Purpose:

Students will use water displacement to find the volume of a person and calculate their density.

Background:

Which is heavier, muscle or fat? This really is not the correct question. Many people are quoted as saying that muscle is heavier than fat. However, a large piece of fat would clearly be heavier than a small piece of muscle. So what is the real issue?

The real question is an issue of density. Muscle is more dense than fat, meaning that if you had two identically sized pieces of muscle and fat, the piece of muscle would in fact be heavier.

So what is the density of the human body? How can we find the density of a body that is made up of so many different things? Our bodies are a mixture of many different tissues: fat, muscle, bone, blood, and many more. Each has it’s own density, so the density we calculate will be an average density of all the materials in the body.

What is the actual density of a human body? A simple way to estimate the density of the human body is to compare it to the density of water. Water has a density of 1.0 g/mL. Anything that is more dense than water will sink in water, while anything less dense will float. Does a human body float or sink in water?

\[ \text{density} = \frac{\text{mass}}{\text{volume}} \quad D = \frac{m}{V} \]

Materials:

Bathroom scale
Meter stick
Large barrel of water


1. Each person being measured must weigh themselves for the class on a bathroom scale. However this scale reads in pounds. Record the number of pounds in the table and convert them to grams.

\[ 1 \text{ kg} = 2.2 \text{ lbs} \]
\[ 1 \text{ kg} = 1000 \text{ g} \]

Part 2: Measuring Human Volume

1. Completely fill the density barrel with water.
2. Have one person climb into the barrel and slowly crouch down until they are completely submerged.
3. This person should very slowly stand up and climb out of the barrel, trying not to spill excess water out of the barrel.
4. Once the water in the barrel has calmed down, measure the distance from the top edge of the barrel to the surface of the water in centimeters to see how much water they pushed out of the barrel and enter this in the table. Also measure the diameter of the barrel.
5. Use the equation for the volume of a cylinder to calculate the amount of air in the barrel, which is representative of their body’s volume.

\[ \text{Cylinder} = \pi r^2 h \]

Part 3: Calculating Human Density

6. With the mass and volume for each person figured out, calculate their densities and record it in the table.
**Calculations:** Show your work below for how you did the calculations for the first person in the table.

1. Show how to convert a person’s weight in pounds into mass in grams. \((1 \text{ kg} = 2.2 \text{ lbs}; 1 \text{ kg} = 1000 \text{ g})\)

2. Show how to calculate the volume of air in the barrel in \(\text{cm}^3\) after a person gets out using the cylinder equation.

3. Show how to calculate the a person’s density.

<table>
<thead>
<tr>
<th>Name</th>
<th>Weight (lbs)</th>
<th>Mass (g)</th>
<th>Radius of barrel (cm)</th>
<th>Height Displaced (cm)</th>
<th>Volume ((\text{cm}^3))</th>
<th>Body Density ((\text{g/cm}^3))</th>
<th>Will they float or sink?</th>
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