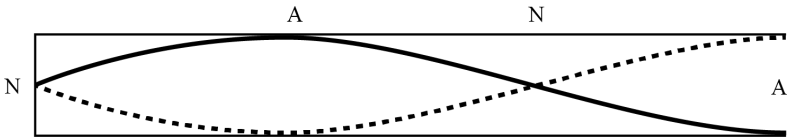
Assessment Schedule – 2024

Physics: Demonstrate understanding of wave systems (91523)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	 Note: wave must reach end of pipe	• Correct shape with one node and antinode labelled correctly.		
(b)	For the 3rd harmonic: $3\times\frac{1}{4}\lambda = 8.50\times10^{-2}$ m $\lambda = 8.50\times10^{-2}\times\frac{4}{3} = 0.1133$ m $f = \frac{v}{\lambda} = f = \frac{343}{0.1133} = 3026.475 = 3030$ Hz	• Correct wavelength. OR One error in calculation.	• Correct answer.	
(c)	Standing waves are formed in the pan flute when the sound waves travel down the pipe, reflect off each end and interfere with itself to form a series of nodes and antinodes. (Waves in phase form antinodes, waves out of phase form nodes) Waves reflect off the open end with no phase change. As the waves are in phase they constructively interfere, forming antinodes at the open end. Waves reflect off the fixed end, with a 180° phase change. As the waves are 180° out of phase they destructively interfere, forming a node at the closed end. Higher harmonics are multiples of the first harmonic, ($f_2 = 2 \times f_1$, $f_3 = 3 \times f_1$ etc) only those that are odd multiples of a ¼ wavelength, so that they produce a node at the fixed end and an antinode at the open end, will resonate to produce a standing wave in the pipe. (It is not possible to produce the second (and other even) harmonic as two quarter wavelengths (= half wavelength) which have nodes at both ends (or antinodes at both ends).)	• ONE of: - Waves reflect and interfere. - Waves in phase produce A. - Waves 180° out of phase produce N. - Recognition that a closed pipe must have a **node at the closed end** and an **antinode at the open end**.	• Justifies end condition(s). OR Explains odd multiples of quarter wavelengths to have N at closed end, A at open end.	• Justifies end condition(s). AND Explains odd multiples of quarter wavelengths to have N at closed end, A at open end. *Accept correct pressure model justification.*

(d)	As pipe is longer, wavelength is greater, so frequency is less than 523 Hz. $f_b = \lvert f_1 - f_2 \rvert$ $9 = \lvert 523 - f_2 \rvert$ $f_2 = 523 - 9$ $f_2 = 514$ untuned pipe $v = f\lambda$ $343 = 514\lambda$ $\lambda = 0.667315$ m $L = \frac{1}{4}\lambda$ $L = 0.166829$ $\Delta L = 0.166829 - 0.164$ $\Delta L = 0.0028288$ Cork needs to be pushed in 0.002828 m (2.83 mm). As the cork gets closer to the correct position, the beat frequency will decrease (longer time between loud sections). So **no beat** will be heard.	• $f_2 = 514$ Hz No beat.	• Correct length of untuned pipe. OR As f get closer, beat frequency decreases (more time between loud regions).	• Correct ΔL. AND As f get closer, beat frequency decreases (more time between loud regions) (No beat is heard.)

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence	1a	2a	3a or 1a + 1m	4a or 2a + 1m	3a + 1m	2a + 2m or 3a + 1e	2a + 1m + 1e or 2m + 1e	2a + 2e or 1m + 2e

