# Mass and Volume Lab Report

## How to write the lab report.

## The report must be **typed**.

## Avoid using personal pronouns such as I, he, she, we.

## Avoid using the phrase “in this experiment.”

## Proof read your report and correct spelling and grammar mistakes.

# **Title Page**

## The title page must contain:

## the title of the experiment,

## your name,

## the date,

## period number,

* lab group color

## and names of your lab partners.

## .

# **Introduction and Background**

## **State the purpose of the experiment (what you hope to accomplish)**

### **The purpose of this experiment is to determine the density of an unknown metal. The precision and accuracy of the results will also be determined.**

## **State the background, theory and formulas**

## **Density is an import property of substances that have uniform composition.**

## **A substance can be identified by its density because density is a characteristic physical property matter.**

* **The ratio of mass to volume of a substance is defined as density.**

## **Density can be determined by measuring the mass and volume of a substance.**



### **Density is calculated as follows:**

### **where D = density, m=mass, and V = volume**

## **State the hypothesis, variables and calculated quantity.**

### **If the mass of a substance can be determined then the volume can be determined and the density of the substance can be calculated and the substance can be identified.**

### **The independent variable is \_\_\_\_\_\_\_\_\_\_\_\_.**

### **The dependent variable is \_\_\_\_\_\_\_\_\_\_\_\_\_.**

### **The calculated quantity is \_\_\_\_\_\_\_\_\_\_\_\_\_.**

## **Give a brief overview of the experiment:**

### **The mass and volume of three metal samples will be measured.**

### **Mass is measured directly \_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

### **The volume of an irregularly shaped solid can be determined by \_\_\_\_\_\_\_\_\_\_\_\_\_.**

# **Methods**

## This section contains the procedure and lists the important materials used.

## Explain how you studied the problem or performed the experiment.

### **Three samples of an unknown metal were massed. The volume of these samples was determined by water displacement using a \_\_\_ mL graduated cylinder for the \_\_\_ metal and a \_\_\_ mL graduated cylinder for the \_\_\_ metal. The identity of the unknown metal was identified by comparing the experimentally determined value of density to the table of known densities in the lab handout.**

## Explain how you studied the problem or performed the experiment. You should include enough detail so most high school student could repeat your experiment

# **Data and Results**

## The following items are in this section:

## Data tables

## You use the table attached to the end of this document and it must be completely filled in. In addition to the mass of the sample, the volume of the sample and the density of the sample you must include

* Deviation
* Percent deviation
* Average experimental value of Density
* Average deviation (mean deviation)
* Average percent deviation (Mean Percent Deviation)
* Numbers are neatly ‘lined up”
* ***Below the data table show the class average density for each of your two metals***

## Graphs (you must use a printed graph like the one we did in Excel) and include the following:

1. x axis is labeled with the name of the IV found in the data table.
2. y axis is labeled with the name of the **DV** found in the data table.
3. Title: The effect of \_\_\_\_\_ (the IV) \_\_\_\_\_\_\_\_ on \_\_\_\_ (the DV) \_\_\_\_\_ or Mass vs. Volume.
4. Scale the axes (numbers)
5. Show the origin
6. Plot both sets of points on the same graph
7. Draw a best fit lines (trend line) for both metals on one graph
8. Include the linear equation of each line (y = mx +b)
9. Include the R2 value
10. Show the 5% test calculation and if you y-intercept is equal to or less that 5% of the maximum y value (mass) then state that your y intercept is negligible and should be considered zero: rewrite the equation excluding the value of ‘b’.
    1. If your value of b is > 5% max y, try 10% test instead of the 5% test.

## Any observations relevant to the conclusions of the experiment should be described as well.

## .

* If you include a revised data table, you must include your original “unrevised” data table.
* Explain in the results section why you revised the calculations in your revised data table.
* Explain that you suspected that one or two of your values were in error because it had a large % experimental error, or large % deviation or a value had a large variation. State which values are erroneous and the numeric value of the error or deviation.
* Explain that for the purposes of this investigation, density values with percent deviation values and or percent error values greater than 20% should be considered potential outliers.

