

Exercise walk-through

5.5

Pressure and pressure differences in fluids – physics only (4.5.5)

AQA · GCSE · Physics

Exercises 2.1·2.3

2.1 A force of 200 N acts on an area of 0.25 m^2 . Calculate the pressure. [2]

2.2 (HT) State the two liquid properties that raise the pressure at a point below the surface. [2]

2.3 Explain why a balloon rises in water in terms of the forces on it. [2]

Exercises 2.1·2.3

2.1 A force of 200 N acts on an area of 0.25 m². Calculate the pressure. [2]

2.1

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

(C1, A1)

2.2 (HT) State the two liquid properties that raise the pressure at a point below the surface. [2]

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

2.3 Explain why a balloon rises in water in terms of the forces on it. [2]

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.

Exercise 3.1

3.1 A swimming pool is filled to a depth of 2.0 m ($\rho = 1000 \text{ kg/m}^3$, $g = 9.8 \text{ N/kg}$; HT).

(a) Calculate the pressure due to the water at the bottom. [3]

(b) Explain why the pressure on the side walls near the bottom is greater than near the top. [2]

(c) The pool's bottom has an area of 50 m^2 . Calculate the water's force on the bottom. [2]

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3.1 (a)

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

(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).

Exercise 3.2

3.2 A submarine dives.

- (a) Explain what happens to the pressure on the hull as the depth increases. [2]
- (b) (HT) At 30 m the water pressure is about 294 kPa greater than at the surface. State what would happen to a diver's lungs of volume 6.0 L at this depth if held, in terms of pressure and volume at constant temperature. [2]
- (c) Explain why the submarine's hull must be strong, using pressure and force. [2]

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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 $6.0 \times \frac{101}{101+294} \approx 1.5$ 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.

Exercise 3.3

3.3 A jar contains oil floating on vinegar with a solid bead at the bottom (oil $\rho = 920$, vinegar $\rho = 1010 \text{ kg/m}^3$).

- (a) Explain, with densities, why the oil floats on the vinegar. [2]
- (b) The bead (volume $1.0 \times 10^{-6} \text{ m}^3$, density 2500 kg/m^3) sits in the vinegar. Calculate the upthrust on it in the vinegar ($g = 9.8 \text{ N/kg}$, HT method $F = pA$ not needed: use ρVg). [3]
- (c) Calculate the bead's weight and state whether it stays on the bottom. [3]



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Full solution 3.3

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

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

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

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