**Density of Pennies Lab**

* **Question:** How are valid measurements made in science?
* **Introduction:** Today’s penny is quite different from the penny of three decades ago. Before 1982, pennies were made of an alloy (solid mixture with at least one component being a metal) of copper. Since then, they have been made with an outside coating of copper and an inner core of a different metal. These differences in composition of older and more recently minted pennies have resulted in differences in the pennies properties. One of these differences is the density, which is the mass per unit volume (usually in g/mL or g/cm3). **We are going to use the property density to identify the metal inside the pennies.**

**slope** *n.* **4.** *Mathematics.* **a.** The rate at which an ordinate of a point of a line on a coordinate plane changes with respect to a change in the abscissa. **b.** Rise over run

**density** *n.*, *pl.* **densities**. **b.** The mass per unit volume of a substance under specified conditions of pressure and temperature.

* **Safety:** Be careful when working with electrical equipment around water so that you do not get shocked. Goggles are required.

**Data Table #1 – Pre-1982 (older) Pennies**

*(Copy into your lab notebook before lab day.)*

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Pennies | Mass of Pennies (g) | Total Volume in Cylinder (mL) | Net Volume of Pennies (cm3) |
| 0 | 0.00 | 30.0 | 0.0 |
| 5 |  |  |  |
| 10 |  |  |  |
| 15 |  |  |  |
| 20 |  |  |  |
| 25 |  |  |  |
| 30 |  |  |  |
| 35 |  |  |  |
| 40 |  |  |  |
| 45 |  |  |  |
| 50 |  |  |  |

**Data Table #2 – Post-1982 (newer) Pennies**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Pennies | Mass of Pennies (g) | Total Volume in Cylinder (mL) | Net Volume of Pennies (cm3) |
| 0 | 0.00 | 30.0 | 0.0 |
| 5 |  |  |  |
| 10 |  |  |  |
| 15 |  |  |  |
| 20 |  |  |  |
| 25 |  |  |  |
| 30 |  |  |  |
| 35 |  |  |  |
| 40 |  |  |  |
| 45 |  |  |  |
| 50 |  |  |  |

 *(Copy into your lab notebook before lab day.)*

* **Procedures:** (* each of the steps as you complete them.)*

*Day 1: Pre-1982 Pennies*

* 1. Find the mass of 5 dry pennies. (They must be dry!). Record the mass in the data table of your lab notebook.
* 2. Add 5 more pennies to the first group. Record the mass of these 10 pennies.
* 3. Repeat step 2, each time adding 5 more pennies to those already on the balance, until you have used all 50 pennies. Be sure to record all data.
* 4. Fill the graduated cylinder to **exactly 30.0 mL** with water. Make sure you read the water level at the bottom of the meniscus at eye level.
* 5. Still working with the same set of 50 pennies, hold your graduated cylinder on an angle to avoid splashing, gently drop 5 of the pennies (one at a time) into the graduated cylinder. Record the new water level in the second column of your table.
* 6. Fill in the last column – net volume of the pennies - by subtracting the initial volume (30.0 mL) from the total volume.
* 7. Add 5 more pennies to the graduated cylinder, making a total of 10 pennies. Record the new level. Find the net volume of 10 pennies, by subtracting 30.0 mL.
* 8. Repeat step 7 for 15, 20, 25, 30, 35, 40, 45 and 50 pennies. Record the total water level each time and then subtract 30.0 mL for net volume.
* 9. Discard the water. Dry the pennies with a paper towel thoroughly and return to the container.

*Day 2: Post-1982 Pennies*

* 10. Repeat steps 1-9 using 50 post-1982 pennies. And record your data in the correct data table on the right. Make sure the pennies are dry when you measure the mass. Again, **please dry** the pennies with paper towels before returning.
* **Calculations:**

**GRAPH** - Make a graph by plotting the penny volume (x-axis) and penny mass (y-axis) of the Pre-1982 pennies data set. After you have plotted your points, draw a “best fit” straight line through each set of data.

Repeat for the data set of Post-1982 pennies, but use a different color for this line. (You will have two lines on one graph.)

1. **SLOPE** From the graph, determine the **slope** of each line of your graph. The slope will be equal to the density.



|  |  |  |
| --- | --- | --- |
| Element | Atomic Symbol | Density (g/cm3) |
| Aluminum  | Al | 2.70 |
| Copper | Cu | 8.96 |
| Iron | Fe | 7.86 |
| Lead | Pb | 11.34 |
| Magnesium | Mg | 1.74 |
| Nickel | Ni | 8.90 |
| Titanium | Ti | 4.50 |
| Zinc | Zn | 7.14 |
| Zirconium | Zr | 6.49 |

* **Conclusion:** The slope of your post-1982 pennies line should give you the identity of the metal that makes up most of the mass. Compare your value to the chart below and identify the metal in these pennies.

*“By comparing the experimental density of the post-1982 pennies with the accepted value of various metals given in the chart, it was determined that these pennies are mostly \_\_\_\_\_\_\_\_\_\_\_\_\_.”*

EXTRA CREDIT: Calculate your percent error for the pre-1982 pennies. The pre-1982 pennies are almost pure solid copper. Find the accepted value of the density of copper on the above chart. Your experimental value is the slope of your line.