**MYSTERY LIQUID DENSITY LAB**          Names:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Per:\_\_\_

In this lab, you’re going to have some fun with density! You will collect data for the mass and volumes a liquid, and graph the results. You will then learn how that graph can help you make accurate predictions. But be very careful with your data collecting and your graph analysis: your grade is riding on it!

**liquid X**

 **volume mass**

 **(mL) (g)**

Procedure: Important: Use the same graduated cylinder throughout and the same scale.

1. Pour 15-20 mL of liquid X (red) into the small cup (between the lines). Then transfer this liquid into the graduated cylinder; record the precise volume in the table at right.

2. Weigh the cylinder and liquid on one of the scales at the front of the room.  Record this mass in the table at right.

3. Repeat steps 1 and 2 four more times, for a total of five volume & mass readings – each time adding more and more liquid to the cylinder.

4. When you have finished five trials, pour liquid X back into the bottle from which it came.

5. Recopy your data onto the spreadsheet on the computer, and save it to your own H:drive. It is set up to graph the data points for you. Then print out your graph (two copies, one for you, one for your partner) and use a ruler to carefully draw a best fit straight line for the five points. (Ignore any obvious outliers.) Extend

this line across the entire graph grid as shown at right and label it “liquid X”. Then use your

liquid X

best fit line to make the following predictions:

**A. Predict how much the empty graduated cylinder weighs:**

Within score

0.5 g = 5.0 pts

1.0 g = 4.5 pts

2.0 g = 4.0 pts

3.0 g = 3.5 pts

5.0 g = 3.0 pts

10 g = 2.0 pts

You tried 1.0 pt

Be as precise and accurate as you can. Your grade is based on how close your prediction is to the actual mass. (See scoring table at right.)

Once you have written down your prediction in the space above, dry out your graduated cylinder, and hand it (and this sheet) to your instructor, He/she will weigh it (on the same scale you have been using) and tell you your score.

**B. Predict how much the cylinder will weigh with 50.0 mL of liq X in it:**

Once you have written down your prediction in the space above, pour precisely 50.0 mL of liquid X into the cylinder – use a dropper if you want to make this very precise – and hand it (along with this sheet) to your instructor, He/she will weigh it and tell you your score.

**C. Predict what volume of liq X must be added to the cylinder to give a total mass of 125.00g:**

Add precisely this much liquid X to the cylinder – again using a dropper if you want – then hand it to your instructor, He/she will weigh it and tell you your score.

**liquid Y**

 **volume mass**

 **(mL) (g)**

6. Rinse out and dry out your cylinder, and now repeat steps 1-4 above, but this time use liquid Y (blue) instead of X. Record your data in the table at right. Plot these points (by hand) *on the same graph you used for liquid X*. Draw a separate best fit line for these data. Then answer the follow up questions below for homework.

**Follow-up Questions:**

1) How do the y-intercepts of the two lines compare? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2) Should the y-intercepts be the same? \_\_\_\_\_\_ Explain: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3) How do the slopes of the two lines compare? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4) Based on their slope comparison, which liquid is more dense? \_\_\_\_\_ How can you tell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (continued on the next page)

5) Now use your best fit lines to determine the precise densities of the two liquids. To do this, you must understand the mathematical definition of “slope.” Slope is defined as how much a line goes up divided by how far it goes over. This is sometimes called “rise over run,” and for a graph it is defined as the change in y-value divided by the change in x-value. Since our graph has mass plotted on the y-axis and volume plotted on the x-axis, the slope will be the change in mass divided by the change in volume. Mass divided by volume is density, so once you found the slope, you’ve found the density! And finding the slope of a line is actually very easy. Let’s start with the line for liquid X:

a) Pick any two points on the line for **liquid X**. Don’t use data points; just use any points on the best-fit line. Try to use points that are pretty far apart and which are easy to read.

