (cm^3) - 1.97(g)$$

$$m(g) = 2.32\ \frac{g}{(cm^3)} \cdot V(cm^3) - 1.97(g)$$

$$m(g) = 2.32\ \frac{g}{(cm^3)} \cdot V(cm^3) - 0\ (g)$$

$$m(g) = 2.32\ \frac{g}{(cm^3)} \cdot V(cm^3)$$

$$m(g) = Density\ \frac{g}{(cm^3)} \cdot V(cm^3)$$

$$m(g) = \rho\ \frac{g}{(cm^3)} \cdot V(cm^3)$$

$$m = \rho \cdot V$$

The general equation is the process of converting the equation from the graph into the general equation that can be found in any textbook.

These units are always the y-axis units over the x-axis units.

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Y-Intercept Explanation

The y-intercept should be zero because as the volume becomes infinitely small, there are fewer and fewer particles of matter.

The theoretical y-intercept is an open circle because once the volume equals zero the system ceases to exist.

The y-intercept explanation comes in 2 parts:

1) What should it be theoretically or what it represents.
2) Is it an open or closed circle

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Error Analysis

One error could be assuming the masses were perfect cubes when in fact they had rounded edges.

This error would cause the measured volumes to be larger than in actuality.

This would shift every point on the graph, giving a y-intercept under the actual value.

The error analysis comes in 3 parts:

1) Identify the error
2) Determine what will be effected
3) Explain how this will change the numeric result (slope or y-int.)

Most standard labs should run 4 pages in the lab book and one page of printouts.

Longer labs could result from:

1. Non-linear relationships
2. Lab extensions
3. Multiple-variables tested

Each title box needs a variable and a unit. Averages need a place on the table as well because they will be graphed later.

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Excel will produce a print-out of the data table. There must be labels and units in the headings. Units are not necessary for each value.

A minimum of 3 trials is required for all DV data.

Volume(cm^3)	Height(cm)	Width(cm)	Length(cm)	Mass (g) Trial 1	Mass (g) Trial 2	Mass (g) Trial 3	Average mass (g)
1.41	1.2	1.06	1.11	3.24	3.2	3.21	3.22
8	1.98	1.97	2.05	17.76	17.77	17.77	17.77
27.51	3.06	3.1	2.9	60.52	60.54	60.49	60.52
37.7	3.31	3.39	3.35	113	114	114.6	113.8
59.2	3.92	3.87	3.9	110.3	110.9	111.3	110.8
67.73	4.12	4.12	3.99	154.42	154.41	154.48	154.44
127.71	5	4.95	5.16	295.01	294.94	296	295.32
214.17	5.9	6.03	6.02	499.02	497.86	500.02	498.97

Each lab requires changing the IV a minimum of 8 times. The minimum is lowered if the student is not provided enough materials to change the IV 8 times.

Once you plot the points you must do a linear or a curve fit for the line.

The mathematical model of the line is **required** on the printout.

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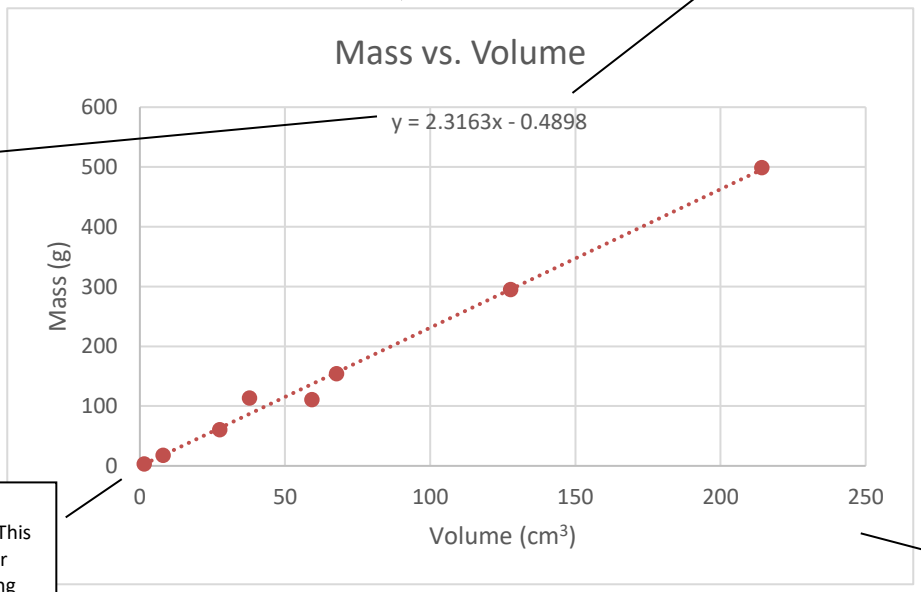

The graph must be scaled from zero. This prevents non-linear lines from appearing linear.

The y-axis increments do not have to be the same as the x-axis.