

Solutions

2.1 Volume: $V = 4.0 \times 2.0 \times 5.0 = 40 \text{ cm}^3 = 4.0 \times 10^{-5} \text{ m}^3$ (C1); mass $m = 0.352 \text{ kg}$ (C1).

$$\rho = \frac{0.352 \text{ kg}}{4.0 \times 10^{-5} \text{ m}^3} = \mathbf{8800 \text{ kg/m}^3}$$

(answer with unit A1.)

2.2 In a gas the particles are much further apart, so the same number of particles occupies a far larger volume – most of a gas is empty space.

2.3 Rearrange first: $V = m/\rho$ (C1); per second, $m = 824\,000 \text{ kg}$ (C1).

$$V = \frac{824\,000 \text{ kg}}{1030 \text{ kg/m}^3} = \mathbf{800 \text{ m}^3}$$

(answer A1.)

3.1 (a) Fill the displacement can to the spout and let it finish dripping; lower the rock fully on thin string; collect the displaced water in a measuring cylinder read at eye level; the volume collected equals the rock's volume, and the mass from a balance gives $\rho = m/V$.
(b)

$$\rho = \frac{84 \text{ g}}{33 \text{ cm}^3} = \mathbf{2.5 \text{ g/cm}^3} \text{ (2 s.f.)}$$

(division 1, answer with unit 1.) (c) $2.5 \times 1000 = \mathbf{2500 \text{ kg/m}^3}$.

3.2 (a) The cylinder's resolution (0.2 cm^3 divisions) is too coarse for a 0.44 cm^3 object.
(b) The thick string displaces extra water, so the measured volume is too large – and the density comes out too small. (c) Subtract 0.02 g from each reading.

3.3 (a) Zinc mass = $0.50 - m$; volumes add:

$$V_{\text{total}} = \frac{m}{8900} + \frac{0.50 - m}{7100} \quad \text{and} \quad V_{\text{total}} = \frac{0.50}{8500}$$

(equation set up C1, both volume terms A1.) (b) Multiply through by the denominators (or equate):

$$\begin{aligned} \frac{m}{8900} + \frac{0.50 - m}{7100} &= 5.882 \times 10^{-5} \\ 7100m + 8900(0.50 - m) &= 5.882 \times 10^{-5} \times 8900 \times 7100 \\ 7100m + 4450 - 8900m &= 3713 \quad \Rightarrow \quad 1800m = 737 \\ m &= \mathbf{0.41 \text{ kg}} \text{ (copper)} \end{aligned}$$

(algebra C1, substitution C1, answer A1.) (c) Any one: the volumes simply add (no contraction on mixing); the densities stay as tabulated in alloy form.