8. Superposition

8.1 Stationary waves

Paper 2

Marking Scheme

Q1.

(a)	wave(s) (travel along string and) reflect at fixed point / wall / Q / end / vibration generator / P	**B1**
	incident and reflected waves superpose	**B1**
(b)	0.80 m	**A1**
(c)	same wavelength as original throughout **and** passing through intersection of solid and dashed lines	**B1**
	reflected in dashed line **and** of same amplitude	**B1**
(d)	180°	**A1**

Q2.

(b)(i)	A marked at the open end of the pipe	**B1**
(b)(ii)	$f = v / \lambda$	**C1**
	$\lambda = 4 \times 4.5 \times 10^{-2}$	**C1**
	$f = 340 / (4 \times 4.5 \times 10^{-2})$ $= 1900$ Hz	**A1**
(b)(iii)	the node–antinode distance is longer **or** the wavelength (of the wave) is longer	**M1**
	(the speed of sound is constant so) the frequency (of the wave) is lower	**A1**

Q3.

(b)(ii)	$L = \frac{3}{4} \times \lambda = \frac{3}{4} \times 0.20$ $= 0.15$ m	**A1**
(b)(iii)	$\lambda = 4 \times 0.15$ **or** 0.20×3 $= 0.60$ m	**A1**

Q4.

(a)	(when two or more) waves meet / overlap (at a point)	**B1**
	(resultant) displacement is the sum of the individual displacements	**B1**

Q5.

(a)	wave(s) (travel along string and) reflect at fixed point / A / B / end	**B1**
	incident and reflected waves superpose / interfere **or** two waves travelling / with speed in opposite directions superpose / interfere	**B1**
(b)	line has an approximate sinusoidal shape with maximum downward displacement at P and zero displacement at each node	**B1**
(c)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$\lambda = 35 \times 0.040$ **or** $35 / 25$ $(= 1.4$ m)	**C1**
	distance $= 1.4 \times 2.5$ $= 3.5$ m	**A1**

Q6.

(c)(i)	the waves have different amplitudes	**B1**
	cannot have resultant displacement that is always zero **or** cannot have (complete) destructive interference (at nodes) **or** (at nodes resultant) amplitude is the difference of the amplitudes	**B1**

Q7.

(a)	(they travel in) opposite directions	**B1**
(b)(i)	straight line from A to B, labelled P	**B1**
	line that is 'mirror image' of given line, labelled Q	**B1**
(b)(ii)	$\lambda = 0.80 / 2$ $(= 0.40$ m)	**C1**
	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$v = 0.40 / 0.016$ **or** 62.5×0.40 $= 25$ m s^{-1}	**A1**

Q8.

(a)	a (much) louder sound can be heard	**B1**
(b)	$v = f\lambda$	**C1**
	$\lambda = 340 / 530$ $(= 0.64$ m)	**C1**
	height $= 0.64 / 4$ $= 0.16$ m	**A1**
(c)	distance $= 0.64 / 2$ **or** 0.16×2 **or** $(¾ \times 0.64 - ¼ \times 0.64)$ $= 0.32$ m	**A1**

Q9.

(a)(ii)	waves meet/overlap (at a point)	**B1**
	(resultant) displacement is sum of individual displacements	**B1**

Q10.

(c)(i)	(position where) zero amplitude	**B1**
(c)(ii)	2	**A1**
(c)(iii)	180°	**A1**
(c)(iv)	string drawn between X and Y with one antinode midway along the string	**B1**

Q11.

(a)	the waves (of the same type) move in opposite directions and overlap	**B1**
	the waves have the same (speed and) frequency/wavelength	**B1**
(b)(i)	zero amplitude	**B1**
(b)(ii)	distance $= 6.0 \times 4$ $= 24$ cm	**A1**
(b)(iii)	180°	**A1**

Q12.

(b)(iv)	displacement $= 1.00 - 3.00$ $= -2.00$ mm	**A1**

Q13.

(a)(ii)	(position where) maximum amplitude	**B1**
(b)(i)	$\lambda = 4 \times 0.045$ (= 0.18 (m) or 18 (cm))	**C1**
	$v = f\lambda$	**C1**
	$f = 340/0.18$ $= 1900$ Hz	**A1**
(b)(ii)	distance = $\lambda/2$ (= 0.09 (m) or 9 (cm))	**C1**
	time = 0.09 / 0.0075 = 12 s	**A1**
	or	
	$t = 4.5/0.75$ **and** $t = 13.5/0.75$	**(C1)**
	time = 18 – 6 = 12 s	**(A1)**

Q14.

(b)(i)	phase difference = 180°	**A1**
(b)(ii)	$v = f\lambda$	**C1**
	$\lambda/2 = 25$ (cm) or 0.25 (m)	**C1**
	$f = 330/0.50$ $= 660$ Hz	**A1**