## **It was suspected that the density value of 12.18 g/mL was an error because it had a 200 % deviation and a percent error of 138%. For the purposes of this investigation, density values with % deviation greater than 20% and percent errors greater or equal to 20%. This value is outside the acceptable margin of error for this investigation. This value is causing the percent range to be above an acceptable value of precision. The experimental values were recalculated eliminating this unreliable data.**

* Include any observations that may have caused errors or bad date such as some of the water splashed out of the graduated cylinder when you added the metal, or you the meniscus rose up beyond the highest reading on the cylinder or your group read the scale or the graduated cylinder incorrectly, or you recoded the data incorrectly, or whatever errors you think your lab group committed.
* I will give you an F if you use whiteout or pencil in any data table or graph.

# Conclusion

# **This is the section of the report in which you discuss the results and conclusions that can be drawn from the experimental data that you have collected, and also how well the data support those conclusions.**

# **Restate the purpose of the study. You can copy the purpose form the lab handout.**

# **The conclusion is a response to the purpose of the experiment.**

# **State the major findings of the experiment.**

# **If the purpose is to determine density, the ID of the metal, the precision and accuracy of the data then each of these are the major findings.**

# **Explain how the data supports your findings.**

# **Focus on interpretation of the results.**

* **Analyze the experimental errors**
* **Suggest improvements to the experiment.**

# **Post-lab questions sub-section**

## Answer the post-lab questions at the beginning of the conclusion.

## Write & answer all 6 of the lab questions.

## **Show one sample calculation for density** as part of your question 1 answer.

## **Show the calculation for percent error** as your answer for question 3 using **your average density** from your data table and **the accepted value of your metal.**

## **Show the calculation for percent range** as your answer for question 6. Use the density data from your samples in your data table in your calculation.

## Your answer must agree with the “**Percent Range of Density Data”** result in your data table.

**Conclusion sub-section**

* Restate the purpose of the experiment.
  + **The purpose of this experiment is to determine the density of an unknown metal. The precision and accuracy of the results will also be determined.**
* **State: For the purposes of this investigation data is considered precise if the Percent Range of Density Data is less than or equal to 10% and the results are considered accurate if the percent error is less than or equal to 10%.**

# **State the Conclusion:**

## Report the density of the metal and identify the metal and state how you arrived at these conclusions (justify your conclusions).

### **Example: It was experimental determined that the density of the unknown metal was 14.1 g/cm3. Because the data was accurate and within the range of being precise, the identity of the unknown metal could be determined by comparing the experimentally determined value of density to the values provided in the Mass and Volume lab handout. The identity of unknown metal was determined to be gold.**

* Note: if you are a little bit above 10 % ( no more that 2% above 10%) say your values are **reasonably accurate (or precise) because the data is \_\_\_\_% above 10% accurate (or precise).**
* State if your data was or was not precise.

## State the percent experimental error.

## State if your average density was or was not accurate.

* State that:
* **To test the reliability of the data that “we” are using the class average for density of the \_\_\_ (gold or red) metal and silver metal because these average include 90 trials ( 3 trials each x 30 lab groups).**

## **State if the hypothesis is consistent with your experimental results and whether or not the data supports the hypothesis and exactly what data supports or does not support the hypothesis.**

## **Example:**

### **The mass and volume of the metal sample were determined as shown in the Table of Results. The density was calculated and the average density was determined also shown in the Table of Results. Because the mass and volume of the metal samples were determined and the average density of the metal was calculated the hypothesis that density can be determined from mass and volume data is reliable.**

