LAB 4

Measuring Objects

The **density** of a material is its mass per unit volume. A block of steel is heavier than a block of balsa wood with the same size and shape because steel has a greater density than balsa wood.

Finding the Density of an Object

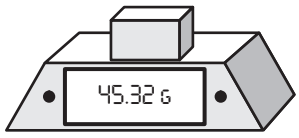
You can use these steps to find the density of a rectangular prism that is made of a uniform material.

1. Use a scale to find the mass of the object.
2. Measure the length, width, and height of the object.
3. Find the volume of the object by finding the product of the length, width, and height.
4. Find the object's density by dividing the mass by the volume.
5. Round the result to the appropriate number of significant digits.

In this lab you will use what you have learned about precision, accuracy, significant digits, and measurement errors to calculate the density of an object. You will need a scale, a ruler, and a block made of wood, metal, or another material.

STEP 1 Use a scale to find the mass of the block.

EXAMPLE The block shown has a mass of 45.32 g. This scale is precise to the nearest 0.01 gram. Assuming the scale is accurate, this means the actual mass of the block is 45.32 g $\pm$ 0.005 g.



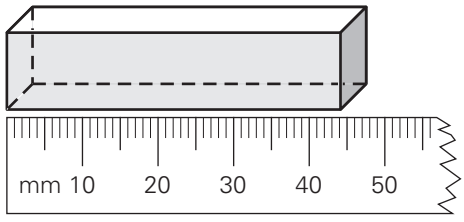
a. What is the level of precision of your scale?

b. What is the mass of your block?

c. Assuming your scale is accurate, what is the minimum possible mass of your block? What is the maximum possible mass?

STEP 2 Measure the length, width, and height of the block. Be sure to measure the block to the greatest level of precision possible for your ruler.

EXAMPLE The length of the block shown can be measured to the nearest millimeter (or 0.1 centimeter). Its length is 44 mm or 4.4 cm.



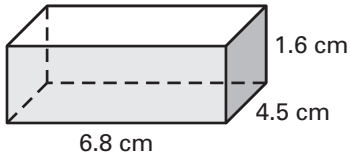
a. What is the level of precision of your ruler?

b. What are the length, width, and height of your block?

c. What does the level of precision of your ruler tell you about the maximum possible error in your measurements of the length, width, and height?

d. How many significant digits are in each of your measurements?

STEP 3 **Find the volume of the block by finding the product of the length, width, and height.**



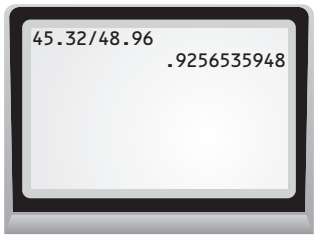
EXAMPLE The block shown has volume $V = 6.8 \times 4.5 \times 1.6 = 48.96\ \text{cm}^3$.

a. What is the volume of your block?

b. Given the possible measurement errors from Step 2, what is the minimum possible volume of your block? What is the maximum possible volume?

c. How should you report the volume of your block using the correct number of significant digits?

STEP 4 **Find the block's density by dividing the mass by the volume. Be sure to use all the digits in the calculated volume from Step 3a. (You will round your final result to the appropriate number of significant digits in Step 5.)**



EXAMPLE A block with a mass of 45.32 g and a volume of 48.96 cm^3 has a density of $\frac{45.32}{48.96} \approx 0.9256535948\ \text{g/cm}^3$.

a. What is the density of your block?

b. Explain why you should calculate the block's density using all the digits in the volume from Step 3(a) rather than the rounded volume from Step 3(c).

STEP 5 **Round the density to the appropriate number of significant digits. Recall that the quotient of two measurements should have the same number of significant digits as the least precise measurement.**

EXAMPLE A mass of 45.32 g and a volume of 48.96 cm^3 both have 4 significant digits. The quotient of these measurements should also have 4 significant digits.

$$\frac{45.32}{48.96} \approx 0.9256535948$$
$$\approx 0.9257\ \text{g/cm}^3$$

a. How many significant digits are in the mass of your block?

b. How many significant digits should you report for the density of your block?

c. What is the density of your block with the correct number of significant digits?

What Do You Think?

1. The density of water is 1 g/cm^3. Any object with a density less than 1 g/cm^3 will float in water, and any object with a density greater than 1 g/cm^3 will sink in water. If you place your block in a container of water, do you expect it to float or sink? Why?

2. What are some possible sources of error that may have occurred in finding the density of your block?

3. Describe how you could find the density of your block to a greater level of precision.