2. DENSITY AND MEASUREMENT

Equipment list:

- One aluminum block (record its number)
- Vernier Caliper (record its serial number)
- Triple beam mass balance (record the number)
- One digital balance

How to use the triple beam balance: The balance should be "zeroed" before each use. Make sure the pointing arm at the right side of the scale oscillates evenly up and down about the reference mark on its right. You should **gently** push the arm to induce the oscillations. Never take a reading without moving the arm; static friction might hold the arm in place and prevent an accurate reading.

The two larger sliding weights should each be placed securely in the notches along the balance's arm when taking a measurement. The smallest sliding weight has no notches but moves continuously along its arm; this allows a precise reading.

By examining the scale, you should confirm that the smallest increment of the balance is 0.1 grams. You should interpolate to values less than this and since the absolute uncertainty is equal to one half the smallest increment, a typical reading from this balance would be interpolated to the *hundredth* of a gram for a value of say, (154.23 ± 0.05) grams.

How to use the vernier calipers: The vernier calipers provided have two different scales, decimal inches and centimeters, we will use the centimeter scale only.

Before measuring an object, you should push the jaws of the caliper completely closed and confirm that the vernier measures a zero length. If it does not measure zero, a systematic error will be introduced into all your measurements and you should correct all your measurements by this amount. When measuring the length on an object, you should cinch up the jaws onto the object securely and snugly. Your vernier calipers have beveled (angled) edges at the tip of its "jaws". Use these beveled edges to take your length measurements. **Don't slide the vernier scale across the main scale unless you are pressing in the "thumb stop".** Not pressing the thumb stop increases the friction of the vernier against the main scale so the vernier will not slip when you are taking a measurement.

Theory: All matter has mass, the measure of inertia. Any object has its mass contained in a definable volume. Density is the measure of how much mass is contained in an object's volume:

Density = Mass/Volume

Purpose: To measure the *mass* of the aluminum block three different ways and compare the values.

Procedure:

CAUTION: Aluminum is a soft metal and can easily be scratched or nicked if handled carelessly. Please be careful not to drop or bang your aluminum block, since this *may* change its dimensions and effect the accuracy of your measurements.

Determine the mass of the aluminum block three different ways and then compare the three different calculated masses and their absolute uncertainties.

1. Measure the mass of the block on the pan balance *five different times*. Use the statistical method discussed in the LAB SKILLS MANUAL to find the most probable value and its absolute uncertainty for the mass of your block.

2. Measure the mass of the block on the digital balance. Record the absolute uncertainty as well. Refer to the lab skills manual on how to find the uncertainty in a digital readout.

3. Solving the density equation given above for mass, the mass of a body can be computed if we know its density and volume. Measure the volume of the block. To do this, measure the length, height, and width of your block with the vernier calipers provided. Each measurement will have an uncertainty; record the uncertainty in your lab book with the measurement. Justify the uncertainty's value. Given the density of aluminum (2.699 g/cm^3 at STP)and the volume determined by computation, compute the mass of the block and its absolute uncertainty.

Analysis: Discuss how all three calculations of mass overlap when their uncertainties are considered. Discuss your confidence in the accuracy of each calculation. Which of the three mass values has the greatest precision?