**Problem: What is the best indirect way to determine the thickness of aluminum foil?**

**Objectives:**

1. Use communication skills and collaboration within a lab group to determine the best way to solve a problem.
2. To correctly apply the principles of significant figures in calculating the thickness of aluminum foil.
3. To correctly use exponential notation in expressing the results of the calculation.

**Introduction:**

In science, we must often use on set of measurements to indirectly measure other quantities. For example, a GPS determines location on the basis of transmission time from a number of satellites; radar and sonar determine distance on the basis of the time to hear an echo. In biology, if you wanted to measure the number of bacteria in a colony in a test tube you could use something called a spectrophotometer to measure it indirectly. A spectrophotometer works by shining light in onside of a tube and measuring how much actually gets through to the other side. Since more light getting through means less bacteria in the tube, you can work backwards to figure out how many bacteria are there. In this experiment you will be practicing your indirect measurement skills by applying what you have learned about measurement and significant figures to determine the thickness of aluminum foil. Since our normal laboratory tools are not suitable for direct measurement, you must determine how to do calculate thickness indirectly.

**Pre-Lab:** In your lab notebook, answer the following questions by: showing your work and using the correct number of significant figures, scientific notation, and units.

1. What is the volume of a block with the dimensions L= 8.20 cm, W= 2.25cm, H= 1.0 cm?
2. If the density of a substance is 0.525 g/cm3 and the volume is 18.25 cm3, what is the mass of the sample?
3. A piece of paper has an area of 30.2 cm2 and a volume of 5.2 x 10 cm3. What is the thickness?

**Challenge:**

1. There are 2 types of foil: thin and pie pan. Each group will receive 3 rectangular pieces each.
2. Determine a way to identify each piece and label them.
3. As a group, discuss and come up with a way to indirectly measure/calculate the thickness of each piece of aluminum foil.
4. Write out the procedure agreed upon in your lab notebook.
5. Carry out your procedure for all pieces of foil provided. Make sure that you record your data in an organized manner (i.e. a data table).
6. Show all calculations for each piece in an organized manner in your lab notebook.
7. Record your group’s thicknesses on the class data table.

**Analysis Questions:** Answer the following question in your lab notebook. Show all work and write in complete sentences.

1. One aluminum atom has a diameter of 2.5 x 10-8 cm. How many atoms thick is the thin aluminum foil?
2. What are some potential sources of error?
3. Compare your answers with the class. How do they compare? Can you determine how accurate your measurements are? Why?
4. If you had used a very crude balance that allowed only one significant figure, how would this have affected your results for (a) the area of the foil? Explain (b) volume of the foil? Explain. (c) thickness of the foil? Explain.
5. A very thin layer of gold plating was applied to the top of a metal tray that measured 22.22 cm by 13.22 cm. The mass of the tray before the gold plating was 75.3455 grams. After the gold plating the mass was 75.3967 grams. The density of gold is 19.32 g/cm3. Calculate the thickness of the applied plating.
6. By mistake, a quart 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/cm3. Assuming the oil spread into a uniform, thin layer over the water, how thick was the oil slick? 1.06 quart = 1.00 liter