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	$n\lambda =$ path difference.	• Correct answer.		
(b)	$d = \frac{1}{N} = d = \frac{1}{200\,000} = d = 5\times10^{-6}$ m $n\lambda = d\sin\theta$ $n = \frac{d\sin\theta}{\lambda} \rightarrow n = \frac{5\times10^{-6}\sin 90}{638\times10^{-9}} = 7.837$ Since n is an integer, there will be 7 dots either side of the centre dot. Total number of dots = 7 + 7 + 1 = 15	• Correct value for $d = 5 \times 10^{-6}$ m. Attempts to use $n\lambda = dsin\theta$ 2n+1 (i.e. substituted correctly but wrong d)	• One error in calculation. OR Correct answer of $n = 7.83$.	• Correct answer of 15 dots in total. (Must indicate central maxima.) NOT $2 \times 7.84 = 15.68$
(c)	The pattern formed by two slits is not as bright or well-defined as that from a diffraction grating. The fringes will also be close together. The slit separation for two slits is much greater than that of a diffraction grating, as $n\lambda = d\sin\theta$, increasing d will decrease the angle to the maxima, causing the pattern to cover a narrow area with the maxima closer together. As there are only two slits of the same width, less light is able to pass through resulting in maxima that are less bright The pattern is less well defined (maxima with fuzzy edges). As there are only two slits, there is a gradual change from the maxima to the minima. (With a diffraction gratings, the resulting interference from many slits results in overall destructive interference, even when adjacent slits are only slightly out of phase)	• Identify maxima closer difference. OR Identify less bright. OR Identify less well defined.	• Justify ONE of: - maxima closer together - less Bright - less well defined.	• Justify THREE of: - maxima closer together - less bright - less well defined.

(d)	White light is composed of several colours. Each colour has its own wavelength and frequency. Blue has a shorter wavelength compared to red light. Therefore the path difference of blue light is less when compared to red light and hence it forms a maxima at a smaller angle compared to red light. Therefore blue is formed on the inside of each spectrum, while red with the longer wavelength and larger path difference, has a larger angle to the maxima and so forms on the outside of each spectrum. NOT ACCEPTED longer wavelengths diffract more.	• Identifies: Blue has a shorter wavelength. OR Red has a longer wavelength. Blue has a shorter path difference. OR Red has a longer path difference.	• Justifies that Red is further from the central maxima using: path difference OR formula.	

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Q	Evidence	Achievement	Merit	Excellence
THREE (a)	Jane and her friends will hear a higher frequency / pitch than the driver.	• Higher frequency.		
(b)	Jane and her friends would hear a sound of a higher pitch. As the train blowing its whistle approaches Jane and her friends on the platform, the train moves toward the previously emitted wavefront and so each successive wavefront is emitted closer to previous wavefront, than if the train was stationary. This causes the wave fronts bunch up in front of the train, resulting in the apparent wavelength to decrease. The speed of sound remains the constant (at 343 m s^{-1}. Since $v = f\lambda$, when wavelength decreases, the frequency will increase.	• ONE of: - The wave fronts bunch up, so apparent wavelength decreases. - The speed of sound is constant Note: NOT waves bunch Note: NOT speed of train const.	• The wave fronts bunch up, so apparent wavelength decreases. AND The speed of sound stays the same. AND So Jane and her friends will hear a note of higher pitch.	
(c)	$f'_{\text{toward}} = \frac{fv_w}{v_w - v_s}$ and $f'_{\text{away}} = \frac{fv_w}{v_w + v_s}$ $f'_t(v_w - v_s) = fv_w$ and $f'_a(v_w + v_s) = fv_w$ So $f'_t(v_w - v_s) = f'_a(v_w + v_s)$ $1270(343 - v_s) = 1190(343 + v_s)$ $435\,610 - 1270v_s = 408\,170 + 1190v_s$ $435\,610 - 408\,170 = v_s(1190 + 1270)$ $v_s = \frac{27\,440}{2460} = 11.2 \text{ m s}^{-1}$	• Correct choice of equations for approaching and receding • Note: can cancel fv_w together $f'(v_w - v_s) = f''(v_w + v_s)$.	• One error in calculation. If incorrectly assumed that $f = 1230$ (midpoint) then $v = 10.8$ m s^{-1}.	• Correct answer.

(d)	The graph shows an increasing higher pitch as the train approaches and a decreasing lower pitch as the train goes away. Since graph has a positive gradient, the pitch is increasing as the train approaches, this means the velocity of the train is increasing (the train is accelerating) towards Jane and her friends. When the train is right in front of Jane and her friends, they hear the actual pitch (the graph line crosses the actual frequency), as there is not component of the velocity toward them. Since graph has a negative gradient, the pitch is decreasing as the train is receding, therefore the velocity of the train is increasing away from Jane and her friends once it goes past them (accelerating away from them).	• Identify TWO: - Increasing higher pitch. - Actual frequency when it is in front of Jane and her friends. - Decreasing lower pitch.	• Justify ONE of: - Increasing higher pitch. - Actual frequency when it is in front of Jane and her friends. - Decreasing lower pitch.	Complete answer.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 06	07 – 12	13 – 19	20 – 24