611-2150 (45-070) Density Experimentation Lab

Parts List:

29-1209	Spring Scale, Blue, 250 g/2.5 N
30-230	Overflow Can
30-240	Catch bucket
50-5601	Specimen, Al
53-5603	Specimen, Cu
58-5603	Specimen, Zn

Additional Materials Needed:

- Distilled water
- Thermometer
- Graduated cylinder

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

Description:

Use this kit to determine the densities of three different density cylinders by a water displacement method. Demonstrate Archimedes' Principle through mathematical calculation.

About Density:

Why does wood float and iron sink? Wood floats because it has a lower density than water. Whether something floats or sinks depends on its density, the amount of mass per volume (or the amount of matter per amount of space the object takes up.) When an object is dropped into water, it displaces a certain amount of water. Since the displaced water was being held up by the water around and below it, the object displacing it is pushed up with the same amount of force by the surrounding water. If the object is the same weight or lighter than the displaced water, it will float; if heavier, it will sink.

A good example would be boats. When a wooden boat is dropped into a bathtub, it displaces only an amount of water that has the same weight as the boat. The rest of its volume sits above the water; in other words, it floats. An iron cube, even a small one, is heavy for its size. When you drop it into a body of water, it weighs more than the water it displaces; therefore, it slides to the bottom. An iron or steel-sided ship floats if its hull contains a big enough bubble of air to make its overall density less than that of an equal volume of water.

The standard for comparing densities is water. At a temperature near 4° C, water has a density of 1.000000 grams per mL or .999973 grams per cubic cm.

Densities change with temperature and pressure - almost always higher at low temperature and usually higher at high pressure.

The densities of solids range from 0.08 gm/cm^3 (for solid hydrogen) to 22.48 gm/cm^3 (for the metal osmium.)

Experiment 1: Determining Density

You will need:

• Graduated cylinder or caliper

Measure the mass (***m***) of each cylinder in grams using the spring scale. Subtract 1.2g to compensate for the hook in the top of the cylinder. Record your calculation.

Measure the volume (***v***) in mL with either a graduated cylinder or caliper. The measured volume of a cylinder is calculated using the formula: $\pi r^2 h$

Where:

r = radius

h = height.

Calculate the volume for each cylinder independently as there may be slight differences between the samples. Be careful to watch your units to obtain the volume in mL.

Calculate the density of each cylinder using the formula: $d=m/v$

Where:

d = density

m = mass

v = volume

To determine the composition of each sample, compare the values you have determined for each density with the table.

Density can be described as a way to measure how tightly the molecules in a material are packed. Different alloys of each material may differ from the approximate values in the table.

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$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Volume = (π r^2 h) or displacement in mL in a graduated cylinder.

$$\text{Specific Gravity} = \frac{\text{weight of cube in air}}{\text{weight of cube in air - weight of cube in water}}$$

Experiment 2: Determining Density Using Specific Gravity

You will need:

- Beaker of water
- 150g or larger spring scale (or for more accuracy, a balance that the cubes can be hung from).
- Stand to mount the spring scale

The most accurate method for determining density is to suspend the sample by a thread or wire from a scale or balance and record its weight. Raise a container of water around the sample, completely submerging it, and weigh the sample again. The difference between weights is the weight of **water displaced.** From this value, and the density of water (defined at 1 g/ml) you attain volume of the sample.

If you wish to be very exact, take the temperature of the water and find its exact density from a handbook. To be still more exact, take note of the air temperature and barometric pressure since the air exerts buoyancy on the sample, and on the balance weights, of about .0013 g/ml. Any precise calculation will have to account for the hook on the cube. The mass of the hook is approximately 1.2g.

Suspend each cube one at a time from the spring scale (or balance), and record each mass. Next, submerge each cube from the spring scale into the beaker of water one at a time and measure each mass under water. Only submerge the weight until the top is slightly under water, this will keep the hook on the cube out of the measurement.

Calculate each specific gravity using the formula above. Specific gravity is a form of relative density in which the density of one material is compared with that of another. In our case we are comparing our cubes to the density of water. Water is the basic standard, and is considered to have a specific gravity of 1.

Real World Applications:

Density can be used to compute the weight of a piece of machinery or part of a bridge or building before it is actually constructed. An engineer needs only to know the volume and density of the material of which it is to be made. The engineer can compute beforehand the load that each part of the structure will have to support. This will determine whether the design is of sufficient strength.

Density can also be used to differentiate a pure metal from an alloy, as in the classic case where Archimedes had to determine if Sicily's king had a crown of pure gold or an alloy.

The Table below lists identifying characteristics and approximate densities for materials in this set.

Material	Characteristics	Density (g/ml)
Copper	Red Cube	8.9
Steel	Black or Silver Cube	7.8
Zinc	Silver Cube-Heavy	6.7
Aluminum	Silver Cube-Light	2.7

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How to Teach with Density Experimentation Kit:
Concepts Taught: Mass; Volume; Density; Specific Gravity; Buoyancy
Curriculum Fit: Physical Science and Chemical Science/ Matter. *Unit: Observation and Measurement of Physical Properties.*
Grades 6-8 and up.

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