611-2055 (30-110) Specific Gravity Specimens

Warranty and Parts:

We replace all defective or missing parts free of charge. All products warranted to be free from defect for **90 days.** Does not apply to accident, misuse or normal wear and tear.

About Density:

A **practical definition** of density is a **quantity divided by the space it occupies.** Since people are measured as a number and the space they occupy is the surface of the earth, population density is expressed as the number of people per square mile. Most material is measured in **weight** units: pounds, grams, kilograms, tons etc. The space they occupy is **volume.** Volume is expressed in cubic centimeters, milliliters (almost the same), gallons, cubic feet, liters and occasionally cubic inches.

The most common measure for density is **grams per milliliter** (or cubic centimeter) for solids and liquids and **grams per liter** for gases. The standard for comparing densities is water. At a temperature near 4° C water has a density of almost exactly **one**, 1.000,000 grams per milliliter or .999973 grams per cubic cm.

Densities change with temperature and pressure. They are almost always higher at low temperature and higher at high pressure.

The specific density of solids falls within a range of 0.08 gm/cm^3 (for solid hydrogen) to 22.48 gm/cm^3 (for the metal osmium.)

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

Material	Characteristics	Density (g/ml)
Copper	Copper colored cylinder	8.9
Brass	Gold colored cylinder	8.0
Steel	Grey colored cylinder	7.6
Aluminum	Silver colored cylinder	2.7
Glass	Clear sphere 1/2" dia (marble)	2.3
Graphite	Black round rod	2.2
Vinyl Plastic	Grey colored cylinder	1.4
Polyethylene	White round rod	0.98
Styrofoam	White or green irregular lump	0.05

Determining Density:

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. A container of water is then raised around the sample, completely submerging it, and the sample is weighed 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 arrive at the volume of the sample.

You may also take the **temperature** of the water and find its exact density from a handbook. For greater accuracy, take note of the air temperature and barometric pressure since air exerts buoyancy on the sample and on the balance weights of about .0013 g/ml. If you use a laboratory triple beam scale, you can expect an accuracy 99% with a 10 ml sample. With an analytical balance, you can expect accuracy of 99.99% to 99.999% if you allow for the effects of temperature and air density.

Additional Materials Needed:

- **Triple beam balance**
- **Beaker of water**
- **String or wire**
- **Needle or toothpick**

Specific Gravity:

Specific Gravity is almost the same as density except that this density may be determined using water at 20°, 25° C or some temperature other than 40°, without correcting for temperature or air pressure.

$$\text{Density} = \frac{(\text{Weight of sample in air})(\text{Density of water})}{(\text{Weight of sample in air}) - (\text{weight of sample in water})}$$

For exact determination of density, see Weighings - Reduction to Vacuo *and* Water - Density of *in* ***Handbook of Physics and Chemistry.***

$$\text{Specific Gravity} = \frac{(\text{Weight of sample in air})}{(\text{Weight of sample in air}) - (\text{Weight of sample in water})}$$

Here, water and samples are at room temperature, with no corrections made.

How To Use:

Compute differing specific gravity values unique to each material.

Identify the material by computing specific gravity.

Weigh in water by measuring the volume of water displaced when the object is fully submerged in water. To determine **specific gravity,** divide the weight of the object in air by its loss of weight in water.

For those materials that do not sink, use a toothpick or needle to push the object down to the bottom of the beaker. Hold the object lightly, putting no additional pressure on it other than the force required to submerge it, and measure the volume of water displaced.

Compute specific gravity according to the formulas above.

To determine the composition of each sample, compare the values you have determined for its specific gravity to the table on Page 1.

You will need: *beaker of water, needle or toothpick, triple beam balance.*

For those materials that sink, use your balance to weigh each object twice - first in air, then in water.

Real World Applications:

Specific Gravity can be used to measure the concentration of solutions and to determine the percentage of alcohol in grape juice during wine-making. It can be used to differentiate a pure metal or an alloy - for instance, whether the material is tool steel or ordinary steel, or, in the more classic case, whether the crown of the king of Sicily during Archimedes' time was pure or altered gold.

P/N 24-3011

Related Products:

611-2005 Equal Mass Specimens:
Set of 5 cylinders with same mass and differing densities and lengths: polyethylene, copper, aluminum, PVC, nylon.

611-2110 Bucket and Cylinder:
Show how something submerged in water loses weight equal to its own volume of water. Two precision-machined pieces whose volumes are equal: one solid with ring; one hollow with handle and hook. Instructions and dacron line

611-2100 Density Rod:
Precision-machined aluminum cylinder floats in cold water, sinks in hot. Fits most graduated cylinders. Instructions.

611-2105 Reverse Density Rod
This weighted plastic rod floats in hot water, sinks in cold!

611-2025 Density Cube Set/10:
10 cubes with vastly different characteristics. A best seller.

611-2085 Overflow Can and 611-2270 Catchbucket
Two sturdy aluminum pieces. Can has angled plastic molded spout.

611-2060 Metal Specimens:
Four metal specimens with equal volume: copper, brass, aluminum, steel.

How To Teach with Specimens

Concepts: Mass. Volume. Density. Specific Gravity. Buoyancy. Flotation.

Curriculum Fit: Physical Science and Chemical Science/ Matter. *Unit: Observation and Measurement of Physical Properties.* **Grades 6-8.**