

611-2020 (30-005) Metal Density Cubes

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.

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. They are almost always higher at low temperature. They are usually higher at high pressure.

The densities of solids range from 0.08 gm/cm³ (for solid hydrogen) to 22.48 gm/cm³ (for the metal osmium.)

Additional Materials Needed:

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

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.

If you use 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.

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

Material	Characteristics	Density (g/ml)
Copper	Copper Cube	8.9
Brass	Gold Cube	8.0
Steel	Grey Cube	7.6
Aluminum	Silver Cube	2.7

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

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

How To Use:

1. Compute differing density values unique to each material.
2. Identify the material by computing density.

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.

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 on page 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.

How To Teach with

30-161 Density Cubes:

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.*

Related Products:

Science First is a designer and manufacturer of hands-on science labs. Our products are available from most science education distributors. For more information, contact us at 1-800-875-3214.

• 30-100 Equal Mass Specimens:

Set of 5 cylinders with same mass and differing densities and lengths: polyethylene, copper, aluminum, PVC, nylon. Instructions.

• 30-120 Bucket & 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

• 30-200 Hydrostatic Studies Kit:

Convenient all-inclusive set containing: Overflow Can, Catchbucket, Specific Gravity Specimens, 30-100 Equal Mass Specimens, Bucket & Cylinder, Spring balance; instructions.

• 30-230 Overflow Can and 30-240

Catchbucket: Fill can with water; put object with unknown volume in water, catch water that gushes out into **Catchbucket**; weigh water to determine volume. Sturdy aluminum. Can has angled plastic molded spout.

• **30-090 Metal Specimens:** 4 metal specimens with equal volume. Copper, brass, aluminum, steel.

• **30-100 Specific Gravity Specimens:** 10 different specimens for determining specific gravity.

• **30-160 Density Rod:** Precision-machined aluminum cylinder floats in cold water, sinks in hot. Fits most graduated cylinders. Instructions.

New! 30-162 Reverse Density Rod - High density plastic rod sinks in cold water, floats in hot.

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