

AS Physics 9702

Unit 5 · Work, energy and power

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.

U5-Q1 · 5 marks

(a) Only the horizontal force component contributes: $W = 60 \times 5.0 \times \cos 40^\circ = 229.8 \text{ J} \approx 230 \text{ J}$. (b) $W_R = -18 \times 5.0 = -90 \text{ J}$. (c) The normal reaction is perpendicular to displacement, so its work is zero. Weight also does zero work. Total work = $229.8 - 90 = 139.8 \text{ J} \approx 140 \text{ J}$.

U5-Q2 · 6 marks

(a) Energy lost = $mgh = 1.5 \times 9.81 \times 1.2 = 17.658 \text{ J}$. (b) $E_K = (1/2) \times 1.5 \times 4.0^2 = 12.0 \text{ J}$. (c) Other transfers = $17.658 - 12.0 = 5.658 \text{ J} \approx 5.7 \text{ J}$. Mechanical energy decreases, but energy appears in internal energy of the parcel, track and surroundings, and possibly sound. Total energy is conserved when those stores are included.

U5-Q3 · 5 marks

(a) Efficiency is useful energy output divided by total energy input: $\eta = 33.6 / 48 = 0.700 = 70.0\%$. (b) Unwanted transfer = $48 - 33.6 = 14.4 \text{ kJ}$. (c) Overall efficiency = $0.700 \times 0.85 = 0.595 = 59.5\%$. Equivalently, useful load energy is 28.56 kJ from a 48 kJ input.

U5-Q4 · 5 marks

(a) Power is work done per unit time. $P = 18\,000 / 12.0 = 1500 \text{ W}$. (b) $P_{\text{in}} = 1500 / 0.75 = 2000 \text{ W}$. (c) The rate of doing work may vary during the 12 s ; dividing total work by total time gives its average.

U5-Q5 · 6 marks

(a) $P = W / t = Fs / t$. Since $v = s / t$ for uniform motion, $P = Fv$. The same relation is instantaneous when the time interval is made small. (b) $F = P / v = 9600 / 12 = 800 \text{ N}$. (c) $F = 9600 / 8.0 = 1200 \text{ N}$. A real drive has limited torque/traction, so it cannot maintain constant power with arbitrarily large force as speed approaches zero.

U5-Q6 · 6 marks

(a) Slow lifting gives approximately zero acceleration, so lifting force = weight = mg . Work over vertical displacement Δh is $mg\Delta h$; with no change in kinetic energy or other transfers, this equals ΔE_p . Thus $\Delta E_p = mg\Delta h$. (b) Use vertical height, not slope distance: $6.0 \times 9.81 \times 1.5 = 88.29 \text{ J} \approx 88 \text{ J}$. (c) No; the increase depends on the initial and final heights in this uniform field.

U5-Q7 · 6 marks

(a) Resultant work $W = Fs = mas$. From the motion equation, $as = (v^2 - u^2) / 2$, so $W = (1/2)m(v^2 - u^2) = \Delta E_k$. With $u = 0$ and initial kinetic energy zero, $E_k = (1/2)mv^2$. (b) $\Delta E_k = (1/2) \times 900 \times (256 - 100) = 70\,200 \text{ J}$. (c) The difference of the squared speeds is required, not the square of their difference; these are algebraically different.

U5-Q8 · 6 marks

(a) Vertical speed = $15 / 20 = 0.75 \text{ m s}^{-1}$. (b) Rate of increase of potential energy = $mgv_{\text{vertical}} = 1000 \times 9.81 \times 0.75 = 7357.5 \text{ W}$. (c) Power against resistance = $500 \times 15 = 7500 \text{ W}$. Driving power = $14\,857.5 \text{ W} \approx 14.9 \text{ kW}$. Speed and mass are constant, so kinetic energy is unchanged; engine energy supplies potential energy and dissipative transfers.

U5-Q9 · 5 marks

(a) Work is the graph area: triangular area $(1/2) \times 3.0 \times 20 = 30 \text{ J}$ plus rectangular area $2.0 \times 20 = 40 \text{ J}$, giving 70 J . (b) This resultant work equals ΔE_k . Thus $(1/2) \times 4.0 \times v^2 = 70$, so $v = \sqrt{35} = 5.92 \text{ m s}^{-1}$.

U5-Q10 · 6 marks

(a) $P = mgh / t = 2.00 \times 9.81 \times 1.20 / 3.00 = 7.848 \text{ W} \approx 7.85 \text{ W}$. Efficiency = $7.848 / 10.0 = 0.7848 \approx 78.5\%$. (b) Maximum percentage uncertainty $\approx 100(0.01/2.00 + 0.01/1.20 + 0.10/3.00) = 4.67\%$. Absolute power uncertainty is about 0.37 W . (c) Time a longer lift, or use electronic start/stop sensors; repeats reduce random scatter but do not necessarily remove a consistent reaction-time bias.

U5-Q11 · 2 marks

Correct option: A. The displacement component along the upward force is zero, so $W = Fs \cos 90^\circ = 0$. B ignores the angle. C confuses the supporting force with weight, which also does zero work for exactly horizontal motion. D confuses energy used inside the student with mechanical work by the specified force on the bag. Award one mark for A and one for the perpendicular-force explanation.

U5-Q12 · 2 marks

Correct option: C. The new energy is $(1.20)^2 = 1.44$ times the original, so the increase is 44%. A treats energy as proportional to speed. B doubles the percentage change as though it were an exact rule for a substantial change; that is only a small-change approximation. D gives the final energy as a percentage of the original, not its percentage increase.

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