Solutions

Each answer shows the steps, then the **result**.

2.1

- density is **mass per unit volume**, unit kg m^{-3}

2.2

- $\rho = m/V$

$$\rho = \frac{2400 \text{ kg}}{0.30 \text{ m}^3} = \mathbf{8000} \text{ kg m}^{-3}$$

2.3

- $p = F/A$

$$p = \frac{200 \text{ N}}{0.50 \text{ m}^2} = \mathbf{400} \text{ Pa}$$

2.4

- the **difference in pressure** between the bottom and top of the object (the bottom is deeper)

3.1 B

- $\Delta p = \rho g \Delta h$ depends only on **density** and **depth**
- **A** / **D** (volume, area) do not appear: a narrow tube and a wide tank of the same depth give the same pressure

3.2

- $\Delta p = \rho g h$

$$\Delta p = (1000 \text{ kg m}^{-3})(9.81 \text{ m s}^{-2})(2.5 \text{ m}) = \mathbf{2.5 \times 10^4} \text{ Pa}$$

3.3

- upthrust = weight of fluid displaced $= \rho g V$

$$F = (1000 \text{ kg m}^{-3})(9.81 \text{ m s}^{-2})(2.0 \times 10^{-3} \text{ m}^3) = \mathbf{19.6} \text{ N}$$

3.4

- mass of the column $m = \rho V = \rho A h$
- weight $W = mg = \rho A h g$ presses on area A

$$\Delta p = \frac{W}{A} = \rho g h$$

3.5

(a) density is **mass per unit volume**

(b) $V = 8.02 \text{ cm} \times 4.15 \text{ cm} \times 2.05 \text{ cm} = 68.2 \text{ cm}^3$

- convert: $V = 6.82 \times 10^{-5} \text{ m}^3$

$$\rho = \frac{0.512 \text{ kg}}{6.82 \times 10^{-5} \text{ m}^3} = \mathbf{7.5 \times 10^3} \text{ kg m}^{-3}$$

(c) percentage uncertainties

- mass: $0.001/0.512 = 0.20\%$; x: $0.01/8.02 = 0.12\%$; y: $0.01/4.15 = 0.24\%$; z: $0.01/2.05 = 0.49\%$
- total $= 0.20 + 0.12 + 0.24 + 0.49 = \mathbf{1.1}\%$

(d) the **height** z

- it is the smallest length, so the same ± 0.01 cm is the largest percentage of it

(e) upthrust $= \rho_{\text{water}} g V$

$$F = (1000 \text{ kg m}^{-3})(9.81 \text{ m s}^{-2})(6.82 \times 10^{-5} \text{ m}^3) = \mathbf{0.67} \text{ N}$$

- the block's weight is $mg = (0.512 \text{ kg})(9.81 \text{ m s}^{-2}) = 5.0$ N, much larger, so it **sinks**

(f) floating: upthrust = weight $\Rightarrow \rho_{\text{water}} V_{\text{sub}} = \rho_{\text{wood}} V_{\text{total}}$

$$\frac{V_{\text{sub}}}{V_{\text{total}}} = \frac{650}{1000} = 0.65 \Rightarrow \mathbf{65}\% \text{ below the surface}$$

(g)

$$\Delta p = \rho g h = (1000 \text{ kg m}^{-3})(9.81 \text{ m s}^{-2})(2.0 \text{ m}) = 1.96 \times 10^4 \text{ Pa}$$

- $A = 25 \text{ m} \times 10 \text{ m} = 250 \text{ m}^2$

$$F = pA = (1.96 \times 10^4 \text{ Pa})(250 \text{ m}^2) = \mathbf{4.9 \times 10^6} \text{ N}$$

- assumption: flat bottom (same depth everywhere); atmospheric pressure is **not** included