# Steel Sphere Density Kit

P1-1035

## INSTRUCTIONAL GUIDE

## Contents

- Two steel spheres (diameter: 3.5 cm, 12.7 cm)

Required for experiment:

- Digital Balance (02-7000)
- Bowl of water
- Metric Ruler 10-pack (01-0115)

**or**

- Fiberglass metric Tape Measure 10-pack (01-3985)

## Background

There is an age-old science questions that is intended to illustrate the difference between weight and density. It is: "Which is heavier a pound of nails or a pound of feathers?" This question is explored using the Steel Sphere Density Kit. The kit contains two steel spheres of approximate equal weight but greatly different volumes since the larger sphere is hollow. In the initial idea section students are asked why the larger sphere, being so much bigger, doesn't weight more. This is intended to get the students thinking about the concept of density without first starting with a formal definition.

## Experiments

Place both spheres in two identical paper bags without letting the students see the two spheres. Ask several students to hold the bags at the same time one in each hand and ask them to compare their weights. Also, ask them to change hands holding the bags since one arm being stronger may affect which one feels heavier. The conclusion should be reached that both bags and their contents weight approximately the same. Open the bags revealing the contents, and showing that one sphere to be substantially larger. At this point, ask each student in the class to explain why they think the larger sphere weights the same if it is so much bigger. This discussion should begin to lead to an understanding of the concept of density.

(Note: if the students were to hold each sphere in their bare hands, they may believe the smaller sphere is heavier because of the greater pressure it exerts on the hand. So as not to confuse weight with pressure, the spheres are put into the paper bags.)

**What does “bigger” mean?**

Volume is a commonly misunderstood concept. Explore this concept with the students by asking them questions like which would take more spheres to fill a certain container or if placed under water in a fish tank which sphere would make the water level rise more. At this point, introduce the formula for the volume of a sphere:

$$V = {}^{4}/_{3}\,\pi r^{3}$$

The value 'r' in represents the radius of the sphere. However, it is easier to measure the diameter or circumference of the sphere than the radius. Therefore, you can measure one of those quantities first,

and then calculate the volume V. One way to measure the circumference is to wrap a thin strip of paper around the sphere and stick a pin through the paper where it overlaps. When laid out flat, the distance between the two pin holes can be measured to obtain the circumference.

Bring out a large bowl or tank of water. Ask the students what they think will happen when you place the two steel spheres into the water and why? How many students think the small sphere will sink? How many think the large sphere will sink? Place the sphere into the water. After observing that the small sphere sinks and the large sphere floats, ask the students why they think the results were different if they both had the same weight.

Density is a two-variable concept. Remind the students that size alone or weight alone cannot be used to represent the density of an object, as illustrated by the question of the nails and feathers. Mathematically, density is expressed as a ratio of an objects mass to its volume and given by the formula:

$$D = {}^{m}/_{V}$$

Where D is the density, m is mass, and V is volume. The units of density are given in $kg/m^3$ or $g/cm^3$.

The density of fresh water is 1 $g/cm^3$. Based on the observed results of the large sphere floating and the small sphere sinking in the water, ask the students to predict the value of the density of each sphere is in relationship to the density of water (greater or less then 1$g/cm^3$).

Now calculate the density of each sphere by measuring their mass and diameter or circumference. Fill in the data table below and show the calculations for the volume and density.

| | Weight* Mass (g) | Diameter or Circumference (cm) | Radius (cm) | Volume ($cm^3$) | Density ($g/cm^3$) |
|---|---|---|---|---|---|
| Solid steel sphere | | | | | |
| Hollow steel sphere | | | | | |

*Since the weight of an object is proportional to its mass by the gravitational constant, the term weight is used in places where mass is the accepted term.

In conclusion, ask each student to write a sentence explaining how the density of the spheres is different than the volume of the spheres. Write a second sentence explaining how the density of the spheres is different than their weight (mass).

## Related Products

**Density Rod Set (P1-1020)** Use this discrepant event to test students' understanding of density, buoyancy, and thermal expansion! The aluminum rod floats in cool water and sinks in warm.

**Assorted Density Block Set (P1-1010)** One cube each of aluminum, brass, copper, iron, lead, and zinc. 20mm cubes in storage case.

**Aluminum Density Determination Set (P1-1100)** Set includes 12 samples of aluminum. Students learn that the density of a substance is constant even as its mass and volume change.