



Subject: Science/ Physics

Title: Density

Name: Answer Key

Grade-Section:CS

Objectives:

- 1- Define Density
- 2- Learn how to calculate density
- 3- Differentiate between the density of regular and irregular solids
- 4- Examine how to calculate the density of liquids

What is Density?

Density is defined as the **mass** (amount of matter) of a substance that is found in a certain **volume**.

How do we calculate density?

$$DENSITY = \frac{MASS}{VOLUME} = kg/m^3$$

In our course we will use two units for density:

- 1- kg/m^3
- 2- g/cm^3

To solve density problems, list the known and unknown values, then use one of the following.

- ▶ When a problem requires you to calculate density, use the density equation, $D = \frac{M}{V}$
- ▶ You can solve for mass by multiplying both sides of the density equation by volume.

$$D V = \frac{M \cancel{V}}{\cancel{V}} \quad \text{or} \quad M = D V$$

- ▶ You can solve for volume by dividing both sides of the equation above by density.

$$\frac{M}{D} = \frac{\cancel{D} V}{\cancel{D}} \quad \text{or} \quad V = \frac{M}{D}$$



Exercise:

- 1) A metal cylinder has a mass of 6.20g and a volume of 124 cm³. What is the density of the cylinder?

$$D = \frac{m}{v} = \frac{6.2}{124} = 0.05 \text{ g/cm}^3$$

- 2) What is the mass of an object that has a density of 8g/cm³ and a volume of 64 cm³?

$$m = D \times V = 8 \times 64 = 512\text{g}$$

- 3) A piece of tin has a mass of 16.52 g and a volume of 2.26 cm³. What is the density of tin?

$$D = \frac{m}{V} = \frac{16.52}{2.26} = 7.31 \text{ g/cm}^3$$

- 4) A man has a 50.0 cm³ bottle completely filled with 163 g of a slimy green liquid. What is the density of the liquid?

$$D = \frac{m}{V} = \frac{163}{50} = 3.26\text{g/cm}^3$$

- 5) What is the volume of 325 g of metal with a density of 9.0 g/ cm³?

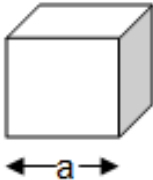
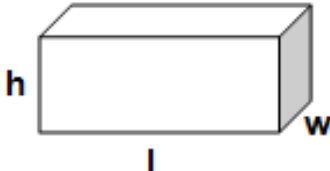
$$V = \frac{m}{D} = \frac{325}{9} = 36.11 \text{ cm}^3$$

- 6) You have a box that has a volume of 412 cm³ and weighs 42g. What is its density?

$$D = \frac{m}{V} = \frac{42}{412} = 0.102 \text{ g/cm}^3$$

Volume of a rectangular shaped object/cube

To find the volume we use the following rule: Length x Width x Height (L x W x H).

Figure	Formula	Variables
<p>Cube</p> 	a^3	a = length of edge
<p>Rectangular prism</p> 	$l \times w \times h$	l = length w = width h = height

Example:

Find the **volume** in each of the following:

- 1) A cube has a length of 3 cm. (Note – a cube has six equal sides).

$$\text{Solution: } V = 3 \times 3 \times 3 = 27 \text{ cm}^3.$$

- 2) A piece of wood has a length of 10 cm, width of 18 cm, and height of 3 cm.

$$\text{Solution: } V = 10 \times 18 \times 3 = 540 \text{ cm}^3$$

Check your understanding:

- 1) A rectangular fish tank is 60.00 cm long, 200.00 mm wide, and 200.00 m deep.

(a) What volume of water can it hold?

$$V = l \times w \times d$$

$$\text{length} = 60\text{cm}$$

$$\text{width} = \frac{200\text{mm}}{10} = 20 \text{ cm}$$

$$\text{depth} = 200\text{m} \times 100 = 20,000 \text{ cm}$$

$$V = 60 \times 20 \times 20000 = 24000000 \text{ cm}^3$$

(b) What is the mass of the water?

$$m = D \times V = 1 \times 24000000 = 24000000 \text{ g}$$

- 2) Calculate the density of a 500 g rectangular block with the following dimensions:

length=8 cm, width=6 cm, height=5 cm.

$$V = l \times w \times h = 8 \times 6 \times 5 = 240 \text{ cm}^3$$

$$D = \frac{m}{V} = \frac{500}{240} = 2.08 \text{ g/cm}^3$$

- 3) A gold cube is 150.00 mm long, 10.00 cm wide, and 0.95 m thick. If gold has a density of 19.3 g/cm^3 , calculate the mass of the gold cube.

$$l = \frac{150\text{mm}}{10} = 15 \text{ cm}$$

$$w = 10 \text{ cm}$$

$$t = 0.95\text{m} \times 100 = 95 \text{ cm}$$

$$V = l \times w \times t = 15 \times 10 \times 95 = 14,250 \text{ cm}^3$$

$$m = D \times V = 19.3 \times 14250 = 275,025 \text{ g}$$

Volume of an irregularly shaped object

Use a graduated cylinder filled with a fluid.

- Record the beginning amount of fluid.
- Drop the object into the graduated cylinder.
- Record the level of the fluid with the object.

To determine the volume:

Level of fluid with object – beginning amount of fluid



Example:

A graduated cylinder is filled to the 30mL mark with water. You drop in a rock. The water level rises to 48mL.

$$\text{Solution: } V = 48\text{mL} - 30\text{mL} = 18\text{mL} = 18 \text{ cm}^3$$

Check your understanding:

- 1) A bead weighs 15 g. You place it in a graduated cylinder that has 20mL of water in it. After placing the bead in the cylinder, the water level is now at 30mL. What is its density?

$$V_{\text{bead}} = V_2 - V_1 = 30 - 20 = 10\text{ml} = 10\text{cm}^3$$

$$D = \frac{m}{V} = \frac{15}{10} = 1.5 \text{ g/cm}^3$$

- 2) An irregular object with a mass of 118 g **displaces** 25mL of water when placed in a graduated cylinder. Calculate the density of the object.

$$D = \frac{m}{V} = \frac{118}{25} = 4.72 \text{ g/cm}^3$$

- 3) A graduated cylinder is filled with water to a level of 40.0 mL. When a piece of copper is lowered into the cylinder, the water level rises to 63.4 mL. Find the volume of the copper sample. If the density of the copper is 8.9 g/cm³, what is its mass?

$$V_{\text{copper}} = V_2 - V_1 = 63.4 - 40 = 23.4\text{ml} = 23.4\text{cm}^3$$

$$m = D \times V = 8.9 \times 23.4 = 0.38 \text{ g}$$

Density of Liquids:

- Just like solids, liquids also have their own characteristic density.
- The volume of a liquid can be measured directly with a graduated cylinder.
- To measure the mass of the liquid we do the following:
 - An empty measuring cylinder is put on a balance and its mass is found (M1)
 - The liquid is poured into the measuring cylinder and the mass is found on the balance as (M2)
 - Thus $\text{Mass} = M2 - M1$