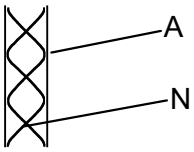
Assessment Schedule – 2005

Physics: Demonstrate understanding of wave systems (90520)

Evidence Statement

Judgements in italics indicate replacement evidence and so are not counted for sufficiency.

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(a) (i)	$v = f\lambda$ $\Rightarrow \quad \lambda = 340 \div 685 = 0.49635$	Correct substitution and rearranging. A2		
1(a) (ii)	2 significant figures because the lowest number of sf in the substituted data is 2.	Units and Sig fig: 3 correct units given from 1e, 2c, 2d, 2g plus 2sf in 1(a)(ii) correctly justified. A1		
1(b)	 Accept other diagrams (eg arrow displacement diagram) that clearly show correct understanding.	Antinodes at both ends of the pipe. A1	Correct wave shape. M1	
1(c)		1 antinode and 1 node correctly labelled. A1		
1(d)	A closed pipe must have a node at the closed end. / A closed pipe can only fit an odd number of $\frac{1}{4}\ \lambda$ whereas an open pipe fits an even number of $\frac{1}{4}\ \lambda$.	Correct answer. A1		
1(e)	$L = 1\frac{1}{2}\ \lambda$ $= 1.5 \times 0.49635$ $= 0.74453 \quad = 0.74$ m	*Correct consequential answer if the incorrect answer to (b) shows a half or one full wavelength.* *A2*	Correct answer or correct consequential answer if the incorrect answer to (b) shows a wavelength other than half or one full wavelength. M2	
1(f)	Waves travel along the pipe and are reflected back from the open end to create standing waves. It is an open pipe so there are antinodes at each end. Only a certain number of nodes and antinodes, and hence wavelengths, can fit into the pipe. The flow of air through the pipe causes waves to be generated which will have a range of frequencies. Only those that match the 'fit' will generate standing waves.	Idea of wave reflection setting up a standing wave in the pipe. A1	Wave reflection from end linked to setting up standing waves and only certain wavelengths (frequencies) can fit the pipe. M1	Full and clear explanation. E1

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(g)	A 9 Hz beat means that the frequency of the note from Joe's pipe was either 694 Hz or 676 Hz. $\lambda = \frac{v}{f}$ and $L = 1.5\lambda$ $\Rightarrow L = 1.5 \times \frac{v}{f}$ $\Rightarrow L = 1.5 \times \frac{340}{694}$ or $1.5 \times \frac{340}{676}$ $\Rightarrow L = 0.73487$ m or 0.75444 m $\Rightarrow \Delta L = 0.74453 - 0.73487$ or $0.75444 - 0.74453$ $\Rightarrow \Delta L = 0.00966$ or 0.00991 $\Rightarrow \Delta L = 0.01$ m		*ΔL calculated from one frequency only. Consequential on 1e.* M2	Correct answer. E2
2(a)	The first line will be violet. λ for violet is less than λ for red, hence violet will have a smaller diffraction angle.	*Idea that $\lambda_V < \lambda_R$ or $f_V > f_R$ the key concept.* A1	Correct colour and reason. M1	
2(b)	Spacing $d = \frac{1}{N} = \frac{1}{6100}$ $= 1.63934 \times 10^{-4}$ cm $= 1.63934 \times 10^{-6}$ m	Correct working. A2		
2(c)	$d\sin\theta = n\lambda \quad \Rightarrow \sin\theta = \frac{1 \times 4.86 \times 10^{-7}}{1.63934 \times 10^{-6}}$ $= 0.296461$ $\Rightarrow \theta = 17.24 = 17°$ (0.3 rad)	Correct answer. A2		
2(d)	$d\sin\theta = n\lambda$ $\Rightarrow \lambda_{red} = 1.63934 \times 10^{-6} \times \sin 23.5^{o}$ $= 6.53685 \times 10^{-7}$ $2\lambda_{red} = 3\lambda_{purple}$ $\lambda_{purple} = \frac{2 \times 6.53685 \times 10^{-7}}{3}$ $= 4.35790 \times 10^{-7} \quad = 4.4 \times 10^{-7}$ m	*Correct λ_{red}* A2		Correct answer. E2
2(e)	Decreasing N will increase d. If d increases, the angle of diffraction for each λ must decrease. This means that each spectrum will be closer to the straight-through position and higher order spectra will be seen, eg there will be more than three spectra. Decreasing N and increasing d means that less waves add completely in phase or completely out of phase. Partial reinforcement or cancellation means wider, less well defined lines.	*An observed difference is stated eg each line will be thicker / lines will not be as sharp / angle of diffraction decreases etc.* A1	An increase in d is linked to EITHER the decreased angle OR the increase in number of spectra seen OR less well defined lines. M1	2 differences are clearly explained. E1

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
2(f)	As the atoms are moving, when light is emitted from atoms that are moving away from the detector they will have a decreased frequency, and an increased frequency when moving towards the detector. The atoms are moving in different directions and with a range of speeds. Hence there is a spread of values for the frequency of the emitted lines.	*Awareness that a moving source will change the frequency of the observed wave.* A1	Correct identification of frequency increasing or decreasing for movement towards or away from the detector. M1	*Discussion on a band of frequencies coming from the fact that atoms are moving in all directions with a range of speeds.* *E1*
2(g)	$f' = f(\frac{v_w}{v_w - v_s})$ $\Rightarrow = 7.36\ 10^{14} \times 14\ (3.00 \times 10^8 - v_s)$ $= 7.32 \times 10^{14} \times 3.00 \times 10^8$ $\Rightarrow v_s = 1.63043 \times 10^6$ $= 1.63 \times 10^6\ \text{m s}^{-1}$		Correct answer. M2	

Question Analysis:

Italics indicates that this question has already appeared in the table so should not count towards total opportunities.

	Quns	A	M	E
C1	8	1(a)(ii) 1(b) 1(c) 1(d) 1(f)	*1(b) 1(f)* 2(a) 2(e) 2(f)	*1(f) 2(e)*
C2	7	1(a)(i) 2(b) 2(c)	1(e) 2(g)	1(g) 2(d)

Judgement Statement

Criterion 1

Achievement	Achievement with Merit	Achievement with Excellence
FOUR opportunities answered at Achievement level or higher. 4 × A1	FIVE opportunities answered with THREE at Merit level or higher. 3 × M1 *plus* 2 × A1	FIVE opportunities answered with ONE at Excellence level and at least TWO at Merit level or higher. 1 × E1 *plus* 2 × M1 *plus* 2 × A1

Criterion 2

Achievement	Achievement with Merit	Achievement with Excellence
TWO opportunities answered at Achievement level or higher. 2 × A2	THREE opportunities answered with ONE at Merit level or higher. 1 × M2 *plus* 2 × A2	FOUR opportunities answered with ONE at Excellence level and at least ONE at Merit level or higher. 1 × E1 *plus* 1 × M2 *plus* 2 × A2