b) Read the volume and mass for the higher point: Vhigher = \_\_\_\_\_\_\_\_\_ mhigher = \_\_\_\_\_\_\_\_\_

c) Read the volume and mass for the lower point: Vlower = \_\_\_\_\_\_\_\_\_ mlower = \_\_\_\_\_\_\_\_\_

d) Subtract the volumes (Vhigher - Vlower) = to get the change in volume: V = \_\_\_\_\_\_\_\_\_\_

e) Subtract the masses (mhigher - mlower) = to get the change in mass: m = \_\_\_\_\_\_\_\_\_\_

f) Divide: This is the slope of the line, and it is also the density of liquid X. m/V =

Repeat this calculation for liquid Y:

a) Pick any two points on the line for **liquid Y**. Don’t use your data points; just use any points on the best-fit line. Try to use points that are pretty far apart and which are easy to read.

b) Read the volume and mass for the higher point: Vhigher = \_\_\_\_\_\_\_\_\_ mhigher = \_\_\_\_\_\_\_\_\_

c) Read the volume and mass for the lower point: Vlower = \_\_\_\_\_\_\_\_\_ mlower = \_\_\_\_\_\_\_\_\_

d) Subtract the volumes (Vhigher - Vlower) = to get the change in volume: V = \_\_\_\_\_\_\_\_\_\_

e) Subtract the masses (mhigher - mlower) = to get the change in mass: m = \_\_\_\_\_\_\_\_\_\_

f) Divide: This is the slope of the line, and it is also the density of liquid Y. m/V =

Note: If you go back and open the spreadsheet file you saved on your H-drive, you can right click on one of the plotted data points, then click on “Add Trendline,” then click on “Options,” then check the box next to “Display Equation on Chart,” then click “OK.” This will give you the equation for the best fit line that the computer calculated. It is in the format y = mx + b. The “m” is the slope (the density) and the “b” is the y-intercept (the mass of the empty graduated cylinder). How do these two values compare to the ones you determined above?

**Mass as a function of volume for liquids P & Q**

**70**

**60**

**50**

**40**

**30**

**20**

**10**

**0**

**0**

**10**

**20**

**30**

**40**

**50**

**60**

**volume (mL)**

**mass (g)**

Joey repeated the experiment using two other liquids,

P & Q, and plotted the data at right: P = Q = Draw in best- fit lines (ignoring outliers) for the two data sets. Then answer the following questions:

6) What would be the mass of 43.0 mL of liquid P (together with the cylinder)? \_\_\_\_\_\_\_\_

7) What volume of liquid Q would (together with the cylinder) have a mass of 44.0g? \_\_\_\_\_\_\_\_\_

8) The data indicate that Joey didn’t quite follow all the directions. Can you figure out what mistake Joey made?

9) In spite of his mistake, the data Joey collected will still give accurate results for the densities of P and Q.

Even still, Joey is a little distraught, so can you please help by doing these calculations for him?

Density of P = =

Density of Q = =

Joey thanks you! (continued on the next page)

Plot the following data on the graph below; you will need to increment and label the axes yourself. Then draw a best fit line (ignoring any outliers) and use it to answer the questions below:

 Volume of mass of liquid Z

Liquid Z (mL) & cylinder (g)

 17.5 52.73

 33.7 74.60

 52.1 99.43

 71.1 116.72

 86.4 145.78

10) First give a title to your graph.

11) Which data line at right must have been read incorrectly? (Circle it).

12) Using the best fit line, what is the mass of the empty cylinder? \_\_\_\_\_\_\_\_\_\_

13) What volume of liquid Z must be added to the cylinder to give a total mass of 85.0 g? \_\_\_\_\_\_\_\_\_\_\_

14) What is the density of liquid Z? \_\_\_\_\_\_\_\_\_\_ Show work:

15) Liquid J is precisely half as dense as liquid Z. Draw in (and label) a line for liquid J on the graph below (assume the same cylinder was used).