

Question			Answer	Marks	Guidance
1	(a)	(i)	is a transfer of energy as a result of oscillations (of the source/medium/particles through which energy is travelling)	M1 A1	accept carries/AW accept without the transfer of the medium/particles/matter
		(ii)	a <i>progressive</i> wave transfers energy a <i>progressive</i> wave transfers shape/information either every point on a <i>progressive</i> wave has the same amplitude or every point on a <i>progressive</i> wave oscillates all points on a <i>progressive</i> wave have different phase (in one λ)	B1 B1 B1 B1	or a <i>stationary</i> wave traps energy in pockets/AW or a <i>stationary</i> wave does not transfer shape/information or a <i>stationary</i> wave has nodes and antinodes or in a <i>stationary</i> wave some points do not move (nodes) or all points in a <i>stationary</i> wave between nodes are in phase or in adjacent loops are in antiphase max 2 marks
A A A	(b)	(shape: sinusoidal and only 2 cycles amplitude constant at 0.03 m (y-axis labelled) period 0.2 s (x-axis labelled to 0.4 s) phase: cosine curve	B1 B1 B1 B1	one correct label of 0.03 m on y-axis is enough to score mark
		(ii) 1 2 3	X W W and X	B1 B1 B1	
		(iii)	Y vertically up Z vertically down	B1 B1	award 1 mark if directions of both reversed
	(c)		v has increased by 2 so (λ has increased by same factor) new $\lambda = 0.60 \times 2 = 1.2$ (m)	M1 A1	correct reasoning correct answer
A A A	(d)		f has increased by 2 so point W has to move same distance in half the time/double the distance in the same time therefore speed is doubled to $1.9 \text{ (m s}^{-1}\text{)}$	M1 A1	N.B. zero marks for using $v = f \lambda$ as this is the wave velocity not the particle velocity allow $v = 2\pi fA$ or v proportional to f(mark BOD) accept $1.88 \text{ (m s}^{-1}\text{)}$
Total				17	

Question			Answer	Marks	Guidance
2	(a)	(i)	when 2 or more waves <u>meet</u> (at a point) the (resultant) <u>displacement</u> is equal to the (vector) <u>sum</u> of the <u>displacements</u> of each wave	B1 B1	accept alternative words which mean <i>meet</i> not <i>collide, interfere</i> or <i>superpose</i> not amplitude
		(ii)	travel through a vacuum/ at c (in a vacuum)	B1	allow caused by oscillating charges; consist of electric and magnetic fields/oscillations
		(iii)	only transverse waves can be polarised	B1	accept sound waves are longitudinal/not transverse
A A A	(b)	(the waves interfere/superpose producing a stationary wave (with nodes and antinodes) the resultant signal is zero at a node distance from max (antinode) to zero (node) is <u>$\lambda/4 = 0.75 \text{ cm}$</u>	B1 B1 B1 B1	constructive interference produces maximum (at R) or signals in phase/zero path diff. of waves (at R) destructive interference produces minimum/zero signal or out of phase/ $\frac{1}{2}\lambda$ or phase difference of <u>$\frac{\pi}{2}$</u> is caused by 0.75 cm shift maximum of 3/4 if nodes and antinodes interchanged QWC mark in bold
A A A		(ii)	emitted waves are polarised (in vertical plane) detected signal from T_2 falls to zero (when T_2 is rotated by 90°) aerial only receives signal from one transmitter (T_1 , signal is halved) (no change in detected signal as) no interference/signals at right angles to each other/AW	B1 B1 B1 B1	plane of oscillation of waves from T_2 changes/AW max 3 marks from 4 marking points
Total				11	

Question		Answer	Marks	Guidance
3	(a)	light from the two sources must be/slits is coherent only possible to produce constant phase difference using a single source	B1 B1	allow 'has a constant phase difference' for 'is coherent' allow separate light sources are not coherent/do not have a constant phase difference
	(b)	at D: 180° or π rad at B: 0 or 360° or 2π rad	B1 B1	max 1 out of 2 if unit omitted except on zero allow $^\circ$ as symbol for rad
	(c)	(2.0×10^{-3} (m)	B1	allow 1 SF and 2 mm; allow 1.8 or 1.9 mm, only 2 SF
		(ii) $\lambda = ax/D$ $= 0.4 \times 10^{-3} \times 2.0 \times 10^{-3} / 1.5$ $= 5.3(3) \times 10^{-7}$ (m)	C1 C1 A1	select formula ecf c(i) ; substitute answer
	(d)	2λ 1060 (nm)	C1 A1	ecf c(ii) ; allow 1000 for 5×10^{-7} allow 1066, 1067, 1070, 1100
A A A	(e)	($E = (8.7 \times 10^{-19} - 5.0 \times 10^{-19}) = 3.7 \times 10^{-19}$ (J) select $E = hc/\lambda$ $E = 6.63 \times 10^{-34} \times 3.0 \times 10^8 / 5.3 \times 10^{-7}$ $= 3.73 \times 10^{-19}$ (J) [or 3.98×10^{-19} if using 5.0×10^{-7}]	B1 C1 M1 A1	readings from diagram must see substitution ora substitute for E and find λ calculation ora 5.4×10^{-7} (m) N.B. the B mark can be awarded inside the calculation only for the ora method
		(ii) X in infra-red/ir Z in ultra-violet/uv	B1 B1	allow 1 mark for answers reversed
Total			16	