

## Density Activity

### Overview

In this activity, students learn what density is and how to calculate the density of an object. Additionally, they will develop a sense of how density is impacted by changing mass or volume. They discover the general trends occurring with the changing values.

The Density virtual instrument, VI, will be used in this activity. The VI shows the relationship of mass and volume to density. It will be instrumental in demonstrating how density changes as mass or volume change.

### Objectives

Students will be able to:

- Describe how density changes in response to changing mass or volume
- Calculate the density of an object given its mass and volume

### Standards (TEKS)

IPC 7A

### Activity

Density is the ratio of the mass of an object to its volume. The standard units for density are kilograms per cubic meter,  $\text{kg/m}^3$ .

Consider a simple, though not entirely scientific, metaphor for density. The more stuff you put in a closet, the more full, or dense it is. If you take the same amount of stuff and put it into a larger closet, the less full or dense the closet is.

- 1) Open and run the Density virtual instrument, VI.

The graph in the VI represents density for many values of mass and volume. The darker the color on the graph is, the greater the density is. There is a red crosshairs on the graph called a cursor. The position of the cursor controls the mass and volume used to calculate the density displayed on the left. You can click and drag on the vertical line of the cursor to change the mass, the horizontal line to change the volume, or on the point of intersection to change both mass and volume at once.

- 2) Click and drag the vertical red line of the cursor to the right.
  - a) Notice the mass increases.
  - b) What happens to density as mass increases?
- 3) Click and drag the vertical red line of the cursor to the left.
  - a) Notice the mass decreases.



b) What happens to density as mass decreases?

When variables change in relationship to one another, sometimes they will change together. That is, if one variable gets doubled so does the other variable. For example, if you get paid by the hour and you work twice as long, you get twice the pay. We call this **direct variation**.

If the change is opposite, that is, if one variable gets larger and the other gets smaller as a result, we call it **inverse variation**. For example, if you are splitting a pizza equally among friends, then the more friends you include, the less pizza you each get.

- 4) Is the relationship between density and mass an example of direct or inverse variation?
- 5) Describe this relationship between density and mass in your own words.

Next, let's take a look at what happens to density when you change the volume of space the mass is occupying.

- 6) Click and drag the horizontal red line of the cursor upward.
  - a) Notice the volume increases.
  - b) What happens to density as volume increases?
- 7) Click and drag horizontal red line of the cursor downward.
  - a) Notice the volume decreases.
  - b) What happens to density as volume decreases?
- 8) Is the relationship between density and volume an example of direct or inverse variation?
- 9) Describe this relationship between density and volume in your own words.
- 10) Stop the VI.

When mass is measured in kilograms (kg) and volume is measured in cubic meters ( $m^3$ ), density can be calculated by dividing the mass by the volume. That is,  $D = \frac{m}{V}$ . For example, a large rock with a mass of 40 kg and a volume of  $2 m^3$  has a density of  $40/2 = 20 \text{ kg}/m^3$ .

- 11) Calculate the density of an object with the following characteristics. Convert units to kg and  $m^3$  as needed. (Hint:  $1 m^3$  is  $100 \times 100 \text{ cm}$ .)
  - a) mass = 3 kg and volume =  $0.5 m^3$
  - b) volume =  $2 m^3$  and mass = 14 kg and
  - c) mass = 210 g and volume =  $2 m^3$
  - d) mass = 27 kg and volume =  $2500 \text{ cm}^3$
- 12) Calculate the density of an object with a mass of 40 kg and volume of  $25 m^3$ .
  - a) Double the mass and recalculate the density.
  - b) Double the volume and recalculate the density.

- c) Does the density change as expected? Explain.
- 13) A construction crew has found a rather large and unusual rock while excavating a site. If they know the stone's density, they may be able to determine what type of rock it is. Using a crane and a scale, they determine the rock is 2512.5 kg. Using a special, proprietary method they determine the rock has a volume of 123.2 m<sup>3</sup>.
- What is the density of the rock?
  - What is one way the crew may have determined the rock's volume?

With this formula for density,  $D = \frac{m}{V}$ , as long as you know values for two of the variables and a little bit of algebra, you can find the value of the third.

- 14) Find the mass of an object if
- Density = 150 kg/m<sup>3</sup> and volume = 0.3 m<sup>3</sup>.
  - Density = 5.75 kg/m<sup>3</sup> and volume = 12 m<sup>3</sup>.
  - Volume = 2.5 m<sup>3</sup> and density = 13 kg/m<sup>3</sup>.
- 15) Find the volume of an object if
- Density = 2.35 kg/m<sup>3</sup> and mass = 14 kg.
  - Density = 32 kg/m<sup>3</sup> and mass = 1600 kg.
  - Mass = 1300 g and density = 42 kg/m<sup>3</sup>.