

AS Physics 9702

Unit 8 · Superposition

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.

U8-Q1 · 6 marks

(a) Resultant displacement is the algebraic sum of the separate displacements: $+4.0 - 1.5 = +2.5$ mm. (b) At nodes the contributions remain opposite and cancel; at antinodes they reinforce to the greatest oscillation amplitude. Equal-frequency, equal-wavelength, equal-amplitude waves travelling oppositely can give this stationary pattern. (c) Other points pass through equilibrium. Draw both travelling-wave curves at several times and add their signed vertical ordinates; only positions whose resultant remains zero are nodes.

U8-Q2 · 6 marks

(a) Drive the stretched string with a variable-frequency generator; its wave reflects and overlaps with the oppositely travelling wave. Adjust frequency or tension until a stable resonant pattern appears. (b) Three loops contain three half-wavelengths: $0.90 = 3\lambda/2$, so $\lambda = 0.60$ m. $v = f\lambda = 120 \times 0.60 = 72$ m s⁻¹. (c) Node-to-nearest-antinode spacing is $\lambda/4 = 0.15$ m. Adjacent loops oscillate in antiphase, differing by 180°.

U8-Q3 · 6 marks

(a) Incident and reflected waves of the same frequency travel oppositely and superpose; near a node their electric fields cancel, giving a low detector signal. (b) Six minima span five half-wavelength gaps. $\lambda = 2 \times 80.0/5 = 32.0$ mm = 0.0320 m. $f = c/\lambda = 9.375 \times 10^9$ Hz ≈ 9.38 GHz. (c) A larger measured distance reduces fractional position uncertainty. Fixed probe orientation prevents changes in sensitivity to polarisation from being mistaken for spatial intensity variation.

U8-Q4 · 6 marks

(a) Diffraction is wave spreading beyond a gap or around an obstacle into regions including the geometrical shadow. (b) A 120 mm gap is eight wavelengths wide, so fronts are mainly straight with spreading near edges. An 18 mm gap is comparable to λ , so the transmitted waves spread much more strongly with curved fronts. (c) Keep water depth and source frequency fixed, producing approximately unchanged wavelength. Change only gap width while observing or recording wavefront curvature beyond the barrier. Use the same source geometry and reduce reflected waves with absorbing edges where possible.

U8-Q5 · 8 marks

(a) Coherent waves have the same frequency and maintain a constant phase difference. Two independent equal-frequency sources can have a wandering phase relationship, moving the pattern too rapidly to give stable fringes. (b) Water: two point dippers driven by one oscillator give strong/weak motion lines. Sound: two speakers driven by one signal generator give loud/quiet positions scanned with a microphone. Microwaves: one transmitter illuminates two slits, and a receiver scans intensity maxima/minima beyond them. Each shares an oscillator or parent wave. (c) Constructive: path difference $m\lambda$. Destructive: $(m + 1/2)\lambda$. Unequal amplitudes prevent complete cancellation; background or reflections can also raise minima.

U8-Q6 · 6 marks

(a) The lamps do not maintain a constant relative phase, so their interference pattern changes rapidly and averages out. (b) Illuminate both close, narrow slits from one monochromatic laser, or use a monochromatic source followed by a single slit to provide coherent illumination. Ensure the beams overlap on a distant screen and their polarisation components can interfere; similar amplitudes improve contrast. (c) Keep the beam and specular reflections away from eyes, use a beam stop, and never look directly into the beam.

U8-Q7 · 7 marks

(a) There are eight fringe intervals: $x = 28.8/8 = 3.60$ mm. $\lambda = ax/D = (0.30 \times 10^{-3})(3.60 \times 10^{-3})/1.80 = 6.00 \times 10^{-7}$ m = 600 nm. (b) The screen is far from the slits compared with separation, and observation angles are small, so $\sin \theta \approx \tan \theta$. (c) Maximum percentage uncertainty = $2.0 + 1.5 + 0.5 = 4.0\%$. Dividing span and its absolute uncertainty by the exact integer eight leaves fractional uncertainty unchanged.

U8-Q8 · 6 marks

(a) Line density = $600 \times 1000 = 6.00 \times 10^5$ m⁻¹. $d = 1/N = 1.6667 \times 10^{-6}$ m. (b) $\sin \theta = n\lambda/d = 2 \times 520 \times 10^{-9}/(1.6667 \times 10^{-6}) = 0.624$, so $\theta = 38.61^\circ$. (c) $n \leq d/\lambda = 3.205$, so highest integer order is 3. Orders -3, -2, -1, 0, +1, +2, +3 give seven principal maxima, assuming all can be detected.

U8-Q9 · 7 marks

(a) Measure screen distance from the grating plane, centre-to-centre separation of opposite first-order spots, and use known grating spacing. Measure each first-order spot's displacement from the zero-order spot and compare them to check alignment. Half the total separation then gives the mean y and reduces the effect of uncertainty in locating the central spot; halving the separation alone cannot reveal asymmetry. (b) $y = 0.80/2 = 0.40$ m. $\theta = \arctan(0.40/1.50) = 14.931^\circ$. $d = 1/(400 \times 1000) = 2.50 \times 10^{-6}$ m. $\lambda = d \sin \theta = 6.4416 \times 10^{-7}$ m ≈ 644 nm. Equivalently $\sin \theta = 0.40/\sqrt{(1.50^2 + 0.40^2)}$. (c) Keep incidence normal and the screen perpendicular to the central beam; compare wavelengths obtained from repeated measurements or another order.

U8-Q10 · 7 marks

(a) The closed end is a displacement node; the open end is a displacement antinode. Incident and reflected sound form a resonant stationary pattern with enhanced oscillation amplitude when the boundary conditions are satisfied. (b) Consecutive lengths differ by $\lambda/2$: $\lambda = 2(0.510 - 0.170) = 0.680$ m. $f = 340/0.680 = 500$ Hz. (c) First closed-open length = $\lambda/4 = 0.170$ m, as observed. First open-open length = $\lambda/2 = 0.340$ m.

U8-Q11 · 2 marks

Correct option: B. Consecutive nodes are $\lambda/2$ apart, so $\lambda = 0.36$ m. The nearest antinode is halfway between nodes, $\lambda/4 = 0.09$ m. A treats node spacing as a full wavelength. C confuses node-to-antinode spacing with node-to-node spacing. D assigns node spacing to $\lambda/4$ and then retains the wrong nearest-antinode separation.

U8-Q12 · 2 marks

Correct option: C. $n \leq d/\lambda = 1.50/0.600 = 2.5$, so the highest integer order is 2. Orders -2 , -1 , 0 , $+1$ and $+2$ give five maxima. A reports only the highest order. B counts orders on one side plus zero but omits the other side. D rounds 2.5 upward to allow a physically impossible third order.

Use with the full notes

[revisiontown.com/as-level-physics-notes-and-worksheets/](https://www.revisiontown.com/as-level-physics-notes-and-worksheets/)

Independent educational resource. Cambridge International does not produce or endorse this resource. Syllabus reference: official Cambridge Physics 9702 syllabus, AS topics 1–11 and Paper 3 practical assessment.