Stationary waves

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Stationary Waves
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	**(a**	diffraction is the spreading of a wave as it passes through a slit or past an edge	B1	
		when two (or more) waves superpose/meet/overlap	M1	
		resultant displacement is the sum of the displacement of each wave	A1	[3]
	(b)	$n\lambda = d \sin\theta$ and $v = f\lambda$	C1	
		max order number for $\theta = 90°$ hence n (= f / vN) = $7.06 \times 10^{14} / (3 \times 10^{8} \times 650 \times 10^{3})$	M	
		$n = 3.6$ hence number of orders = 3	A1	[3]
	(c)	greater wavelength so fewer orders seen	A1	[1]
2	**(a (i)**	coherent: constant phase difference	B1	
		interference is the (overlapping of waves and the) sum of/addition of displacement of two waves	B1	[2]
	(ii)	wavelength = 3.2 m (allow ± 0.05 m)	M1	
		f (= v / λ = 240 / 3.2) = 75 Hz	A1	[2]
	(iii)	90° (allow ± 2°) or $\pi/2$ rad	A1	[1]
	(iv)	sketch has amplitude 3.0 ± 0.1 cm	M1	
		correct displacement values at previous peaks to produce correct shape	A1	[2]
	(b) (i)	$\lambda = ax / D$	C1	
		$x = (546 \times 10^{-9} \times 0.85) / 0.13 \times 10^{-3}$ (= 3.57×10^{-3} m)	C1	
		AB = 8.9 (8.93) $\times 10^{-3}$ m	A1	[3]
	(ii)	shorter wavelength for blue light so separation is less	B1	[1]

3	**(a**	two waves (of the same kind) travelling in opposite directions overlap	B1	
		waves have same frequency / wavelength and speed	B1	[2]
	(b)	**(i)** $T = 0.8\,(\text{ms})$		
		$f = 1 / (0.8 \times 10^{-3}) = 1250\,(\text{Hz})$		[2]
		(ii) microphone is moved from plate to loudspeaker or vice versa	B1	
		wavelength is the twice the distance between adjacent maxima or minima (seen on c.r.o.)	B1	[2]
		(iii) $v = f\lambda$	C1	
		$= 1250 \times 0.26$		
		$= 330\ (325)\,\text{m s}^{-1}$	A1	[2]

4	**(a**	**(i)** progressive wave transfers energy, stationary wave no transfer of energy / keeps energy within wave	B1	[1]
		(ii) (progressive) wave / wave from loudspeaker reflects at end of tube	B1	
		reflected wave overlaps (another) progressive wave	B1	
		same frequency and speed hence stationary wave formed	B1	[3]
		(iii) (side to side) along length of tube / along axis of tube	B1	[1]
	(b)	all three nodes clearly marked with N / clearly labelled at cross-over points	B1	[1]
	(c)	phase difference = 0	A1	[1]
	(d)	**(i)** $v = f\lambda$	C1	
		$\lambda = 330 / 440 = 0.75\,\text{m}$	A	[2]
		(ii) $L = 5/4\ \lambda$	C1	
		$= 5/4 \times 0.75 = 0.94\,\text{m}$	A1	[2]

5	**(a**	**(i)**	$v = f\lambda$	C1	
			λ = 40 / 50 = 0.8(0) m	A1	[2]
		(ii)	waves (travel along string and) reflect at Q / wall / fixed end	B1	
			incident and reflected waves interfere / superpose	B1	[2]
	(b)	**(i)**	nodes labelled at P, Q and the two points at zero displacement	B1	
			antinodes labelled at the three points of maximum displacement	B1	[2]
		(ii)	(1.5λ for PQ hence PQ = 0.8 × 1.5) = 1.2 m	A	[1]
		(iii)	$T = 1 / f = 1/50 = 20$ ms		
			5 ms is ¼ of cycle	A1	
			horizontal line through PQ drawn on Fig. 5.2	B1	[3]