611-2140 (30-099) What's the Density Set

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.

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. 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.)

Product description:
This set contains twelve specimens of different lengths but the same diameter. To the eye, they appear to be made from the same plastic. Indeed, if they **were** of the same plastic, a graph of mass versus volume for the 12 specimens would result in a straight line, with the slope of the line representing the density of the substance.

Have your class graph the twelve specimens following the procedure below. With time, they will notice scattered data points that do not fall into the pattern of a straight line. Do they fall into any pattern at all?

As more data is collected, it should be possible to see data that correlates to two separate straight lines. Some of the data will fall into one straight line; the rest of the data will fall into the other straight line.

What does this mean? Your class may conclude that the specimens represent two different kinds of plastic. Seeing is not believing here: two different types of plastic are used. 6 specimens are from one and 6 from the other.

The wood base holds all 12 specimens when not in use. If some specimens are missing, this can be easily determined before your class ends for the day.

How to Use:

1. Take one sample from the 12 provided.
2. Weigh sample on triple beam balance.
3. Record weight in grams.
4. Measure length, ℓ, of sample in cm with calipers.
5. Record length.
6. Measure diameter, **d**, of sample in cm.
7. Record diameter.
8. Calculate volume, **v**, of cylinder as follows:

$$v = \left(\frac{d}{2}\right)^2 \pi \ell$$

9. Then calculate density, **d**, as follows:

$$d = \frac{m}{v}$$

10. Look up density in the table provided to determine which material the sample is.

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.

You may also use a graduated cylinder to contain the water. The volume of the displaced water is the difference in readings before the sample is submerged in the water, and after. 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.

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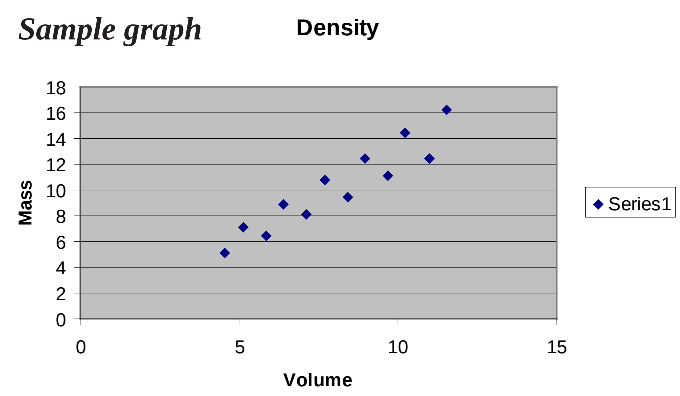
The Answer: Tecamid (LDPE) Density 1.1404 gram/milliliter
Tecaform (Delrin) Density 1.4033 gram/milliliter

The Table below lists approximate densities for common materials.

Material	Density (g/ml)
Copper	8.9
Brass	8.0
Steel	7.6
Aluminum	2.7
Tecaform	1.4033
PVC	1.39 - 1.42
Lignum Vitae	1.28-1.37
Acrylic	1.16 - 1.19
Tecamid	1.1404
Nylon	1.13
Polypropylene	0.85-0.95
Oak	0.60 - 0.90
Pine	0.35-0.60
Poplar	0.35-0.50

Sample graph



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.

Teacher demonstration:

In a big container, add water and then add a high concentration of salt. Place the 12 specimens in the container. What does your class expect to happen?

What *does* happen?

Half the specimens will float and half will sink. What does this show?