8. Superposition

8.3 Interference

Paper 2

Marking Scheme

Q1.

(a)(i)	for maximum intensity, waves must be in phase (at detection)	**B1**
	(phase difference at source means) waves are not in phase / have a 90° phase difference at O	**B1**
(a)(ii)	point B labelled on the line PQ below O	**M1**
	distance OB = distance OA	**A1**
(b)(ii)	$\Delta x = 0.012 / 4$ $= 0.0030$ m	**A1**
(b)(iii)	$\lambda = ax / D$	**C1**
	distance $= \lambda D / a = 0.012 \times 2.3 / 0.18$ $= 0.15$ m	**A1**

Q2.

(b)(i)	constant phase difference (between the waves) (with time)	**B1**
(b)(ii)	$\lambda = ax / D$	**C1**
	$x = 22 / 8$ **or** 2.75 (mm) **or** $22 \times 10^{-3} / 8$ **or** 2.75×10^{-3} (m)	**C1**
	$a = (6.2 \times 10^{-7} \times 2.8) / (22 \times 10^{-3} / 8)$ $= 6.3 \times 10^{-4}$ m	**A1**
(c)(i)	difference in distances $= 6.2 \times 10^{-7} / 2$ $= 3.1 \times 10^{-7}$ m	**A1**
(c)(ii)	phase difference = 360°	**A1**

Q3.

(b)	$\lambda = ax / D$	**C1**
	$\lambda = [(0.65 \times 10^{-3}) \times (1.7 \times 10^{-3})] / 1.9$	**C1**
	$\lambda = 5.8 \times 10^{-7}$ m	**A1**
(c)(i)	waves are out of phase by a quarter of a cycle / period **or** when one wave has maximum/minimum displacement, the other wave has zero displacement	**B1**
(c)(ii)	(statement 2 is) not correct (because) waves do not have phase difference of 180° / not in antiphase **or** one wave has some displacement when other has no displacement **or** the displacements of the waves are not always equal and opposite	**B1**

Q4.

(a)	constant phase difference (between the waves)	**B1**
(b)(i)	path difference = 1.5×660 $= 990$ nm	**A1**
(b)(ii)	phase difference = $360° \times 1.5$ $= 540°$	**A1**
(c)	$\lambda = ax / D$	**C1**
	$x = (660 \times 10^{-9} \times 1.8) / 0.44 \times 10^{-3}$	**C1**
	$= 2.7 \times 10^{-3}$ m	**A1**
(d)	bright fringes are brighter	**B1**
	no change to dark fringes	**B1**
	no change to (fringe) separation / (fringe) spacing	**B1**
(e)	(blue light has) shorter wavelength	**M1**
	(so) decrease (slit) separation	**A1**

Q5.

(c)(iii)	$(1.380 – 1.240) / 0.040 = 3.5$ **or** $1.380 / 0.040 – 1.240 / 0.040 = 3.5$	**A1**
(c)(iv)	phase difference = 1260° **or** 180°	**A1**
(c)(v)	(always) zero	**A1**
(c)(vi)	increase in distance between (adjacent intensity) maxima/minima	**A1**

Q6.

(b)(i)	$\lambda = ax / D$	**C1**
	$= (3.7 \times 10^{-4} \times 4.3 \times 10^{-3}) / 2.3$	**C1**
	$= 6.9 \times 10^{-7}$ (m) $= 690$ nm	**A1**
(b)(ii)	• no change to fringe separation/fringe width/number of fringes • bright fringes are darker • dark fringes are brighter *Any two marking points, 1 mark each*	**B2**

Q7.

(b)(i)	path difference = 0.020 m	**A1**
(b)(ii)	phase difference = 180°	**A1**
(d)(i)	minimum moves closer to the maximum **or** decrease in separation of maximum and minimum	**B1**
(d)(ii)	the maximum and minimum exchange places **or** the maximum becomes a minimum **and** the minimum becomes a maximum	**B1**

Q8.

(c)(i)	constant phase difference (between the waves)	**B1**
(c)(ii)	180°	**A1**
(c)(iii)	path difference $= 2\lambda$ **or** $S_1Y - S_2Y = 2\lambda$	**C1**
	distance $= 7.40 + (0.85 \times 2)$ $= 9.1$ m	**A1**

Q9.

(a)(i)	the dippers are connected to the same vibrator/motor	**B1**
(a)(ii)	(the overlapping waves have) similar/same amplitude	**B1**
(b)	any means of 'freezing' the pattern e.g. use a stroboscope/strobe	**B1**
(d)(i)	path difference = 3.0 cm	**A1**
(d)(ii)	phase difference = 180°	**A1**
(e)	line drawn joining points where only maxima are observed (i.e. through points where wavefronts intersect) of length at least 4 cm	**B1**

Q10.

(c)(i)	(path difference =) $8.0 + (20.8^2 - 8.0^2)^{0.5} - 20.8 = 6.4$ (m)	**A1**
(c)(ii)	• path difference $= 4\lambda$ • waves (meet at C) in phase • constructive interference (of waves) *any two points, one mark each*	**B2**
(c)(iv)	$3\lambda = 6.4$ $\lambda = 2.1$ m	**A1**

Q11.

(a)(ii)	constant phase difference (between (each of) the waves)	**B1**

Q12.

(b)(i)	constant phase difference (between the waves)	**B1**
(b)(ii)	**1.** phase difference = 360° **or** 0	**B1**
	2. path difference $= 1.5\lambda$ $= 1.5 \times 610$ $= 920$ nm	**A1**
(b)(iii)	$\lambda = ax/D$	**C1**
	$x = 22/4$ (= 5.5 mm) **or** $22 \times 10^{-3}/4$ ($= 5.5 \times 10^{-3}$ m)	**C1**
	$a = (610 \times 10^{-9} \times 2.7)/(5.5 \times 10^{-3})$ $= 3.0 \times 10^{-4}$ m	**A1**
(b)(iv)	shorter wavelength **and** (so) separation decreases	**B1**
(b)(v)	• no change to fringe separation/fringe width/number of fringes • bright fringes are brighter • dark fringes are unchanged *Any two of the above three points, 1 mark each.*	**B2**