

PH2

Question		Marking details	Marks Available
1	(a)	(i) $v = \frac{0.15 \text{ m}}{0.0030 \text{ s}}$ (1) [or equiv. or by impl.] = 50 m s ⁻¹ ((unit)) (1)	1
		(ii) Either: $T = 0.012 \text{ s}$ (1) $f = \frac{1}{T}$ [or by impl.] (1) = 83 Hz (1) Or: $\lambda = 0.60 \text{ m}$ (1) $f = \frac{v}{\lambda}$ [in this form – or by impl] (1) = 83 Hz (1) [e.c.f. on v from (i)]	2
	(b)	(i) <u>Two of:</u> 0.90 m, 1.20 m, 1.50 m, 1.80 m	1
	(c)	(ii) I. Varies [smoothly] between maxima and minima / zeroes (1); Maxima midway between minima [or maxima 0.30 m / $\lambda/2$ apart; minima 0.30 m / $\lambda/2$ apart] (1) II. No – for a progressive wave the amplitude is constant along string [or falls gradually]	2 1
		Waves reflected by wall (1) Reflected wave interferes with wave straight from generator [or equivalent, e.g. the two waves travelling in opposite directions interfere] (1) Nodes occur where interference is destructive [accept: where the two waves cancel] (1)	3
			[12]
2.	(a)	(i) $\lambda = \frac{2.0 \times 1.8}{12.0} \text{ m}$ (1) [or by impl.] = 0.30 m (1)	2
		(ii) Reflected sound [would affect the pattern].	1
	(b)	Previously, sound from the two speakers superposed / interfered [or by implication](1) destructively [accept: cancel] at that point (1) as it arrived in antiphase [accept: exactly out of phase] (1)	3
	(c)	Quiet spots are where loud sounds used to be [or equiv.]	1
	(d)	(i) $y = \frac{D\lambda}{a}$ (1) <u>thus</u> [or other qualification, e.g. recalculation] y halves (1) [or equiv] [because a doubles] [Qual. answer “ y decreases” + correct qual reasoning → 1 mark]	2
	(ii) Wavelength halves [or equiv] (1) Separation halves (1)	2	
			[11]

Question		Marking details	Marks Available	
3	(a)	(i) [1.00] $\sin x = 1.52 \sin 25^\circ$ [or by impl, or equiv <u>with data inserted</u>] (1) $\sin x = 0.642$ [or by impl.] (1) $x = 40^\circ$ (1)	3 1	
		(ii) 65°		
		(iii) Either: [1.52 $\sin c = 1.00 \sin 90^\circ$ so] $c = 41^\circ$ (1). <u>$65^\circ > c$ so no escape</u> (1) [No penalty for omission of last point if first mark awarded]	Or: $\sin^{-1}(1.52 \sin 65^\circ) / 1.38$ (1) doesn't exist (1) [so refraction doesn't occur].	2
		(iv) I. total internal reflection [not: TIR, total or internal] reflection II. equal	1 1	
		(b)		
	(i) beam confined to small angle to axis [or damage avoided to reflecting surface] [accept: fewer int. refl ^s]	1		
	(ii) small (1); equal to a few wavelengths (1)	2		
	(iii) light propagates parallel to axis [or without being reflected or along only one path]. [Not – ‘only one <u>beam</u> ’]	1		
		[12]		
	4.	(a)	(i) When e-m radn ⁿ [accept: light, u-v, photons] [of high enough frequency] falls on a surface [or metal] (1) electrons are emitted (1)	2
(ii) Photon knocks out electron [or not] or gives energy to e(1). Photon carries energy hf (1). Electron needs [a minimum] energy ϕ to escape (1) Remainder of photon's energy given to electron as KE (1) [KE_{\max} corresponds to minimum energy ϕ to escape]			4	
(b)		(i) $E_{k \max} = 6.63 \times 10^{-34} \times 7.99 \times 10^{14} - 4.97 \times 10^{-19}$ J (1) [or photon energy <u>shown</u> to be greater than ϕ] $E_{k \max} = 3.27 \times 10^{-20}$ J (1)	2	
		(ii) Photon energy = 4.47×10^{-19} J < ϕ [or equiv], so no emission	1	
		(iii) 3.27×10^{-20} J(1) Photons don't co-operate releasing electron [or equiv] (1)	2	
		[11]		

