7. Waves

7.1 Progressive waves

Paper 2

Marking Scheme

Q1.

(e)	$v = f\lambda$ **and** $f = 1 / T$ **or** $v = \lambda / T$	**C1**
	v = 6.25 × 0.80 **or** 0.80 / 0.16 = 5.0 m s^{-1}	**A1**

Q2.

(b)(i)	$I = P / A$	**C1**
	= 750 / (1300 × 10^{-3})^2	**C1**
	= 440 W m^{-2}	**A1**

Q3.

(b)(i)	$v = f\lambda$	**C1**
	λ = (3.00 × 10^8) / (2.5 × 10^{10}) = 0.012 m	**A1**

Q4.

(a)(ii)	$v = f\lambda$ **or** $c = f\lambda$	**C1**
	f = 3.0 × 10^8 / 8.4 × 10^{-6} = 3.6 × 10^{13} (Hz) = 36 THz	**A1**

Q5.

(b)(i)	$\lambda = v / f$	**C1**
	= 340 / 1700 = 0.20 m	**A1**

Q6.

(b)	$I = P / A$	**C1**
	A = π × 0.028^2 **or** π × 2.8^2 (= 2.46 × 10^{-3} **or** 24.6)	**C1**
	P = 4.7 × 10^{-3} × 2.46 × 10^{-3} = 1.2 × 10^{-5} W	**A1**

Q7.

(d)	(number of periods / cycles) (= t / T) = 0.060 / 0.040 (= 1.5)	**C1**
	amplitude = 72 / 6 = 12 mm	**A1**

Q8.

(c)(ii)	$I \propto A^2$	**C1**
	$A^2 / A_0^2 = (I_0 / 4) / I_0$ $A = 0.5\ A_0$	**C1**
	maximum amplitude $= A_0 + 0.5\ A_0$ $= 1.5\ A_0$	**A1**

Q9.

(a)	distance moved by wavefront/energy during one cycle/oscillation/period (of source) **or** minimum distance between two wavefronts **or** distance between two adjacent wavefronts	**B1**
(b)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$T = 460 \times 10^{-9} / 3.00 \times 10^8$	**C1**
	$= 1.5 \times 10^{-15}$ s	**A1**

Q10.

(a)	time for one oscillation/vibration/cycle **or** time between adjacent wavefronts (passing the same point) **or** shortest time between two wavefronts (passing the same point)	**B1**
(c)(ii)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1/T$	**C1**
	$T = 0.040 / 3.00 \times 10^8$	**C1**
	$= 1.33 \times 10^{-10}$ (s) $= 1.33 \times 10^{-10} / 10^{-12}$ (ps) $= 130$ ps	**A1**

Q11.

(a)	progressive waves transfer energy **or** stationary waves do not transfer energy	**B1**
(b)(i)	0.32 m	**A1**
(b)(ii)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$v = 0.32 / 0.020$ **or** 50×0.32 $= 16$ m s^{-1}	**A1**
(b)(iii)	450° **or** 90°	**A1**

Q12.

(a)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$v = 8.0 \times 10^{-2} / 0.40$ $= 0.20\ \text{m s}^{-1}$	**A1**
(b)	$I \propto A^2$	**C1**
	ratio $= 2^2 / 4^2$	**C1**
	$= 0.25$	**A1**

Q13.

(a)	$v = f\lambda$ **or** $c = f\lambda$	**C1**
	$f = 3.0 \times 10^8 / 0.040$	**C1**
	$= 7.5 \times 10^9$ (Hz) $= 7.5$ GHz	**A1**
(c)	(intensity) increases	**C1**
	(intensity) increases by a factor of 4	**A1**

Q14.

(a)(i)	**1.** $N\lambda$	**B1**
	2. N / f	**B1**
(a)(ii)	v (= distance / time) $= N\lambda / (N / f)$ so $v = f\lambda$	**B1**
(b)	$T = 4.0 \times 0.20 = 0.80$ (ms) **or** 8.0×10^{-4} (s)	**C1**
	$f = 1 / 8.0 \times 10^{-4}$ $= 1300$ Hz	**A1**

Q15.

(a)(i)	distance (in a specified direction of particle/point on wave) from the equilibrium position	**B1**
(a)(ii)	the maximum distance (of particle/point on wave) from the equilibrium position **or** the maximum displacement (of particle/point on wave)	**B1**
(b)	$I \propto A^2$	**C1**
	$I_R / I = (3.6 - 1.2)^2 / (1.2)^2$ resultant intensity $= 4.0I$	**A1**

Q16.

(c)	$vT = \lambda$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$T = 0.060 / 0.40$ $= 0.15$ s	**A1**

Q17.

(a)	distance moved by wavefront/energy during one cycle/oscillation/period (of source) **or** minimum distance between two wavefronts **or** distance between two adjacent wavefronts	**B1**
(b)	(T =) 2.0×2.5 (= 5.0 ms) **or** $2.0 \times 2.5 \times 10^{-3}$ (= 5.0×10^{-3} s)	**C1**
	$f = 1 / (5.0 \times 10^{-3})$ = 200 Hz	**A1**
(c)(iii)	$v = 200 \times 1.6$ = 320 ($m s^{-1}$)	**C1**
	Δt = 6.4 / 320 **or** 27.2 / 320 – 20.8 / 320 = 0.020 s	**A1**

Q18.

(a)(i)	time for one oscillation/one vibration/one cycle **or** time between adjacent wavefronts/points in phase **or** shortest time between two wavefronts/points in phase	**B1**
(a)(ii)	distance moved by wavefront/energy during one cycle/oscillation/period (of source) **or** minimum distance between two wavefronts **or** distance between two adjacent wavefronts **or** minimum distance between two points having the same displacement and moving in the same direction	**B1**
(b)(i)	$v = \lambda / T$ **or** $v = f\lambda$ and $f = 1 / T$	**C1**
	$\lambda = 20 \times 0.60$ = 12 cm	**A1**
(b)(ii)	phase difference = 360° × (0.20/0.60) **or** 360° × (0.40/0.60) = 120° **or** 240°	**A1**
(b)(iii)	$I \propto A^2$	**C1**
	$I_Q / I_P = A_Q^2 / A_P^2$ $= 2.0^2 / 3.0^2$ = 0.44	**A1**

Q19.

(a)(i)	distance moved by wavefront/energy during one cycle/oscillation/period (of source) **or** minimum distance between two wavefronts **or** distance between two adjacent wavefronts	**B1**

Q20.

(b)(iii)	(readings from graph =) 2.6 and 4.0	**C1**
	ratio = $(2.6/4.0)^{1/2}$ = 0.81	**A1**