

Solutions

2.1

$$p = F/A = 200/0.25 = \mathbf{800 \text{ Pa}}$$

(C1, A1)

2.2 The height (depth) of liquid above the point and the liquid's density.

2.3 The water exerts a larger pressure on the balloon's bottom than its top, so the resultant force – the upthrust – acts upwards and exceeds the balloon's weight: it rises.

3.1 (a)

$$p = h\rho g = 2.0 \times 1000 \times 9.8 = \mathbf{19\,600 \text{ Pa}} \ (\approx 20 \text{ kPa})$$

(equation C1, substitution C1, answer A1) (b) Pressure grows with the height of water above that point, so near the bottom the column above is taller – greater pressure. (c) $F = pA = 19\,600 \times 50 = \mathbf{980\,000 \text{ N}} \approx 980 \text{ kN}$ (C1, A1).

3.2 (a) The height of water above the hull increases with depth, and pressure increases with column height ($p = h\rho g$). (b) The external pressure is higher, so the trapped air is compressed; at constant temperature $pV = \text{constant}$, so the volume falls – about $6.0 \times \frac{101}{101+294} \approx 1.5 \text{ L}$. (c) The pressure acts on a large hull area, and $F = pA$ gives a very large force trying to crush it – the hull must resist that.

3.3 (a) Oil is less dense than vinegar: a floating layer displaces until upthrust = weight, which needs the lighter liquid on top. (b) Upthrust = weight of vinegar displaced:

$$F = \rho_{\text{vinegar}} Vg = 1010 \times 1.0 \times 10^{-6} \times 9.8 = \mathbf{9.9 \times 10^{-3} \text{ N}}$$

(equation C1, substitution C1, answer A1) (c) Weight:

$$W = mg = \rho_{\text{bead}} Vg = 2500 \times 1.0 \times 10^{-6} \times 9.8 = \mathbf{2.45 \times 10^{-2} \text{ N}}$$

(C1, A1) – greater than the upthrust (0.0099 N), so the bead **stays on the bottom**.