Question		Marking details	Marks Available
5.	(a)	(i) Fraction = $\frac{[3.297 \times 10^{-18} - 2.983 \times 10^{-18}](1)}{3.297 \times 10^{-18}} = 0.095 (1)$ [accept $\frac{2}{21}$]	2
		(ii) $\lambda = \frac{hc}{E_{\text{photon}}}$ (1) [or $\lambda = \frac{c}{f}$ and $f = \frac{E_{\text{photon}}}{h}$] (1) [or by impl.] $\lambda = 633 \text{ nm}$ (1)	2
	(b)	(i) A[n incident] photon (1) of energy equal to $(E_U - E_L)$ (1) [or equiv.]	2
		(ii) Now 2 photons [original and emitted] [or by impl.] (1) Photons in phase / travel in same dir ⁿ / have same f, λ or E (1)	2
	(iii) Fewer electrons in L than U (1) [accept pop ⁿ inversion] [So] stimulated emission commoner than absorption (1) [or less pumping needed]	2	
	(iv) Mirrors cause light to traverse cavity [or HeNe etc] to and fro (1) increasing chances of stimulated emission / increases amplification / increases intensity (1) [or any other correct point, e.g. resonant selection of particular λ]. [No credit for light escaping from r.h. mirror]	2	
			[12]
6	(a)	A surface / body that absorbs all radiation incident / falling on it.	1
	(b)	$\lambda_{1\text{max}} = 250 [\pm 10] \text{ nm}$ (1) $T = \frac{W}{\lambda_{1\text{max}}}$ (1)[<u>thus</u> or by impl.] = 11500 K (1) [e.c.f. on $\lambda_{1\text{max}}$]	3
	(c)	(i) $A = \frac{\text{power}}{\sigma T^4}$ [transposition at any stage] (1) $= \frac{2.53 \times 10^{31}}{5.67 \times 10^{-8} \times 11500^4}$ (e.c.f.) (1) = $2.55 \times 10^{22} \text{ m}^2$ ((unit)) [e.c.f. on T , e.g. $10^4 \text{ K} \rightarrow 4.46 \times 10^{22} \text{ m}^2$]	3
	(d)	(ii) Either $A_{\text{Sun}} = 4\pi r_{\text{Sun}}^2$ [or by impl.] (1) $= 6.1 \times 10^{18} \text{ m}^2 \ll A_{\text{Rigel}}$ (1) e.c.f over slips in 4 or π Or $r_{\text{Rigel}} = A_{\text{Rigel}} / 4\pi$ (1) $= 4.5 \times 10^{10} \text{ m} \gg r_{\text{Sun}}$ (1) e.c.f over slips in 4 or π	2
	(iii) Spectral intensity higher at 400 nm than at 700 nm (1) 400 nm is at violet end of visible spectrum (1) [or converse] <u>So Rigel not</u> a red giant [Not a freestanding mark] [NB – “Peak closer to violet than red,” unsupported by figures, loses first mark]	3	
			[12]

Question			Marking details	Marks Available
7.	(a)	(i)	e	1
		(ii)	zero	1
	(b)	baryon	1	
	(c)	p = uud (1) u quark number for x = 4 - 3 [= 1][or equiv] (1) d quark number for x = 2 - 1 - (-1) [=2] [or equiv] (1) So x is a neutron (1) [or Δ^0]	4	
	(d)	Lepton number zero before and after	1	
	(e)	Any 1 × (1) of <ul style="list-style-type: none"> • High KE means short contact time ✓ • u and d numbers separately conserved [so not weak] ✓ • no γ involvement [suggests not e-m] ✓ So strong (1)	2	
				[10]