

APOLLO

Wave phenomena

HL

Physics

First assessment 2025

18 questions | mark schemes

Mark-scheme answers

Physics HL | Paper 1A | May 2025 TZ1 | Q20 | 1 marks

20. C

Physics HL | Paper 1A | May 2025 TZ1 | Q21 | 1 marks

21. C

Physics HL | Paper 1A | May 2025 TZ1 | Q23 | 1 marks

23. D

Physics HL | Paper 1A | May 2025 TZ3 | Q22 | 1 marks

22. B

Physics HL | Paper 1A | May 2025 TZ3 | Q23 | 1 marks

23. B

Physics HL | Paper 1A | May 2025 TZ3 | Q24 | 1 marks

24. D

2.	a		measure P to be at the centre of the flat edge/side so that incident rays are aimed at P /go through radial lines OR check that the incident angle is 0° at every point of incidence ✓		[1]
2	b	i	$\theta_r = 49^\circ$ ✓	Accept correct answer only	[1]
2	b	ii	0.755 ✓	Accept only 0.755. Answer must be quoted to 3 sf.	[1]
2	c	i	use two points from the line that use more than half the line of best fit ✓ gradient = 1.5 ✓	Allow (implicit) use of the origin. Look for $\Delta x \geq 0.3$	[2]
2	c	ii	draw max from lower end of lower error bar to upper end of upper error bar ✓		[1]
2	c	iii	States gradient gives the value of the refractive index OR $n = 1.5$ ✓ $n = 1.5 \pm 0.2$ ✓	MP1 can be shown as an equation Candidates may calculate the uncertainty by using the gradient of the line found in cii) or finding the average of the max and min lines of best fit. Look for working leading to $0.1 \leq \Delta n \leq 0.2$	[2]

Question	Answers	Notes	Total
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2.	a		Measure distance between multiple constructive/maxima fringes ✓ Divide this distance by the number of fringes «subtract 1» OR Divide this distance by the number of minima ✓	<i>Do not accept answers that refer to changing the ruler to other measuring devices</i>	2
2.	b		«A smaller d will» increase fringe separation s ✓ «Relative» uncertainty in s will decrease ✓	<i>Do not award MP2 without correct MP1 except when applying ECF from MP1</i>	2
2.	c	i	$\frac{1}{d}$ ✓	Allow $\frac{D}{d}$	1
2.	c	ii	Uncertainty $\pm 30 \text{ nm}$ ✓ Rounding $\lambda = 610 \pm 30 \text{ nm}$ ✓	MP1 for obtaining uncertainty to any number of s.f. Allow ECF from MP1 for an answer written to correct s.f. Award [2] for BCA	2

4.	a		Light comes from a single source ✓ Waves need to have a constant phase difference / in phase ✓ «To produce» a fixed/stable/clear/constant pattern «over time» OR Only coherent light has this property/produces this pattern ✓		[2 max]
	b	i	Alternative 1 $s = \frac{\lambda D}{d} \Rightarrow \phi = \frac{s}{D} = \frac{\lambda}{d}$ ✓ $\phi = \frac{720 \times 10^{-9}}{0.12 \times 10^{-3}} = 6.0 \times 10^{-3} \text{ rad}$ ✓ Alternative 2 $d \sin \frac{\phi}{2} = \frac{\lambda}{2} \Rightarrow \phi = 2 \sin^{-1} \frac{\lambda}{2d}$ ✓ $\phi = 2 \sin^{-1} \frac{720 \times 10^{-9}}{2 \times 0.12 \times 10^{-3}} = 6.0 \times 10^{-3} \text{ rad}$ ✓ Alternative 3 <<With small angle approximation>> $d \frac{\phi}{2} = \frac{\lambda}{2} \Rightarrow \phi = \frac{\lambda}{d}$ ✓ $\phi = \frac{720 \times 10^{-9}}{0.12 \times 10^{-3}} = 6.0 \times 10^{-3} \text{ rad}$ ✓	Award [2] if 6.0×10^{-3} «rad» is seen as the answer without working Do not penalize if answer in degrees (0.34°) Award [1] for an answer of 0.012 or 0.003 «rad»	[2]
	b	ii	The energy missing at P ₁ and P ₂ is found at the maxima ✓		[1]
	c		Waves arrive in phase OR path difference is zero OR distance is the same ✓		[1]

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	d		Considers the largest wavelength OR $\theta = 90^\circ$ ✓ $d \sin \theta = n\lambda \Rightarrow n = \frac{10^{-3} \sin 90^\circ}{580 \text{ } 650 \times 10^{-9}} = 2.65$ ✓ So the second order/ $n = 2$ ✓	Award [2] if smallest wavelength used and an answer of $n = 3$.	[3]
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Question	Answers	Notes	Total
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Mark-scheme answers

Physics HL | Paper 1A | Nov 2025 TZ1 | Q19 | 1 marks

19. C

Physics HL | Paper 1A | Nov 2025 TZ1 | Q20 | 1 marks

20. C

Physics HL | Paper 1A | Nov 2025 TZ3 | Q20 | 1 marks

20. A

Physics HL | Paper 1A | Nov 2025 TZ3 | Q21 | 1 marks

21. B

Physics HL | Paper 1A | Nov 2025 TZ3 | Q22 | 1 marks

22. C

Physics HL | Paper 1A | Nov 2025 TZ3 | Q23 | 1 marks

23. A

7.	a	«All pairs of rays which are symmetrical with respect to the dotted line have» zero phase/path difference ✓ so interfere constructively at M ✓	Award [1] for a generic reference that a path difference of an integer number of wavelengths produces constructive interference.	[2]
7.	b	First diffraction minimum at / value use of $\theta = 0.04 \text{ rad}$ ✓ $\theta = \frac{\lambda}{b} \Rightarrow \lambda = b\theta = 1.3 \times 10^{-5} \times 0.04 = 5.2 \times 10^{-7} \text{ m}$ ✓	Award full marks for a CNA Allow ECF from MP1	[2]

Question	Answers	Notes	Total
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Mark-scheme answers

Physics HL | Paper 1A | Specimen 2025 | Q22 | 1 marks

22. D

Physics HL | Paper 1A | Specimen 2025 | Q23 | 1 marks

23. D