

## Chapter 8 Density and Buoyancy

### Calculating Density

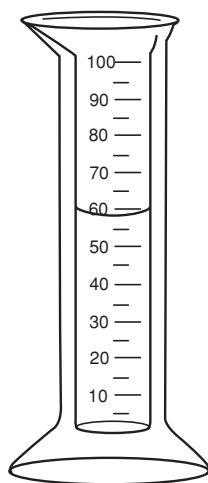
8. b. *Students know* how to calculate the density of substances (regular and irregular solids and liquids) from measurements of mass and volume.

The density of a substance is calculated by dividing its mass by its volume. The formula for calculating density looks like this:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

The mass of a substance is measured on a balance or a scale. If the substance is in a container, the mass of the container is subtracted from the total mass of the substance and the container, leaving the mass of the substance. This is usually necessary if the substance is a liquid.

Volume is measured differently, depending on whether the substance is a liquid, a regular solid, or an irregular solid. The volume of a liquid is measured with a graduated cylinder. Notice that the top surface of the liquid in the graduated cylinder is curved. This curve is called a **meniscus**. The volume of the liquid is equal to the marking at the bottom of the meniscus.

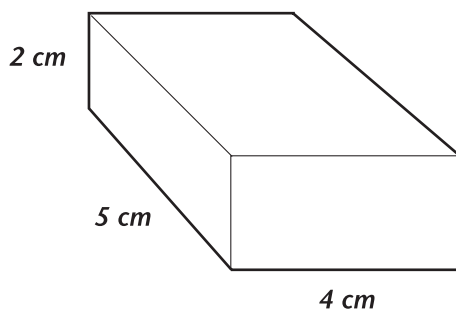


**Figure 8–1 Measuring volume** The volume of liquid in this graduated cylinder is 59 mL.

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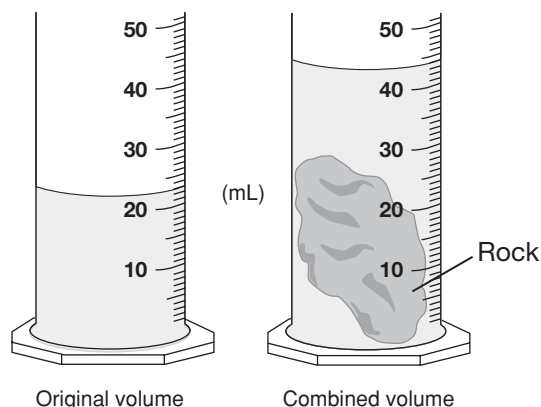
The volume of a regular solid can be found using geometry. For a rectangular solid, the volume is calculated by multiplying the length of the solid by its width and height, using the following formula:

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Height}$$



**Figure 8–2 Calculating volume** The volume of this box is  $4\text{ cm} \times 5\text{ cm} \times 2\text{ cm}$ , or  $40\text{ cm}^3$ .

The volume of an irregular solid, such as a rock, is measured using the water displacement method. In this method, the rock is added to a graduated cylinder that is filled with a known volume of water. The water level in the graduated cylinder will rise by an amount that is equal to the volume of the rock. To find the volume of the rock, the beginning volume of the water is subtracted from the combined volume of the water and the rock.



**Figure 8–3 Calculating volume of an irregular object** The volume of this rock is equal to the volume of the water subtracted from the combined volume of the rock and water, or  $44\text{ mL} - 23\text{ mL} = 21\text{ mL}$ .

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When the mass and volume of an object have been measured, these values can be inserted into the density equation to calculate the density. For example, if the rock in Figure 8–3 has a mass of 69.3 g, the equation would look like this.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{69.3 \text{ g}}{21 \text{ mL}}$$

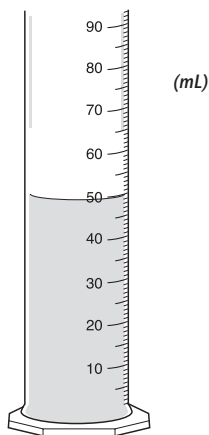
$$\text{Density} = 3.3 \text{ g/mL}$$

**Standard 8. b. Check**

**5** How is the mass of a rectangular solid measured?

- A with a graduated cylinder
- B with a meterstick
- C by the water displacement method
- D on a balance

**6**



This liquid has a mass of 69 g.  
What is its density?

- A 0.72 g/mL
- B 0.72 g/cm<sup>3</sup>
- C 1.38 g/mL
- D 3450 g/cm<sup>3</sup>

**7** What is the density of a substance that has a mass of 24.5 g and a volume of 9.5 mL?

- A 0.9 g/mL
- B 2.6 g/mL
- C 24.5 g/mL
- D 232 g/mL

**8** **Mass and Volume Data for Common Metals**

Metal	Mass of Sample (g)	Volume of Sample (cm <sup>3</sup> )
Iron	244.9	31
Steel	210.6	27
Aluminum	105.3	39
Platinum	321	15

Which metal has the *greatest* density?

- A iron
- B steel
- C aluminum
- D platinum