R11a Part 2 Density, mass, and volume

Warm-up activity

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

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

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

b) Rearrange the formula to make m the subject.

$d = \frac{m}{v}$

$\times v$ $\quad$ $\times v$

$dv = m$

so $m = dv$

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

$m = dv = 5 \times 10 = 50$

d) Rearrange the formula to make v the subject.

$m = dv$

$\div d$ $\quad$ $\div d$

$\frac{m}{d} = v$

so $v = \frac{m}{d}$

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

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

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a

Alpha Exercise

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

a) A block with a volume of **8 cm³** weighs **80 g**. What is the density of this block in g/cm³?

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

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

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

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

c) A gym ball with a volume of **800 cm³** has a mass of 1600 g. What is the density of the ball?

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

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β

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?

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

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

b) Silver has a density of **10.5 g/cm³**. How much does **5 cm³** of silver weigh?

Mass = Density × Volume

$= 10.5\ g/cm^3 \times 5\ cm^3 = 52.5\ g$

c) What is the volume of an object that weighs **40 g** and has a density of **4 g/cm³**.

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{40\ g}{4\ g/cm^3}$$

$= 10\ cm^3$

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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?

Volume $= 2 \times 2 \times 2 = 8\ cm^3$

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

b) Platinum has a density of **21.4 g/cm³**. How much does **1 m³** of platinum weigh?

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

Mass = Density × Volume $= 21.4\ g/cm^3 \times 1{,}000{,}000\ cm^3$

$= 21{,}400{,}000g$ or $21{,}400\ kg$

c) What is the volume of an object that weighs **450 g** and has a density of **7.5 g/cm³**?

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

d) A ball with a volume of **900 cm³** 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/cm³.)

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

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 g/cm^3. How much does 1 m^3 of gold weigh? Give your answer in kg.

Each cm^3 of iridium weighs 22.56 g. ✓
So 100 cm^3 weighs 22.56 x 100 = 2256 g. ✓
Therefore 1 m^3 of iridium weighs 2256 g or 2.256 kg. $1\,m^3 \neq 100\,cm^3$.

Denise has made a mistake. What is it?

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

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

or 22,560 kg

Exam-style question

Wu has made a bronze sculpture.
The sculpture weighs 384.5 kg.
The density of the bronze used is 7.8 g/cm^3.
What is the volume of the sculpture, correct to the nearest cm^3?

Mass = 384.5 kg
= 384,500 g

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

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

to nearest cm^3

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Challenge

Ⓐ A scientist has a measuring jug with a capacity of 800 cm^3 weighs 90 g when empty.

Ⓑ The scientist adds 200 cm^3 of liquid A and 600 cm^3 of liquid B to the jug, so the jug is now full and has a mass of 850 g.

Ⓒ The mass of 200 cm^3 of liquid A is equal to the mass of 350 cm^3 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^3).

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

$200 d_A + 600 d_B = 760$

Divide through by 40

$\Rightarrow$ $5 d_A + 15 d_B = 19$ ①

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

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

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

$= 1.4\ g/cm^3$