

AS Physics 9702

Unit 4 · Forces, density and pressure

Worked answers

Try the separate worksheet first. These worked answers explain methods as well as results. Equivalent valid reasoning and sensible rounding may also be correct. Suggested marks are RevisionTown practice guidance, not Cambridge marking instructions.

Scope: Cambridge International AS Physics 9702, 2025–2027 learning outcomes. The published 2028–2030 AS scope has been checked separately and is substantively unchanged. Version: 11 October 2026.

U4-Q1 · 6 marks

(a) Suspend the card freely from one point, mark the vertical plumb line through the suspension point, then repeat from a different point. The lines intersect at the centre of gravity. Weight must act vertically below the suspension point in equilibrium. (b) Perpendicular distance = $0.300 \sin 40^\circ = 0.1928 \text{ m}$; moment = $24.0 \times 0.1928 = 4.63 \text{ N m}$. (c) Zero, because perpendicular distance is zero.

U4-Q2 · 6 marks

(a) The forces are equal, opposite and parallel, with distinct lines of action. (b) Resultant force = 0; torque = $Fd = 35.0 \times 0.240 = 8.40 \text{ N m}$. (c) Each lever arm is 0.120 m, and both moments have the same sense: $2 \times 35.0 \times 0.120 = 8.40 \text{ N m}$. (d) Separation becomes zero, so both resultant force and torque are zero; there is no couple.

U4-Q3 · 7 marks

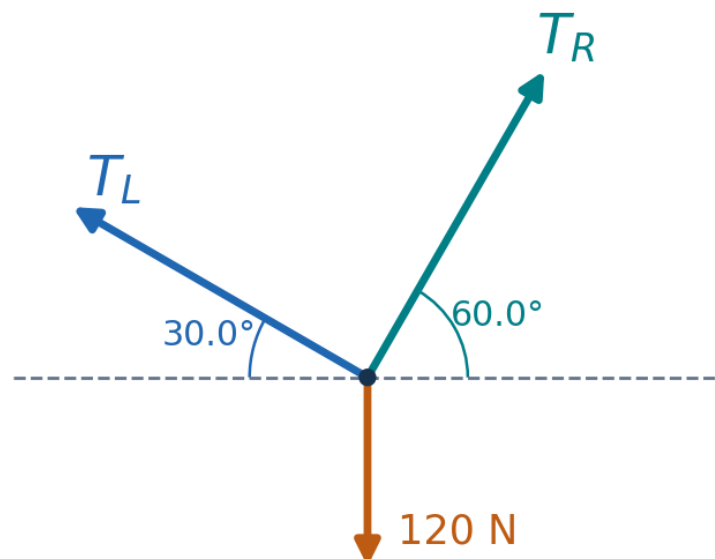
(a) Resultant force and resultant moment must both be zero. (b) Taking moments about the left support: $R_{\text{right}}(3.00) = 90.0(1.50) + 150(2.40) = 495 \text{ N m}$. Thus $R_{\text{right}} = 165 \text{ N}$ upward. Vertical force balance gives $R_{\text{left}} + 165 = 90.0 + 150$, hence $R_{\text{left}} = 75.0 \text{ N}$ upward. (c) A uniform beam's centre of gravity is at its midpoint, so its entire weight can be represented there.

U4-Q4 · 8 marks

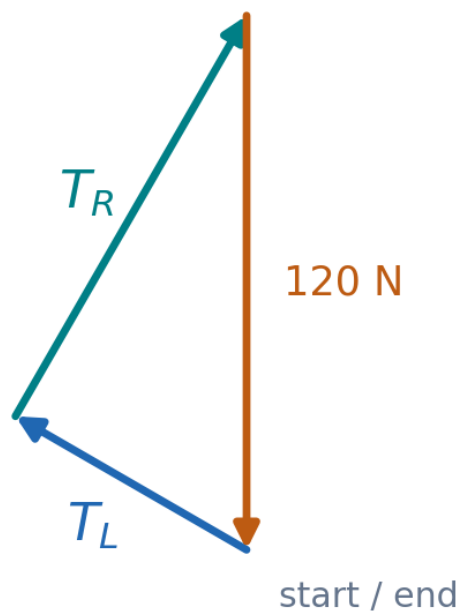
(a) Horizontal balance: $T_L \cos 30^\circ = T_R \cos 60^\circ$, so $T_R = \sqrt{3}T_L$. Vertical balance: $T_L \sin 30^\circ + T_R \sin 60^\circ = 120$. Thus $2T_L = 120$, giving $T_L = 60.0 \text{ N}$ and $T_R = 104 \text{ N}$. (b) Draw the left tension parallel to the left cable, attach the right tension head-to-tail parallel to its cable, then the 120 N vertical downward force; it closes. (c) The vector directions as well as magnitudes must match the real forces. An extended body must also have zero resultant moment.

