

## R11a Part 2 Density, mass, and volume © BossMaths

### Warm-up activity



Here is a formula:  $d = \frac{m}{v}$

- a) Work out the value of  $d$  when  $m = 18$  and  $v = 3$

$$d = \frac{18}{3} = \underline{6}$$

- b) Rearrange the formula to make  $m$  the subject.

$$\begin{array}{l} d = \frac{m}{v} \\ \times v \quad \times v \\ \hline dv = m \end{array} \quad \text{so } \underline{m = dv}$$

- c) Work out the value of  $m$  when  $d = 5$  and  $v = 10$

$$m = dv = 5 \times 10 = \underline{50}$$

- d) Rearrange the formula to make  $v$  the subject.

$$\begin{array}{l} m = dv \\ \div d \quad \div d \\ \hline \frac{m}{d} = v \end{array} \quad \text{so } \underline{v = \frac{m}{d}}$$

- e) Work out the value of  $v$  when  $m = 28$  and  $d = 4$

$$v = \frac{m}{d} = \frac{28}{4} = \underline{7}$$

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Alpha Exercise

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

- a) A block with a volume of **8 cm<sup>3</sup>** weighs **80 g**. What is the density of this block in g/cm<sup>3</sup>?

$$\text{Density} = \frac{80 \text{ g}}{8 \text{ cm}^3} = \underline{10 \text{ g/cm}^3}$$

- b) A **1 cm x 2 cm x 10 cm cuboid** weighs 80 grams. What is the density of the cuboid?

$$\text{Volume of cuboid} = 1 \times 2 \times 10 = 20 \text{ cm}^3$$

$$\text{Density} = \frac{80 \text{ g}}{20 \text{ cm}^3} = \underline{4 \text{ g/cm}^3}$$

- c) A gym ball with a volume of **800 cm<sup>3</sup>** has a mass of 1600 g. What is the density of the ball?

$$\text{Density} = \frac{1600 \text{ g}}{800 \text{ cm}^3} = \underline{2 \text{ g/cm}^3}$$

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### Beta Exercise

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

- a) A **2 cm x 5 cm x 6 cm cuboid** weighs **30 grams**. What is the density of the cuboid?

$$\text{Volume of cuboid} = 2 \times 5 \times 6 = 60 \text{ cm}^3$$

$$\text{Density} = \frac{30 \text{ g}}{60 \text{ cm}^3} = \underline{0.5 \text{ g/cm}^3}$$

- b) Silver has a density of **10.5 g/cm<sup>3</sup>**. How much does **5 cm<sup>3</sup>** of silver weigh?

$$\begin{aligned} \text{Mass} &= \text{Density} \times \text{Volume} \\ &= 10.5 \text{ g/cm}^3 \times 5 \text{ cm}^3 = \underline{52.5 \text{ g}} \end{aligned}$$

- c) What is the volume of an object that weighs **40 g** and has a density of **4 g/cm<sup>3</sup>**.

$$\begin{aligned} \text{Volume} &= \frac{\text{Mass}}{\text{Density}} = \frac{40 \text{ g}}{4 \text{ g/cm}^3} \\ &= \underline{10 \text{ cm}^3} \end{aligned}$$

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### Gamma Exercise

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

- a) A **cube of side 2 cm** has a mass of **72 grams**. What is the density of the cube?

$$\text{Volume} = 2 \times 2 \times 2 = 8 \text{ cm}^3$$

$$\text{Density} = \frac{72 \text{ g}}{8 \text{ cm}^3} = \underline{9 \text{ g/cm}^3}$$

- b) Platinum has a density of **21.4 g/cm<sup>3</sup>**. How much does **1 m<sup>3</sup>** of platinum weigh?

$$1 \text{ m}^3 = 1,000,000 \text{ cm}^3$$

$$\begin{aligned} \text{Mass} &= \text{Density} \times \text{Volume} = 21.4 \text{ g/cm}^3 \times 1,000,000 \text{ cm}^3 \\ &= \underline{21,400,000 \text{ g} \text{ or } 21,400 \text{ kg}} \end{aligned}$$

- c) What is the volume of an object that weighs **450 g** and has a density of **7.5 g/cm<sup>3</sup>**?

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{450 \text{ g}}{7.5 \text{ g/cm}^3} = \underline{60 \text{ cm}^3}$$

- d) A ball with a volume of **900 cm<sup>3</sup>** has a mass of 225 g. What is the density of the ball? Will this ball float on water? (Water has a density of 1 g/cm<sup>3</sup>.)

$$\text{Density} = \frac{225 \text{ g}}{900 \text{ cm}^3} = \underline{0.25 \text{ g/cm}^3}$$

This is less dense than water, so will float.

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Explain the mistake

Denise answers this question as follows:

Iridium has a density of  $22.56 \text{ g/cm}^3$ . How much does  $1 \text{ m}^3$  of gold weigh?  
Give your answer in kg.

Each  $\text{cm}^3$  of iridium weighs  $22.56 \text{ g}$ . ✓

So  $100 \text{ cm}^3$  weighs  $22.56 \times 100 = 2256 \text{ g}$ . ✓

Therefore  $1 \text{ m}^3$  of iridium weighs  $2256 \text{ g}$  or  $2.256 \text{ kg}$ .  $1 \text{ m}^3 \neq 100 \text{ cm}^3$ .

**Denise has made a mistake.** What is it?

$1 \text{ m}^3 = 1,000,000 \text{ cm}^3$ , so  $1 \text{ m}^3$  of iridium weighs

$$22.56 \times 1,000,000 = 22,560,000 \text{ g}$$

$$\text{or } 22,560 \text{ kg}$$

Exam-style question

Wu has made a bronze sculpture.

The sculpture weighs  $384.5 \text{ kg}$ .

The density of the bronze used is  $7.8 \text{ g/cm}^3$ .

What is the volume of the sculpture, correct to the nearest  $\text{cm}^3$ ?

$$\text{Mass} = 384.5 \text{ kg}$$

$$= 384,500 \text{ g}$$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{384,500 \text{ g}}{7.8 \text{ g/cm}^3}$$

$$= \underline{49,295 \text{ cm}^3}$$

to nearest  $\text{cm}^3$

### Challenge

- (A) A scientist has a measuring jug with a capacity of 800 cm<sup>3</sup>. The measuring jug weighs 90 g when empty.
- (B) The scientist adds 200 cm<sup>3</sup> of liquid A and 600 cm<sup>3</sup> of liquid B to the jug, so the jug is now full and has a mass of 850 g.
- (C) The mass of 200 cm<sup>3</sup> of liquid A is equal to the mass of 350 cm<sup>3</sup> of liquid B.

What is the density of liquid A?

Let  $m_A$  and  $m_B$  be the masses (in g) of liquids A and B respectively. Similarly, let  $d_A$  and  $d_B$  be the densities (in g/cm<sup>3</sup>).

$$(A) \& (B) \Rightarrow m_A + m_B = 850 - 90 = 760$$

$$200d_A + 600d_B = 760$$

Divide through by 40

$$\Rightarrow 5d_A + 15d_B = 19 \quad (1)$$

$$(C) \Rightarrow \text{Also } d_B = \frac{200}{350} d_A = \frac{4}{7} d_A \quad (2)$$

$$\text{Substituting (2) into (1): } 5d_A + \frac{60}{7}d_A = 19$$

$$\Rightarrow \frac{95}{7}d_A = 19 \Rightarrow d_A = \frac{7}{95} \times 19$$

$$= \underline{1.4 \text{ g/cm}^3}$$