Wave Basics

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Waves
Sub Topic	Wave Basics
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **76 minutes**

Score: **/63**

Percentage: **/100**

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

1	**(a)**	similarity: e.g. same wavelength/frequency/period, constant phase difference	B1	
		difference: e.g. different amplitude/phase (do not allow a reference to phase for both similarity and difference)	B1	**[2]**
	(b)	constant phase difference so coherent	B1	**[1]**
	(c)	*intensity* $\propto$ *amplitude*^{2}	C1	
		$I \propto 3^2$ and $I_B \propto 2^2$ leading to	M1	
		$I_B = \frac{4}{9}I$	A0	**[2]**
	(ii)	resultant amplitude = 1.0×10^{-4} cm	C1	
		resultant intensity = $\frac{1}{9}I$	A1	**[2]**
	(d)	displacement = 0	B1	**[1]**
	(ii)	$x_A = -2.6 \times 10^{-4}$ cm and $x_B = +1.7 \times 10^{-4}$ cm allow $\pm 0.5 \times 10^{-4}$ cm)	C1	
		resultant displacement = (-) 0.9×10^{-4} cm	A1	**[2]**

2	**(a)**	all same speed in a vacuum (allow medium)/all travel in a vacuum	(1)	
		transverse/can be polarised	(1)	
		undergo diffraction/interference/superposition	(1)	
		can be reflected/refracted	(1)	
		show properties of particles	(1)	
		oscillating electric and magnetic fields	(1)	
		transfer energy/progressive	(1)	
		not affected by electric and magnetic fields	(1)	
		(allow any three, 1 each)		**B3 [3]**
	(b)	495 nm = 495 x 10^{-9} m		**C1**
		number = 1/(495 x 10^{-9}) = 2.02 x 10^{6}		**A1 [2]**
		(allow 2 or more significant figures)		
	(c)	allow $10^{-7} \rightarrow 10^{-11}$ m		**B1**
	(ii)	allow $10^{-3} \rightarrow 10^{-6}$ m		**B1 [2]**

3	**(a)**	**(i)**	λ = 0.6 m	B1	
		(ii)	frequency (= v/λ) = 330/0.60	C1	
			= 550 Hz	A1	**[3]**
			(use of c = 3 x 10^{8} ms^{-1} scores no marks)		
	(b)		amplitude shown as greater than *a* but less than 2*a* and constant	B1	
			correct phase	B1	**[2]**
			(wave to be at least three half-periods, otherwise -1 overall)		
			Total		**[5]**

4 (a) (i) amplitude = 0.4(0) mm A1

(i) wavelength = 7.5×10^{-2} m
(1 sig. fig. -1 unless already penalised) A1

(i) period = 0.225 ms C1
frequency = $1/T$ = 4400 Hz A1

(i) $v = f\lambda$
$= 4400 \times 7.5 \times 10^{-2}$ C1
$= 330$ m s^{-1} ..... A1 [6]

(a) (ii) reasonable shape, same amplitude and wavelength doubled ..... B1 [1]

(b) (i) 1.7(2) μm A1

(ii) d sinθ = $n\lambda$ (double slit formula scores 0/2)
$1.72 \times 10^{-6} \times \sin\theta = 590 \times 10^{-9}$ C1
θ = 20.1° (allow 20°) A1

(iii) ½L = 1.5 tan20.1 ..... C1
L = 1.1 m ..... A1 [5]

5 **(a)** displacement & direction of energy travel normal to one another ... B1 [1]

(b) (i) phase angle of **60°** correct .. (need to see **1½** wavelengths) B1
lags behind T_1 ..... B1 [2]

(ii) waves must be in same place (at same time) B1
resultant <u>displacement</u> = sum of individual <u>displacements</u> ..... B1 [2]

(iii) 1. -1/iA B1
2. ½A ..... (allow e.c.f.) B1
3. zero ..... (allow e.c.f.) ..... B1 [3]

6	**(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	[
		(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	[
		(ii)	shorter wavelength for blue light so separation is less	B1	[1]

7 **(a** stress = Young modulus × strain

= $1.8 \times 10^{11} \times 8.2 \times 10^{-4}$ *or* 1.476×10^{8} C1

= 0.15 (0.148) GPa A1 [2]

(b) (i) wavelength = $3 \times 10^{8} / 12 \times 10^{12}$ C1
= 25 μm A1 [2]

(ii) infra-red / IR B1 [1]

(c) (i) arrow drawn up to the left of 7.5 N force
approximately 5° to 40° to west of north A1 [1]

(ii) **1.** correct vector triangle or working to show
magnitude of resultant force = 6.6 N
allow 6.5 to 6.7 N if scale diagram M1 [1]

2. magnitude of acceleration = 6.6 / 0.75
[scale diagram: (6.5 to 6.7) / 0.75] C1

= 8.8 m s^{-2} [scale diagram: 8.7 – 8.9 m s^{-2}] A1 [2]

(iii) 19° [<u>use of scale diagram</u> allow 17° to 21° (a diagram must be seen)] B1 [1]