MOMENTUM

IB Physics HL

Waves and optics - Set 1 - Markscheme

C.1-C.4 | First assessment 2025 | Higher Level

Independent examination-style practice material

10 original problems

Task 01 - Reading a travelling wave

Paper 2 style | IB code C.1 | Total [7]

Part	Marking guidance	Marks
(a)	A = 0.030 m, omega = 8 pi gives f = 4.0 Hz, and k = 2 pi gives lambda = 1.0 m.	**3**
(b)	v = f lambda = 4.0 m s^{-1}; the form omega t - kx travels in +x.	**2**
(c)	v_y,max = omega A = 0.754 m s^{-1}.	**2**

Task 02 - Standing waves on a string

Paper 2 style | IB code C.2 | Total [6]

Part	Marking guidance	Marks
(a)	$v = \sqrt{T/\mu} = 190\ m\ s^{-1}$.	**2**
(b)	$f_n = nv/(2L)$, giving 79.1 Hz, 158 Hz and 237 Hz.	**3**
(c)	Three antinodes.	**1**

Task 03 - Resonance in air columns

Paper 2 style | IB code C.2 | Total [7]

Part	Marking guidance	Marks
(a)	Open pipe: f = v/(2L) = 200 Hz. Closed pipe: f = v/(4L) = 100 Hz.	**3**
(b)	Next allowed mode is the third harmonic, 300 Hz.	**2**
(c)	A displacement node is required at the closed end and an antinode at the open end, allowing only odd harmonics.	**2**

Task 04 - Doppler shift from an ambulance

Paper 2 style | IB code C.1 | Total [5]

Part	Marking guidance	Marks
(a)	f' = fv/(v-v_s) = 863 Hz.	**2**
(b)	f' = fv/(v+v_s) = 745 Hz.	**2**
(c)	Frequency drops by about 118 Hz.	**1**

Task 05 - Young's double-slit experiment

Paper 2 style | IB code C.3 | Total [5]

Part	Marking guidance	Marks
(a)	Delta y = lambda D/d = 4.00 mm.	**2**
(b)	y_5 = 20.0 mm.	**1**
(c)	Two-slit interference disappears; the remaining slit produces a broader single-slit diffraction pattern.	**2**

Task 06 - Resolving wavelengths with a diffraction grating

Paper 2 style | IB code C.3 | Total [7]

Part	Marking guidance	Marks
(a)	d = 1.667e-6 m; sin theta = lambda/d = 0.300, so theta = 17.5 degrees.	**2**
(b)	m_max = integer part of d/lambda = 3.	**2**
(c)	Using resolving power mN = lambda/Delta lambda gives N = 500/(2(1)) = 250 lines.	**3**

Task 07 - A thin film in reflected light

Paper 2 style | IB code C.3 | Total [7]

Part	Marking guidance	Marks
(a)	With one phase reversal, constructive reflection requires 2nt = (m+1/2)lambda; for m=0, t = lambda/(4n) = 113 nm.	**3**
(b)	Destructive reflection requires 2nt = m lambda; least non-zero t = lambda/(2n) = 226 nm.	**2**
(c)	Different wavelengths satisfy constructive and destructive conditions at different thicknesses.	**2**

Task 08 - Total internal reflection in glass

Paper 2 style | IB code C.3 | Total [5]

Part	Marking guidance	Marks
(a)	sin c = 1/1.50, giving c = 41.8 degrees.	**2**
(b)	Since 50.0 > c, total internal reflection occurs; reflection angle is 50.0 degrees.	**2**
(c)	It requires travel from higher to lower refractive index.	**1**

Task 09 - A converging lens and a real image

Paper 2 style | IB code C.3 | Total [6]

Part	Marking guidance	Marks
(a)	Uses 1/f = 1/u + 1/v, giving v = 20.0 cm.	**2**
(b)	Magnification = -v/u = -0.667, so image height is -1.33 cm and the image is inverted.	**2**
(c)	Shows a ray parallel to the axis refracted through the far focus and a ray through the optical centre undeviated.	**2**

Task 10 - Polarization and Malus' law

Paper 2 style | IB code C.4 | Total [6]

Part	Marking guidance	Marks
(a)	After the first polarizer intensity is I0/2; Malus' law gives I = (I0/2)cos^2(35.0) = 0.336I0.	**3**
(b)	(I0/2)cos^2 theta = I0/8 gives cos theta = 1/2, so theta = 60 degrees.	**2**
(c)	Only transverse waves can be polarized.	**1**