

MATH SKILLS● **Density**

The largest meteorite discovered on Earth is the Hoba West stone in Namibia, Africa. The volume of the stone is about 7.5 m^3 . If the meteorite has a density of 8.0 g/cm^3 , what is its mass?

1. List the given and unknown values.

$$\begin{aligned} \text{Given: } \quad & \text{volume, } V = 7.5 \text{ m}^3 \\ & \text{density, } D = 8.0 \text{ g/cm}^3 \end{aligned}$$

$$\text{Unknown: } \quad \text{mass, } m = ? \text{ kg}$$

2. Rearrange the density equation to calculate for mass.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{mass} = \text{density} \times \text{volume} \quad m = D \times V$$

3. Substitute density and volume values into the density equation, and solve.

$$m = \left(\frac{8.0 \text{ g}}{\text{cm}^3} \times \frac{10^6 \text{ cm}^3}{\text{m}^3} \right) \times 7.5 \text{ m}^3 = 6.0 \times 10^7 \text{ g}$$

$$m = 6.0 \times 10^4 \text{ kg}$$

Your Turn to Think

1. The largest ruby in the world is 10.9 cm long, 9.10 cm wide, and 5.80 cm thick, giving it an overall volume of 575 cm^3 . If the density of ruby—a form of aluminum oxide—is 3.97 g/cm^3 , what is the mass of the largest ruby?
2. Certain compounds called *aerogels* form rigid, lightweight foams that can support a mass many times greater than their own. If a sample of an aerogel has a volume of 87.3 cm^3 and a density of 0.250 g/cm^3 , what is the aerogel's mass?
3. Osmium, a hard, heavy metal used to make durable alloys, has a density of 22.5 g/cm^3 , the greatest density of any element. If a sample of osmium has a volume of 43.2 cm^3 , what is its mass?
4. The element iridium is more resistant to corrosion than any other metal. It also has a slightly smaller density than osmium: 22.42 g/cm^3 . Suppose you have a sample of iridium with a volume of 34.17 cm^3 . What is the mass of this sample?
5. A neutron star, which is the remnant of an exploded massive star, consists of neutrons packed together with a total density of $3.03 \times 10^{14} \text{ g/cm}^3$. If you had a 1.40 cm^3 sample of this matter (about the size of a sugar cube), what would its mass be?

MATH SKILLS● **Density** *continued***Sample Problem**

One of the largest emeralds ever discovered had a mass of 17.23 kg. Assuming its density to be 4.02 g/cm³, what was the emerald's volume?

1. List the given and unknown values.

$$\begin{aligned} \text{Given: } \quad \text{mass, } m &= 17.23 \text{ kg} \\ \text{density, } D &= 4.02 \text{ g/cm}^3 \end{aligned}$$

$$\text{Unknown: } \quad \text{volume, } V = ? \text{ cm}^3$$

2. Rearrange the density equation to calculate for volume.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{volume} = \frac{\text{mass}}{\text{density}}$$

$$V = \frac{m}{D}$$

3. Substitute density and mass values into the density equation, and solve.

$$V = \frac{17.23 \text{ kg}}{4.02 \text{ g/cm}^3} \times \frac{10^3 \text{ g}}{\text{kg}}$$

$$V = 4.29 \times 10^3 \text{ cm}^3$$

Your Turn to Think

- Magnesium is a fairly light metal that is combined with other elements to form lightweight alloys for use in airplanes. The big advantage of magnesium is that it has a relatively low density of 1.74 g/cm³. If a sample of magnesium has a mass of 9.56 g, what is its volume?
- Moon rocks are samples of the moon's crust that were collected and returned to Earth by crew members of the various Apollo missions. Many of the moon rocks are made of basalt, a light, volcanic rock with a density of about 2.7 g/cm³. If a moon rock has a mass of 432 g, what is its volume?
- Although both diamond and graphite consist of pure carbon, they have very different densities. This is because of differences in the way the carbon atoms in each substance are arranged. If you had a diamond with a mass of 1.5 g and a density of 3.51 g/cm³, what would its volume be?

MATH SKILLS● **Density** *continued*

9. One of the largest gold nuggets ever discovered was found in Australia in 1872. The nugget had a mass of 286 kg. Given that 19.32 g/cm^3 is the density of gold, calculate the volume of this nugget.
10. Gasoline, which is a mixture of several hydrocarbon compounds, has one of the lowest densities of any liquid. Given that 0.70 g/cm^3 is the density of gasoline, determine the volume of 2.77 kg of gasoline.

Sample Problem

Lithium is the lightest of metals and the least dense of all nongaseous elements. A pure lithium sample with a volume of 13.0 cm^3 has a mass of 6.94 g. What is the density of lithium?

1. List the given and unknown values.

Given: mass, $m = 6.94 \text{ g}$

volume, $V = 13.0 \text{ cm}^3$

Unknown: density, $D = ? \text{ g/cm}^3$

2. Write down the density equation.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$D = \frac{m}{V}$$

3. Substitute mass and volume values into the density equation, and solve.

$$D = \frac{m}{V} = \frac{6.94 \text{ g}}{13.0 \text{ cm}^3}$$

$$D = 0.534 \text{ g/cm}^3$$

Your Turn to Think

11. Outer space is often described as a vacuum, but there is always some matter present. In the space 300 km above Earth's surface, there is as little as $1.58 \times 10^{-12} \text{ g}$ of matter in a 500.0 cm^3 volume of space. Based on this data, what is the density of the matter in space?
12. The volume of a liquid that fills a flask is 750 cm^3 . The mass of the liquid is 525 g. What is the liquid's density? Is it most likely to be water ($D = 1.0 \text{ g/cm}^3$), gasoline ($D = 0.70 \text{ g/cm}^3$), or ethanol ($D = 0.79 \text{ g/cm}^3$)?

MATH SKILLS● **Density** *continued***Mixed Review**

13. Because inland seas like the Caspian Sea or the Great Salt Lake evaporate faster than they can be refilled, they have higher concentrations of salts than oceans have. The highest concentration of salts in any body of water is found in the Dead Sea, in Israel. If you had 1230 cm^3 of this water, which has a density of 1.22 g/cm^3 , what would be its mass?
14. *Density 21.5* is the title of a composition written for a musician with a platinum flute. Platinum's density is closer to 21.45 g/cm^3 . If the platinum flute's mass is 2.000 kg , what is its volume?
15. The density of sea water is slightly higher than that of fresh water. The higher density is due to the fact that sea water contains salts such as sodium chloride and magnesium chloride. Suppose you have a container that holds 5.00 kg of fresh water, which has a density of 1.00 g/cm^3 . If 5.00 kg of sea water with a density of 1.03 g/cm^3 is placed in a container of the same size, what is the volume of the space that is left unfilled?