**Atomic Thickness of Aluminum Foil (Honors)**

* **Question:** What are the postulates of Atomic Theory?
* **Introduction:** In science, we make use of large and small numbers much of the time. In addition, we must often make use of one set of measurements and known properties (such as density) to indirectly measure other quantities. One example of this type of “measurement” will be found in this experiment. The laboratory tools normally available would not be suitable for the direct measurement of the thickness of a piece of aluminum foil.

 In this activity, you will determine the number of aluminum atoms that give aluminum foil its thickness or “height.” First, you need to determine the density of aluminum. You will determine this using aluminum pellets. Because density is a physical property of aluminum, both the pellets and the foil have the same density. Next, you will determine the height of the foil by rearranging the equation for the volume of a cube, V = l x w x h, to solve for height (h). This equation is **h = V ÷ (l x w)** or **h = V ÷ area**. The volume (V) of the foil is obtained by rearranging the equation for density, D = m ÷ V. This rearranged equation is **V = m ÷D**. Once the height of the foil is calculated, you will divide it by 0.0000000286, which is the height of one aluminum atom. Your answer is the number of atoms held between your fingers when you are holding a piece of aluminum foil.

* **Safety:** Be careful with all electrical equipment so that you do not get shocked.

**Data Table**

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

|  |  |
| --- | --- |
| Mass of tray & Al pellets (g) |  |
| Initial volume (mL) |  |
| Final volume (mL) |  |
| Mass of empty tray (g) |  |
| Foil square sides (cm) |  |
| Foil square mass (g) |  |

* **Procedure:** *(*✓ *each of the steps as you complete them.)*
* 1. Obtain a tray of aluminum pellets. Measure and record the mass of the tray plus the pellets.
* 2. Fill a 50-mL graduated cylinder about half full of tap water. Measure and record as the initial volume.
* 3. Carefully transfer all of the aluminum pellets to the graduated cylinder. Gently shake the graduated cylinder to dislodge any air bubbles. Measure and record the volume as the final volume.
* 4. Measure and record the mass of the empty tray.
* 5. Place a folded piece of paper towel in the bottom of the tray. Sieve out the aluminum pellets over the sink. Place the aluminum pellets atop the paper towel.
* 6. On the sheet of aluminum foil and using a metric ruler, measure out a square of any size with at least 10.0 cm sides. (Hint: Use a sheet of paper as a template for the 90° angles.)
* 7. Ensure you have a square by measuring and comparing the two diagonals of the square.
* 8. Place the foil square on the balance to determine its mass. (If the foil extends beyond the pan, ensure that the foil is not touching anything else but the pan. You may fold the foil square to fit the pan if needed. This will not affect the mass.) Record the mass.
* **Calculations:**
1. **Mass of aluminum pellets**

 Subtract the mass of the empty tray from the mass of the tray and Al pellets.

 *Mass = mass of the tray and Al pellets – mass of the tray*

1. **Volume of aluminum pellets**

 Subtract the initial volume from the final volume.

 *Volume = final volume – initial volume*

1. **Density of aluminum**

 Divide the mass of the pellets by the volume of the pellets

 *Density = mass / volume*

1. **Volume for the square of aluminum foil.**

Divide the mass of the aluminum foil square by the density you just calculated.

*Volume = mass / density*

1. **Area for the square of aluminum foil.**

Multiply the length times the width.

*Area = length x width*

1. **Thickness (height) of the square of aluminum foil.**

Divide the volume by the area

*Thickness = volume / area*

1. Convert the thickness of aluminum foil in cm to **thickness of aluminum foil in number of atoms of aluminum**. 1 aluminum atom = 2.86 x 10-7 cm
* **Conclusion:** “The thickness of heavy-duty aluminum foil is \_\_\_\_\_\_\_\_\_\_\_\_ atoms thick.”

EXTRA CREDIT: Calculate your **percentage error** for your average estimate of the thickness of the foil in cm. The accepted value for heavy duty aluminum foil is 0.00238 cm.