

## Density Rod Set with Twelve Aluminum Rods #DNRDST-AL

### Warning:

- **Not a toy; use only in a laboratory or educational setting.**
- **California Proposition 65 Warning: This product can expose you to chemicals including lead and nickel, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to [www.P65Warnings.ca.gov](http://www.P65Warnings.ca.gov).**



### Introduction

All matter in the universe shares at least two properties: mass and volume. **Mass** is the term used to describe just how much matter exists in an object, while the term **volume** is used to describe how much space that mass occupies. Mass should not be confused with weight, which is a measurement of the force of gravity exerted on a given mass. An object's mass is constant, even in zero-gravity conditions, while its weight will fluctuate based on the gravitational force of the planet or body-in-space it is on.

The relationship between mass and volume is talked about in terms of **density**. If mass is referring to how much matter exists in an object, density refers to how tightly its atoms are packed into the space it occupies. For example, if you compare two identically-shaped objects with different masses, you will know that the heavier (*ie.* more massive) object is the denser of the two.

Your Density Rod Set comes with twelve aluminum rods in different sizes. Each one is an identical metal, meaning they all possess the same density. By knowing that their densities are identical, your set can help you to explore the relationship between mass, volume, and density, and show you that an object's density is not affected by its shape or size.

In order to fully use your set, you will need a few **additional supplies**:

- A device for measuring your rods' dimensions (*eg.* Ruler, calipers)
- A gram scale with a resolution of 0.01g

You will find instructions on the back of this sheet detailing how to use your rods to investigate these fundamental physical properties.



## Finding the Density of Your Rods

As stated on the previous page, density is the relationship between mass and volume. The equation used to find density can be found in the box on the right of this page. You will first find the mass of each of your rods. After, you will find their volumes, calculate the density of each rod, and see that all of their densities work out to be the same. By observing this relationship on your own you will better understand how mass and volume intersect.

### Confirming Mass

1. Using a gram scale (not included), measure the mass of any one of your rods. Record this value in grams (g).
2. Repeat this measurement for each of your five rods.
3. Confirm that each rod in your set has the same mass, and observe that they are all different in size.

### Measuring Volume

1. Using a ruler with a centimeter (cm) scale or a set of calipers, measure the diameter of one of your rods.
2. Divide this number in half to find the radius of your rod.
3. Measure the height (or length) of the rod in centimeters (cm).
4. Using the formula on the right for the volume of the cylinder, calculate the rod's volume. Record this value in cubic centimeters (cm<sup>3</sup>).
5. Repeat these steps for each of your five rods to find their volumes as well.

### Calculating Density

1. With the values you found above and the density formula to the right, calculate the density for each rod in your set.
2. Observe that the density of the each rod is the same regardless of its size. This is because they are all made of the same aluminum. The mass for each rod will increase proportionally to an increase in volume, and the density will remain constant.

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#### Density

$$\rho = \frac{M}{V}$$

#### Volume of a Cylinder

$$V = \pi h r^2$$

#### Radius

$$r = \frac{d}{2}$$

- $\rho$  = Density (g/cm<sup>3</sup>)
- $M$  = Mass (g)
- $V$  = Volume (cm<sup>3</sup>)
- $h$  = Height (cm)
- $r$  = Radius (cm)
- $d$  = Diameter (cm)