673-0115 (30-030) Mole Density Set

Introduction: What is a mole? Though it might be entertaining, this set does not deal with small burrowing mammals. Rather, the term 'mole' refers to a given quantity of a substance. Since volume can change with temperature and other conditions, a method is needed to measure the actual amount of a substance. The name "mole" was coined in German (as *Mol*) by Wilhelm Ostwald in 1893, although the related concept of equivalent mass had been in use at least a century earlier. One mole represents 6.02 x 10^{23} atoms of a substance. This number is referred to as Avogadro's constant (named after Amedeo Avogadro (1776–1856).

While a mole of a substance can be somewhat represented by mass units, on the whole it is a more accurate means of describing the quantity of a given substance.

Operation:

Our set contains approximately one mole of four different metals: iron, copper, zinc, and aluminum. Each of these specimens contains the same number of atoms, but there are several key differences between them. Firstly, they clearly have different volumes. Secondly, they are of different masses. The secret behind this is the fact that every type of atom is unique, with its own properties. An iron atom weighs more than an aluminum atom, so a mole of iron will have a greater mass than a mole of aluminum. Also, some materials have atoms that are bonded closer together, which reduces the volume of a mole of that material. Copper, for example, has closer atoms than zinc, which is why a mole of copper has a smaller volume than a mole of zinc.

A good way to show the importance of moles as a unit is to heat one sample and allow the others to remain cool. As you heat the specimen, its volume will expand. For example, the iron sample, which is smaller than the copper one, can be heated until it is larger. However, the number of atoms will not change. Thus, one can use moles to describe the amount of a substance, irrespective of volume.

Consider the measurement of one mole of silicon. As silicon is a solid at room temperature, the convenient method of measurement is weighing. By consulting published tables, it can easily be found that the atomic weight of silicon is 28.0855. Multiplying by the molar mass constant M_u gives the molar mass in any desired mass units: assuming the measurement is to be made in grams, $M_u = 1$ g/mol, and so the molar mass of silicon is 28.0855 g/mol.

Density Experiment: Obtaining the density of the specimens is relatively easy. You will need a graduated beaker and enough water to fill it half-way. You will also need a scale.

First, record the mass of the sample you wish to use. For easier calculations, you will want to use grams for this value.

Secondly, pour a quantity of water into your beaker. It is easiest if you have the water fill a precise volume that corresponds to the graduations on the beaker. It is best to measure this volume in cubic centimeters.

Next, place the sample in the beaker. A certain amount of water will be displaced; this corresponds to the volume of the sample.

To calculate the density, divided the mass by the volume. This will give grams per cubic centimeter as a unit.

Next, you will want to calculate the molar density. Our sample uses materials that are elemental, so computing the molar mass is fairly easy. The standard atomic weights of these elements is equivalent to the molar mass, given in grams per mole.

Molar volume is the same as the physical volume that you calculated earlier. Dividing the molar mass by the molar volume will yield the molar density.

For example, consider aluminum. Aluminum has a molar mass of 26.98 g/mol. The volume of the sample in our set is approximately 10 cubic centimeters. When we divide, we get a molar density of 2.698 g/mol/cm^3.

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. Designed for ages 13and up. Item is not a toy. It may contain small objects that can be choking hazards.

BENCHMARKS AND STANDARDS

Benchmarks for Science Literacy	National Science Education Standards Content Standard B
Physical Setting 4D/M3cd	**Physical Science 6.1 Structures and Properties of Matter pg.179**
In solids, the atoms or molecules are closely locked in position and can only vibrate. In liquids, they have higher energy, are more loosely connected, and can slide past one another; some molecules may get enough energy to escape into a gas. In gases, the atoms or molecules have still more energy and are free of one another except during occasional collisions.	**Structure and Properties of Matter: Solids, Liquids and Gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids, the structure is nearly rigid; in liquids, molecules move around each other but not apart; and in gases, molecules and atoms move almost independently of eachother and are mostly far apart.**

May we suggest:

673-0110 Mole Box: How to visualize what a mole of air really looks like? Use our custom-printed, die-cut cube... complete with mole! Many concepts in chemistry class are hard to grasp. (Plus we all need a good laugh.) This 6-sided cardboard box, each side 11.2" square, folds into a sturdy cube. Each side is imprinted with useful facts in large type that can be read easily across a classroom.

611-2000 Density Identification Kit: It's a puzzle - it's a lab - it will separate the sheep from the goats. Ask your class to identify each of twelve (12) different samples by determining their density. Each cylinder varies in size and density since it is constructed of a different material. All are 1/2" cm in diameter and range between 4 and 7 cm in length. Includes: 12 samples, an attractive wood storage rack (coated in linseed oil for protection from wet specimens) and instructions. The samples include: **aluminum, brass, copper, acrylic, Pyrex, rubber, nylon, PVC, PTFE, Tecaform, poplar, and oak.**

611-2300 Gas Law Demonstrator: New! The discovery of the Gas Laws goes back always - to 1662, to be exact. But it needn't take a few centuries to understand the concepts. Despite the deceptive simplicity of our design, you can verify both Boyles' Law and Charles Law to a high degree of accuracy. To prove it, we've provided sample data in our instructions.

611-2106 Density Rod Kit: This precisely calibrated aluminum cylinder floats in cold water and sinks in hot, demonstrating the differing density of a liquid at different temperatures. Includes hollow aluminum cylinder that fits most graduated cylinders and instructions with experiments. 6.5 x 1.9 cm.

611-2026 Density Cubes: This Density Cube Set is popular because it meets curriculum standards. At a teacher's suggestion, we've just improved upon our largest set of common materials. Each cube is 1 x 1 x 1", large enough to manipulate easily. We've added two new cubes (for a total of twelve): polypropylene and lignum vitae (ironwood).
Polypropylene floats in water, although because it is dense plastic, your students would expect it to sink. Lignum Vitae sinks in water, but because it is wood, your students would expect it to float. Lignum Vitae is three times harder than oak. One of the hardest and heaviest woods in the world, it has a specific gravity of 1.05 and a density of 77-82 lbs/ft3.

673-0115 Mole Specimen Set: You've all seen the Mole Box, an 11 inch cube which shows 22.4l (one mole) of air. Our specimen set shows the same concept in solid form. Our set includes one mole (6.03 x 1023 particles) of aluminum, copper, iron, and zinc. Includes instructions.

611-2015 Equal Volume Mixed Material Density Set: Our four cylinders of aluminum, glass, nylon and wood each have the same volume. 13 mm x 7.5 cm.

611-2150 Density Experimentation Lab: Our density lab kit contains 3 different density sample cylinders, an overflow can, a catchbucket, a spring scale, and instructions.

611-2250 Hero's Fountain: This classic demonstration of fluid pressure spouts water into the air for several minutes. As water in the top enters the lower bulb, it forces the air in the bulb upward, compressing more air in the upper bulb. The water has nowhere to go but out the upper tube. 50 cm high with instructions.

611-2155 Density Ball: density ball is used demonstrate the effects of temperature and mineral content on density. The metal ball will float in cold water, and sink in hot!
The density of water is not constant but depends upon several factors. The effects of salinity and temperature play a large role in the flow of earth's ocean currents. The 30-166 Density Ball can be used by varying salt content as well as temperature, to show the effects on density.