* **State additional proof that your data is reliable:**
* **Our y-intercept is negligible because b > 5% of the y maximum value. This is important because zero mL of metal has a mass of zero grams. Having a negligible or zero value of b is evidence of reliable results. ( If your value of b is not < or = to 5% of max y, you may say your y-intercept is reasonably negligible if b < 10% of max y.)**
* **Our trend line slope on the graph has an R2  value > \_\_\_\_\_ and thus our trend line is reliable.**
* **Our slope on our graph and our experimental average density are in reasonable agreement (the values are close).**
* **We have small deviations of \_\_\_\_\_ . Our average % deviation was \_\_\_\_\_\_% showing our data was percise**
* You can state that
* **The three trials your group did were not enough trials to provide reliable data, however the combined trials that the class did were enough trials to provide reliable results.**

## If you cannot support the hypothesis you must state that this is because your data is not reliable due to errors and you must explain what these errors are. Unless you do the experiment multiple times, you cannot reject the hypothesis based on your three trials.

## ***If yo***u have a **percent error** over 12% your average density is not accurate or reasonably accurate and you need to speculate about what went wrong (what errors occurred).

## If your percent range is over 10% you need to explain why your data is not precise (hint: errors).

## If one of your values shows a large percent deviation, disregard that value and recalculate the average of the” good” values and state the following:

## **Our group excluded the density value of \_\_\_\_ from the average because we suspected that one of our density values was an error because it had a \_\_(blank)\_\_ percent deviation (you determine “blank”).**

## Any density value that has a percent deviation > 20% is to be suspected as erroneous data and not reliable.

## Any density value that has a percent experimental error > 20% is to be suspected as erroneous data and not reliable.

## Erroneous = incorrect, based on an incorrect assumption, or containing something that is incorrect.

## **Or some other problem such as the volume decreased as the mass increased.**

## Discuss how any errors (such as reading the graduated cylinder incorrectly) may have affected the outcome of your experiment.

## Explain how you could improve your results or improve the experiment.

* The following must be included in you report

1. What new learning took place?

**We learned \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_ ………**

1. Why is this new learning important?

**\_\_\_\_\_\_\_\_\_\_ is important because\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

1. How could you improve the experiment? How could you prevent the errors if you did the experiment again
2. What further investigations could be done?

**Deferent methods or measuring tools could be investigated that would provide more precise or accurate results. This is important because the use of the graduated cylinders introduces a large degree of uncertainty in the measurements and causes errors in correctly determining the volume of the unknown metal.**

**Examples of Sample Calculations**

# **Percent range calculation:**



* **Percent experimental error calculation:**



**The accepted value is your experimentally determined average density (not the class average) from your data table**

**The accepted value is the density value provided on page two of the lab handout**

**found under “lab questions”**

* **Deviation**

**The formula is : d = x –**



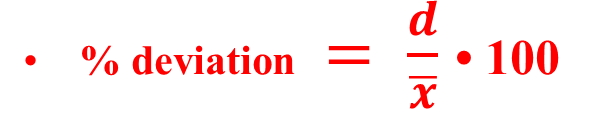
**Where x = the experimental value of density & is the class average value.**



**Example:**

**d = |1.55 – 2.87| = 1.32**

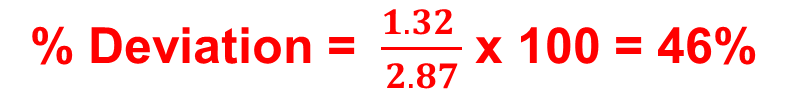
* **Percent Deviation Calculation:**



**where d = the deviation, = the average value**



**Example:**



* **Density calculation:**



Mass and Volume Lab Data Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample | Mass of Sample,  (g) | Volume of sample, (mL) | Density(g/mL) | Deviation | Percent Deviation |
| **Red or Gold 1** |  |  |  |  |  |
| **Red or Gold 2** |  |  |  |  |  |
| **Red or Gold 3** |  |  |  |  |  |
| **AVERAGE:** |  |  |  |  |  |
| Silver 1 |  |  |  |  |  |
| silver 2 |  |  |  |  |  |
| silver 3 |  |  |  |  |  |
| **AVERAGE:** |  |  |  |  |  |

**Class average Densities:** **Red: 8.83 g/mL Gold: 8.62 g/mL**

**Silver: 2.87 g/mL**