611-2000 (30-092) Density Identification Set

Parts List:

23-0092	Instructions
035610	Copper (Alloy 145)
035683	Brass (Alloy 360)
035612	Glass (Pyrex™)
035613	Rubber
035614	Acrylic
035675	Aluminum
035616	Nylon
035701	PVC
035618	Teflon™ (plastic)
035716	Tecaform™ (plastic)
035620	Wood (Birch)
035621	Wood (Oak)
035600	Plastic base

Warranty and Parts:

We replace all defective or missing parts free of charge. Replacement parts may be ordered by referring to part numbers above. We accept Master Card, American Express, Visa, School P.O. All products warranted to be free from defect for **90 days.** Does not apply to accident, misuse or normal wear and tear. Not designed for children under under 13 years of age.

Introduction:

With this clever kit, students try to identify each of 12 different samples by determining their density. Each cylinder varies in size (volume) and density but has the same diameter of 0.5 inches (1.27 cm). Lengths vary between 1.575 and 2.657 inches.

We include 12 of the most common materials, a wood base with a linseed oil coating to hold specimens, and instructions.

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 amount of matter per amount of space the object takes up). When an object is in water, it displaces a certain amount of water. Since the displaced water was held up by the water around and below it, the object displacing it is pushed up with the same force by the surrounding water. If the object is the same weight or lighter than the displaced water, it floats; if heavier, it sinks.

When a wooden boat is dropped into a bathtub, it displaces an amount of water with 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. They are usually higher at low temperature and 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.)

Additional Materials Needed:

- Triple beam balance
- Calipers

How to Use:

1. Take one sample from the 12 provided.
2. Weigh sample on a balance.
3. Record mass, *m*, in grams.
4. Measure length, ℓ, of sample in cm with calipers.
5. Record length.
6. Measure diameter, of sample in cm.
7. Divide the diameter by 2 to determine radius
7. Record radius.
8. Calculate volume, **v**, of cylinder as follows:
   $v = \pi r^2 \ell$
9. Then calculate density, **d**, as follows:
   $d = \frac{m}{v}$
10. Look up density in the table provided to determine the sample's material.

This table lists approximate specific densities for materials in this set.

Material	Density (kg/m^3)
Copper.....	8950
Brass.....	8410
Glass (Pyrex™)...	2230
Rubber.....	1150
Acrylic.....	1400
Aluminum.....	2700
Nylon.....	1120-1160
PVC.....	1480-1520
Teflon™.....	2190
Tecaform™.....	1380-1430
Birch *(lighter)*....	350 - 500
Oak *(darker)*.....	600 - 900

(allow for variations, especially in plastics)

How To Teach with Density Identification Set:

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.**

Another method for determining density:

The most accurate method for determining density is to suspend the sample by a thin 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.

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.

With a laboratory triple beam scale, you can expect an accuracy of 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.

For those materials that sink, use your balance to weigh each object twice - first in air, then in water. Weigh in water by measuring the volume of water displaced when the object is fully submerged in water. To determine **density,** use the formula above.

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 **density** according to the formula above.

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

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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.

Related Products:

Science First *is a designer and manufacturer of hands-on science labs.*

611-2005 Equal Mass Specimens: Set of 5 cylinders with same mass and differing densities and lengths.

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 & dacron line

611-2266 Hydrostatic Studies Kit: Convenient all-inclusive set containing: Overflow Can, Catchbucket, Specific Gravity Specimens, Equal Mass Specimens, Bucket and Cylinder; Spring balance; instructions.

611-2085 Overflow Can and 611-2090 Catchbucket: Fill can with water; put object with unknown volume in water, catch water that gushes out; weigh water to determine volume. Two sturdy aluminum pieces. Can has angled plastic molded spout.

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