6 Wave behaviour
Answers to practice questions

Question	Answer	Marks
1	B	1
2	Velocity in glass = $\frac{3 \times 10^8 \text{ m s}^{-1}}{(\sin i / \sin r)}$ $= 1.9 \times 10^8 \text{ m s}^{-1}$	1 1
3 a	Coherent waves have a constant phase difference.	1
3 b	$\lambda = d \sin \theta = \sin 3°/(80 \times 10^3)$ $= 6.5 \times 10^{-7}$ m Give full credit for a correct final answer.	1 1
4	Graph takes the same shape as that already shown. Correct phase difference of π/2 radians.	1 1
5 a	See Figure 2, Topic 6.4. Marking points: same wavelength limited spreading	 1 1
5 b	Increases By a factor of $\sqrt{2}$	1 1
5 c	Waves diffract (curve) more as they pass through the gap.	1
6 a	$d = \frac{670 \times 10^{-9}}{\sin 31°}$ $= 1.3 \times 10^{-6}$ m	1 1
6 b	Sin $\frac{2\lambda}{d} > 1$ The maximum value a sine can take is 1	1 1
7 a i	See Figure 10, Topic 6.1	1
7 a ii	2.4 m	1
7 a iii	Marking points, any three from: • Waves travel along the tube and reflect. • Waves travelling in opposite directions superpose. • Nodes are positions where the waves superpose in antiphase. Antinodes are positions where the waves superpose in phase.	1 mark for each correct point (3 max)
7 b i	With the closed end on the left the pattern is: N A N A	1
7 b ii	$f = \frac{340 \times 3}{2.4}$ $= 425$ Hz	1 1
7 b iii	Wavelength remains constant (assuming the length of the tube doesn't change) As $f = \frac{v}{\lambda}$ The frequency will rise when the temperature rises.	1 1 1
8 a	% uncertainty in slit separation = 20% The next biggest uncertainty is about 4%	1 1
	Calculated value of wavelength = 4.8×10^{-7} m. Largest value of wavelength from uncertainties = 6.25×10^{-7} m Smallest value of wavelength from uncertainties = 3.54×10^{-7} m Value with uncertainty = $4.8 \pm 2.7 \times 10^{-7}$ m You can also tackle this question by considering % uncertainties. (see Module 2)	1 1 1 1

8 b i	The fringe spacing will remain the same. Doubling the slit separation halves the fringe spacing, but doubling the distance will double the fringe separation. The two changes cancel.	1 1
8 b ii	These changes will have halved the percentage uncertainty in the slit separation; and reduced the percentage uncertainty in the length measurement. These changes will reduce the overall uncertainty. One disadvantage is that the fringes will be less intense and so measurement may be difficult.	1 1 1
9 a	Marking points: • Identifying path difference as the difference in distances from the speakers to the microphone. • Maximum signal when path difference = $n\lambda$ or minimum signal when path difference = $(n + \frac{1}{2})\lambda$. • Waves from speakers meet in phase at microphone when a maximum is detected or meet in antiphase at microphone when a minimum is detected. • As microphone moves along line XY, the path difference between the two speakers and the microphone changes.	1 1 1 1
9 b	0.8 m	1
9 c	$\frac{\text{velocity at } 20° \text{c}}{\text{velocity at } 10° \text{c}} = \sqrt{\frac{293}{283}} = 1.0175$ This is a percentage difference of 1.75% The wavelength of the sound in air will increase by the same factor. This will cause the separation of maxima and minima along line XY to increase (a little).	1 1 1 1
10 a	The distance been two nodes is half a wavelength so one wavelength = 0.65 m × 2 = 1.3 m	1
10 b	speed = frequency x wavelength = 82 Hz x 1.3 m = 106.6… = 1.1×10^2 m (2 s.f.)	1 1
10 c i	$v = \sqrt{\frac{T}{\mu}} \Rightarrow T = v^2\mu = 106.6^2 \times 8.4 \times 10^{-3}$ kg = 95 N (2 s.f.)	1 1
10 c ii	The velocity of the wave along the thinner string is greater so frequency will be greater as the wavelength of the wave along both strings is the same.	1
10 d	Marking points, any three from: • Waves travel along the string in both directions. • Waves are reflected from the ends of the string. • Waves travelling in different directions superpose. • At the ends of the string there is zero displacement. • Points of minimum oscillation are nodes. • Points of maximum oscillation are antinodes. • Midway between two nodes the waves add to give maximum displacement.	1 mark for each correct point (3 max)