Fluids: Pressure, Buoyancy & Bernoulli

Fluids · 4 questions · step-by-step answers at the end

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USEFUL EQUATIONS

$\rho = m/V,\ P = F/A \quad P = P_0 + \rho g h \quad F_b = \rho_{\text{fluid}} V_{\text{sub}} g \quad A_1 v_1 = A_2 v_2$

$P_1 + \tfrac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \tfrac{1}{2}\rho v_2^2 + \rho g y_2$

Questions

Show your working in the space under each question.

1. Water flows at 2.0 m/s in a pipe 4.0 cm wide that narrows to 2.0 cm. Find the new speed and the pressure drop (same height).

2. A solid aluminium cube (ρ = 2700 kg/m³) with 0.20 m sides is fully submerged in water. Find its weight, the buoyant force, and its apparent weight in water.

3. A rock weighs 30 N in air and 20 N fully submerged in water. Find its volume and density.

4. What is the gauge pressure 10 m under water? What is the absolute pressure?

Step-by-step answers

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1. Area ratio = $(4/2)^2 = 4$, so v_2 = **8.0 m/s**; $\Delta P = \tfrac{1}{2}\rho(v_2^2 - v_1^2) = \tfrac{1}{2}(1000)(64 - 4)$ = **30 kPa** lower.

2. 1. Volume $V = (0.20)^3 = 0.008\ m^3$.
2. Weight = $\rho Vg = (2700)(0.008)(9.8)$ = **212 N**.
3. Buoyant force = $\rho_{water} Vg = (1000)(0.008)(9.8)$ = **78 N**.
4. Apparent weight = 212 − 78 = **133 N**. That is what a spring scale would read.

Answer: W = 212 N, F_b = 78 N, apparent weight = 133 N

3. $F_B = 10\ N \rightarrow V = 10/(1000 \times 9.8)$ = **$1.0 \times 10^{-3}\ m^3$**; $\rho = (30/9.8)/V \approx$ **$3000\ kg/m^3$**.

4. Gauge ρgh = **98 kPa**; absolute ≈ 98 + 101 = **199 kPa**.