Selected Questions – Set 8 - Answers

1.

a	i 1	the maximum displacement from equilibrium or rest position	B1	**allow** *zero* or *undisturbed* for *equilibrium*
	2	number of oscillations/vibrations (at a point) per unit time	B1	number of wavelengths passing a point or produced by the wave source per unit time **allow** per second **NOT** *amount* for *number*
	3	how far 'out of step' (out of sync) the oscillations at two points on the wave/string are/AW	B1	**alt e.g.** the fraction of a cycle between the oscillations at the two points
	ii 1	all have same frequency or same amplitude	B1	**N.B.** withhold mark if extra incorrect answers given
	2	all have different phases/ phase differences	B1	**allow** *not in phase* or *all out of phase*
b	i	*progressive* a wave which transfers energy	B1	**accept** phase relationship descriptions between
		stationary a wave which traps/stores energy (in pockets)	B1	different points on wave;
		or *progressive* : transfers shape/information from one place to another		must be a comparison for same property to score both marks
		stationary where the shape does not move along/which has nodes and antinodes/AW		
	ii	the wave reflected (at the fixed end of the wire)	B1	
		interferes/superposes with the incident wave	B1	
		to produce a resultant wave with nodes and antinodes/no energy transfer	B1	
	iii 1	(all points have) same frequency	B1	
		P and Q have same amplitude and (are in) phase	B1	**allow** *same phase difference* here
	2	**S** has larger amplitude than P and Q	B1	**allow** *different to*
		S has a phase difference of π/in antiphase to P and Q	B1	or 180° **max** any 3 out of 4 marking points
	iv 1	15 Hz	B1	
		as all points in the fundamental/first harmonic mode move in phase	B1	**accept** string is ½ λ long/between ends
	2	120 Hz	B1	
		for every 10 cm to be at rest λ = 20 cm (so 4 x frequency of Fig. 4.2)	B1	**accept** as all points are nodes or f = $8f_0$ **or** is 8^{th} harmonic

2.

a	**i**	when two (or more) waves meet/superpose/overlap (at a point) there is a change in overall displacement	M1 A1	**NOT** interact,combine, join, connect, collide, hit, intersect, pass through, etc. **allow** the resultant displacement equals the sum of the individual displacements
	ii	constant phase difference/relationship (between the waves)	B1	**allow** fixed **not** same
b		$\lambda = c/f = 3.0 \times 10^{8} / 1.0 \times 10^{10}$ $\lambda = 3.0 \times 10^{-2}$ so aerial length = 1.5×10^{-2} (m)	M1 A1	 **accept** 1.5 c(m)
c	**i1**	the path difference between the signals (from the two transmitters) changes (along OP) causing the detected signal to vary between maximum and minimum values/AW or when signals (at the point on OP) are in phase there is a maximum when (π) out of phase there is a minimum	B1 B1	**give** 1 mark out of 2 for maxima and minima occur (because of interference)
	2	$x = \lambda D/a = 3.0 \times 10^{-2} \times 4.0/0.20$ (= 0.60) so distance = x/2 = 0.30 (m)	C1 A1	**ecf (b)** 20 times answer to **(b)** **allow** 1 SF answer here
	ii	amplitude of signal decreases (inversely) with distance because energy emitted by the transmitters spreads out (so less is collected by the receiver the further away it is)	B1 B1	**allow** intensity; **no mark if** any suspicion of decrease being caused by interference effect **accept** any statement which conveys the idea of energy spreading correctly,e.g. $I \propto 1/d^2$
	iii	when AO – BO = λ/2 a minimum occurs/AW **or** phase difference of π (180°) between detected signals from A and B so distance = λ/2 = 1.5×10^{-2} (m)	B1 B1	idea that movement of λ/2 will change maximum to minimum or vice versa **ecf (b)** same answer as **(b)**; **accept** 1.5 c(m)
d	**i**	intensity increases by factor of 4 as intensity α (amplitude)^2	B1 B1	
	ii	intensity falls to zero (emitted) signal is (vertically) polarised receiver in position only to detect horizontally polarised signal	B1 B1 B1	 **allow** transmitter and detector act like 'crossed polarisers' or quoting Malus' law correctly

3.

(a) similarity: any valid point e.g. (both have) vibrations, frequency, amplitude, wavelength, period, displacement (not velocity) B1
difference:
e.g. no energy transfer for standing waves }
neighbouring points vibrate in phase for standing waves } B1
only standing waves have nodes and antinodes } [2]
{allow standing waves are "trapped"/fixed/confined/don't move forward}

(b) (i) arrows show vertical oscillations B1
maximum amplitude at top {allow ecf for horiz.} B1
less in middle AND very small (or zero) at base B1 [3]
{allow 1 mark only for unlabelled diagram showing representation of amplitude}
{2 marks for unlabelled diagram plus an arrow}
{allow single headed arrows}

(ii) wavelength = 4 x 0.36 = 1.44m B1 [1]

(iii) recall of $v = f\lambda$ B1
$f = v/\lambda$ = 330/1.44 (allow ecf) = 229 (or 230) Hz B1 [2]

(iv) if open at both ends each end must be an antinode OR diagram B1
hence wavelength = 0.72m {allow ecf} C1
and frequency = 458 (or 460) Hz {allow ecf} A1 [3]

4.

a	i	(Filament) lamp / bulb	B1	
	ii	Resistance is $\frac{V}{I}$ (and not the gradient) – wtte	B1	Allow Resistance is the ratio of *V* and *I*. Not units in definition
	iii	current = 1.2 (A) / $R = \frac{2.0}{1.2}$ resistance = 1.7 (Ω)	C1 A1	Bald 1.7 (Ω) scores 2/2 marks
b		Straight line through the origin (for first three squares for *V*) Correct curve (after three squares of *V*)	B1 B1	These are independent marks
c	i	current = 0 (A)	B1	
	ii	potential difference = 0.4 (V)	B1	

5.

a	i	Straight line (by eye)	B1	
	ii	$Q = It$ $Q = 5.2 \times (3.5 \times 3600)$ charge = 6.55×10^4 unit: coulomb / C	C1 A1 B1	 Allow 2 sf answer Allow 6.6×10^4 This unit mark is an independent mark
b	i	$R = \frac{\rho L}{A}$ $L = \frac{3.6 \times 2.0 \times 10^{-8}}{7.9 \times 10^{-7}}$ length = 9.1×10^{-2} (m)	C1 C1 A1	Allow any subject Bald 9.1×10^{-2} m scores 3/3
	ii 1.	resistance of lamps = $\frac{3.6}{3} (= 1.2)$ total resistance = 1.2 + 0.48 total resistance =1.68 Ω	C1 A1	 Possible ecf from above step for resistance of lamps in parallel Allow 1.7 Ω
	ii 2.	current = $\frac{12}{1.68}$ current 7.1(4) (A)	 B1	 Possible ecf Allow 2 sf answer
	iii	Appreciation that 'internal resistance' is responsible for dimness (Larger) voltage across internal resistance / less p.d across lamps	B1 B1	