

Density, pressure, buoyancy and moving fluids

AP Physics 1 (algebra-based) · Test answers (mark scheme)

Award marks as shown for method, substitution and final answer. In explanation questions, accept any wording that states the correct physical law and links it to the observation. Do not penalise a unit slip twice.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 8

Question 1 Pressure on a surface (2 marks)

(a) $P = F/A = 600 / 0.020 = \mathbf{3.0 \times 10^4 \text{ Pa}}$.

(b) The area doubles, so the pressure is halved to $\mathbf{1.5 \times 10^4 \text{ Pa}}$.

Marking: 1 mark for the substitution and answer in (a); 1 mark for halving in (b).

Question 2 Pressure at 8 m (3 marks)

$pgh = 1000 \times 9.81 \times 8.0 = 7.85 \times 10^4 \text{ Pa}$. $P = 1.01 \times 10^5 + 0.785 \times 10^5 = \mathbf{1.79 \times 10^5 \text{ Pa}}$.

Marking: 1 mark for $P = P_0 + pgh$; 1 mark for pgh ; 1 mark for the final answer with unit.

Question 3 Thick dam walls (2 marks)

Pressure increases linearly with depth ($P = P_0 + pgh$), so the horizontal force of the water is largest at the bottom. The wall needs more strength there, hence it is thicker at the base.

Pressure grows with depth.

Marking: 1 mark for pressure increasing with depth; 1 mark for linking this to greater force at the base.

Question 4 Floating cube (3 marks)

(a) $m = 700 \times 1.0 \times 10^{-3} = 0.70 \text{ kg}$; $W = 0.70 \times 9.81 = \mathbf{6.9 \text{ N}}$.

(b) Floating: $B = W$, so $\rho_w g A h = W$: $1000 \times 9.81 \times 0.010 \times h = 6.867$, giving $h = \mathbf{0.070 \text{ m}}$.

Marking: (a) 1 mark; (b) 1 mark for setting $B = W$, 1 mark for the answer.

Question 5 River narrowing (2 marks)

The flow rate must stay the same, $Av = \text{constant}$. Half the cross-section means the water must move twice as fast, so the speed becomes $\mathbf{1.0 \text{ m/s}}$.

Marking: 1 mark for continuity; 1 mark for doubling.

Question 6 Water pipe rising (3 marks)

The diameter is constant, so the speed is unchanged. $P_2 = P_1 - \rho g \Delta y = 2.50 \times 10^5 - 1000 \times 9.81 \times 4.0 = 2.50 \times 10^5 - 0.392 \times 10^5 = \mathbf{2.1 \times 10^5 \text{ Pa}}$.

Marking: 1 mark for constant speed; 1 mark for the $\rho g \Delta y$ term; 1 mark for the final answer.

Question 7 Lift in wind (2 marks)

Fast air moving over the outside has lower pressure ($P + \frac{1}{2}\rho v^2$ is constant). The air inside is nearly still and at higher pressure, so a net upward force acts on the roof. **Faster air gives lower pressure.**

Marking: 1 mark for lower pressure where speed is higher; 1 mark for the pressure difference giving an upward force.

Question 8 Boat in the sea (3 marks)

The weight of the boat does not change, so the buoyant force is the same. Seawater is denser than river water, so a smaller volume of water has to be displaced to give the same force. The boat **floats higher**.

Marking: 1 mark for buoyant force equal to weight; 1 mark for the higher density; 1 mark for the conclusion.