611-2025 (30-161) Density Cube Set

Set Includes:

030-0500	Aluminum Cube
030-0510	Steel Cube
030-0520	Brass Cube
030-0530	Copper Cube
030-0540	Acrylic Cube
030-0550	Oak Cube
030-0560	Nylon Cube
030-0570	Pine Cube
030-0580	Poplar Cube
030-0590	PVC Cube

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered by referring to part numbers above. All products warranted to be free from defect for **90 days.** Does not apply to accident, misuse or normal wear and tear.

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

Material	Characteristics	Density (g/ml)
Copper	Copper Cube	8.9
Brass	Gold Cube	8.0
Steel	Black Cube-Heavy	7.6
Aluminum	Silver Cube-Light	2.7
Acrylic	Clear Cube	1.16 - 1.19
Oak	Thin Grained Cube	0.60 - 0.90
Nylon	Opaque White Cube	1.13
Pine	Thick Grain- Pine Smell	0.35-0.60
Poplar	Thick Grained Cube	0.35-0.50
PVC	Grey Cube	1.39 - 1.42

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.

Additional Materials Needed:

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

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.)

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. 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

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

$$\text{Volume} = (L)(w)(H)$$

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

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.

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 it lightly, putting no additional pressure on it other than the force required to submerge it, and measure the volume of water displaced. Compute **density** with 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 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:

- **611-2005 Equal Mass Specimens:** Set of 5 cylinders with same mass and differing densities and lengths: polyethylene, copper, aluminum, PVC, nylon. Instructions.
- **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, 611-2005 Equal Mass Specimens, Bucket & Cylinder, Spring balance; instructions.
- **611-2085 Overflow Can**
- **611-2090 Catchbucket:** Fill can with water; put object with unknown volume (such as these **611-2055 Specific Gravity Specimens)** in water, catch water that gushes out into **Catchbucket;** weigh water to determine volume. Two sturdy aluminum pieces. Can has angled plastic molded spout.
- **611-2060 Metal Specimens:** 4 metal specimens with equal volume. Copper, brass, aluminum, steel.
- **611-2055 Specific Gravity Specimens**: 10 different specimens for determining specific gravity.
- **611-2100 Density Rod:** Precision-machined aluminum cylinder floats in cold water, sinks in hot. Fits most graduated cylinders. Instructions.

P/N 24-0161