Figure for U4-Q4 — worked answer

Forces at the knot



Closed head-to-tail force triangle



U4-Q5 · 6 marks

(a) Displaced volume = $20.0 \text{ cm}^3 = 2.00 \times 10^{-5} \text{ m}^3$. Mass = 0.156 kg, so density = $0.156 / (2.00 \times 10^{-5}) = 7800 \text{ kg m}^{-3}$. (b) Ensure complete immersion without touching or spilling liquid; read the meniscus at eye level; remove trapped bubbles. (c) A bubble increases apparent displaced volume without adding appreciable mass, so the calculated density is too low.

U4-Q6 · 5 marks

Area = $0.120 \times 0.0800 = 0.00960 \text{ m}^2$. Pressure = $720 / 0.00960 = 7.50 \times 10^4 \text{ Pa}$. Doubling both dimensions quadruples area, so pressure is one quarter: $1.875 \times 10^4 \text{ Pa} \approx 1.88 \times 10^4 \text{ Pa}$. Pressure is normal force per area, not force per side length.

U4-Q7 · 7 marks

Volume = $A\Delta h$; mass = $\rho A\Delta h$; weight = $\rho A\Delta h g$ downward. The lower-face pressure produces $p_b A$ upward; the upper-face pressure produces $p_t A$ downward. Equilibrium gives $p_b A = p_t A + \rho A\Delta h g$. Divide by A : $p_b - p_t = \rho g\Delta h$. Assume uniform fluid density and g , with stationary fluid. Pressure force and column weight both scale with area, so area cancels.

U4-Q8 · 7 marks

(a) Gauge pressure = $850 \times 9.81 \times 3.20 = 26\,683.2 \text{ Pa} = 26.7 \text{ kPa}$. Absolute pressure = $101 + 26.6832 = 127.6832 \text{ kPa}$, approximately 128 kPa. (b) Gradient = $\rho g = 8338.5 \text{ Pa m}^{-1} \approx 8.34 \times 10^3 \text{ Pa m}^{-1}$; intercept = 101 kPa. (c) No, provided fluid, surface pressure, g and depth are unchanged.

U4-Q9 · 8 marks

(a) $\Delta p = 1000 \times 9.81 \times 0.0500 = 490.5 \text{ Pa}$. (b) Net upward pressure force = $\Delta p A = 490.5 \times 0.00400 = 1.962 \text{ N}$. Displaced volume = $Ah = 2.00 \times 10^{-4} \text{ m}^3$; Archimedes' principle gives $U = 1000 \times 9.81 \times 2.00 \times 10^{-4} = 1.962 \text{ N}$, about 1.96 N. (c) Both face pressures increase equally, so their difference and the upthrust remain unchanged if volume and water density remain constant.

U4-Q10 · 7 marks

(a) $U = \rho g V = 800 \times 9.81 \times 1.50 \times 10^{-4} = 1.1772 \text{ N} \approx 1.18 \text{ N}$. Weight = $0.350 \times 9.81 = 3.4335 \text{ N}$. Equilibrium requires $T + U = W$, so $T = 2.2563 \text{ N} \approx 2.26 \text{ N}$. (b) Floating equilibrium gives $\rho_{\text{water}} g V_{\text{sub}} = \rho_{\text{block}} g V_{\text{total}}$. Fraction = $600/1000 = 0.600$, or 60.0%.

U4-Q11 · 3 marks

Correct option: C. Both translation and rotation must have zero acceleration. A allows a non-zero couple and rotational acceleration. B can coexist with a non-zero force whose line of action passes through the selected point. D describes a couple, whose zero resultant force is accompanied by non-zero torque.

U4-Q12 · 3 marks

Correct option: B. Pressure increases with depth, but upthrust = $\rho g V$ remains unchanged because density and displaced volume are unchanged. A confuses absolute pressure with the pressure difference responsible for upthrust. C incorrectly makes pressure depth-independent and upthrust depth-dependent. D correctly keeps upthrust fixed but ignores hydrostatic pressure increase.

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