The Thickness of a Thin Aluminum Sheet

EXPERIMENT 3A

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.

The formulas that will enable you to find the thickness of the foil are familiar to you. The *volume* of a regular object is found by using the formula $V = L \times W \times H$, where L = length, W = width, and H = height. Imagine that the regular object is a rectangular-shaped piece of foil. Then the formula might be revised to $V = L \times W \times T$, where T = thickness of the foil. Going one step further, the area of the foil can be expressed as $A = L \times W$, so the original formula for volume can be restated as $V = A \times T$. Since this experiment involves finding the thickness, it would be better to rearrange the formula once again. Dividing both sides of the equation by A, we get the new equation: $T = V/A$.

The next problem will be to find the volume and area of a piece of aluminum foil. Remember that *density* is a property that is expressed as $D = m/V$. The density of aluminum is known, and the mass of a piece of aluminum foil can be measured with a balance. The volume of the aluminum can then be calculated by using the rearranged equation: $V = m/D$.

Even thinner than aluminum foil is the hard layer of aluminum oxide that forms on the surface of aluminum exposed to the air. This tenacious coating prevents further corrosion and can be given a constant thickness and a variety of bright colors in a commercial plating process known as *anodizing*.

OBJECTIVES

1. to correctly apply the principles of significant figures in calculating the thickness of aluminum foil
2. to correctly use exponential notation in expressing the results of the thickness calculation

MATERIALS

several rectangular pieces of aluminum foil
centimetre ruler
centigram balance

PROCEDURE

1. Cut four rectangular pieces of aluminum foil. Be sure that the dimensions are at least 10 cm on each side. If samples of more than one type of foil (heavy duty and regular) are available, get two pieces of each type.
2. Using a centimetre ruler, carefully measure the length and width of each piece of foil. Record the measurements in Table 1. How precise can your measurements be? Think carefully before you record your results.

3. Using a balance, find the mass of each piece of aluminum foil. Record the masses in Table 1. Again, be careful to be as precise as possible. Ask your instructor if you are unsure of the precision to which your balance can be read.

REAGENT DISPOSAL

Place the used aluminum foil in the wastepaper basket.

POST LAB DISCUSSION

Accuracy is the closeness of an experimental value to an accepted value. For example, if you were measuring the length of a 100 m track, the accepted value would be 100 m. If your measurement was close to 100.0 m, then your measurement would be considered to be accurate. Precision is the closeness of your repeated measurements to each other. Using the same example, if you measured the track three times and each time found the length to be 98.6 m, your measurements would be precise, but not accurate.

In this experiment, the accepted values for the thickness might be available on the aluminum foil packages, or your instructor might have determined what (s)he believes are the accepted values. The closeness to these accepted values will determine the accuracy of your measurements. If you do two or three trials with the same type of aluminum foil, you can determine the precision of your measurements.

Exponential notation is used in the calculations because of the magnitude of the thickness measurements. Whenever very large or very small numbers are encountered in scientific work, it is best to express those numbers in exponential notation.

DATA AND OBSERVATIONS

Table 1

SHEET NO.	TYPE	LENGTH (cm)	WIDTH (cm)	MASS (g)
1				
2				
3				
4				

COMPLETE IN YOUR NOTEBOOK

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QUESTIONS AND CALCULATIONS

1. For each of the pieces of aluminum foil, you will need to calculate the following:
   a. Area (*A*)
   b. Volume (*V*)
   c. Thickness (*T*)

   Refer to the beginning of this experiment for the formulas to be used. The density of aluminum is 2.70 g/cm^3. Show all of your work and results. Your answers should have the correct number of significant figures and be expressed in exponential notation, where appropriate.

2. Compare your answers with those of other students or, if available, look at the box from the aluminum foil. How do your answers compare? Can you determine how accurate your measurements are? (Why or why not?)

3. How precise are your answers? Recall the definition of precision.
4. If you had used a crude balance that allowed only one significant figure, how would this have affected your results for a. area; b. volume; c. thickness?

FOLLOW-UP QUESTIONS

1. Could this method be used to determine the thickness of an oil spill? What information would be needed?
2. A very thin layer of gold plating was placed on a metal tray that measured 25.22 cm by 13.22 cm. The gold plating increased the mass of the plate by 0.0512 g. Calculate the thickness of the plating. The density of gold is 19.32 g/cm^3.
3. By mistake, one litre (1000 cm^3) of oil was dumped into a swimming pool that measures 25.0 m by 30.0 m. The density of the oil was 0.750 g/cm^3. How thick was the resulting oil slick? Be careful with significant figures and exponential notation.
4. How might this method of finding thickness be used in finding the size of molecules?

CONCLUSION

State the results of Objectives 1 and 2.