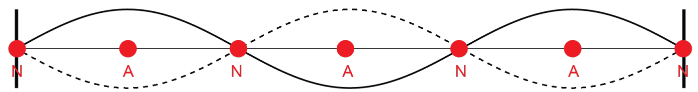
Assessment Schedule – 2023

Physics: Demonstrate understanding of wave systems (91523)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$v = f\lambda$ $= 196 \times (2 \times 0.331)$ $= 129.752$ $= 130 \text{ m s}^{-1}$ (3sf)	• Correct answer (by any valid method).		
(b)	 $\frac{588}{196} = 3$ 3rd hamonic.	• Correct harmonic stated. OR Correct diagram with nodes and antinodes correctly labelled.	• Correct harmonic. AND Correct diagram with nodes and antinodes correctly labelled.	
(c)	$f' = f\frac{v_w}{v_w - v_s}$ $= 196\left(\frac{342}{342 - 5.3}\right)$ $= 199 \text{ Hz}$	• Substituted correctly into equation. E.g. Use $v_w = 130$ (from part a).	• Correct answer.	

(d)	Motion of the sound source causes 1. no change in source frequency 2. no change in the speed of sound 3. As the trailer moves forward when the source emits the next wavefront, the source is closer to the wavefront in front of it than it otherwise would have been if the source was stationary, causing the waves to appear bunched. 4. As $v = f\lambda$, when the speed of sound in air is constant and the apparent wavelength has decreased, the observed frequency at microphone A will increase. 5. As $v = f\lambda$, the speed of sound in air is constant and the apparent wavelength has increased, the observed frequency at microphone B will decrease.	• TWO of: - 1 & 2 - λ in front, decreases. - λ behind, increases. - A detects higher f. - B detects lower f.	• Justifies ONE of the three explain points (3–5).	**For E7:** Minor error. **For E8:** Complete answer.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence.	1a	2a 1m	3a 1a + 1m 1e	4a 2a + 1m	2m	3m 1a + 1m + 1e	2a + 1m + 1e- 2m + $1e^{-}$	2m + e^{+}

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	Increasing length increases wavelength. If v doesn't change, $v = f\lambda$, so increasing λ decreases f.	• decreasing f.		
(b)	Beats are a **regular pulsing in loudness**, due to waves of similar but slightly different frequency from two sources at one location. The waves alternately reinforce and cancel, when they move in and out of phase. When the waves are **in phase**, they constructively interfere to produce a **loud sound** and when the waves are **180° out of phase**, they destructively interfere to produce a **quiet sound**	• Describe volume change OR In phase = loud. Out of phase = quiet.	• Describe volume change AND In phase = loud. Out of phase = quiet.	
(c)(i) (ii) (iii) (iv)	196 ± 2.1= **198.1** or **193.9** Hz If λ is fixed and v increases, f increases. The increase in beat frequency tells us that the string is vibrating further from 196 Hz, so the string must have been at **198.1 Hz**. Sam must **decrease the tension** to get the string to 196 Hz. (decrease v to lower f). When the string is vibrating at exactly 196 Hz, there is **no beat**. She will hear a steady 196 Hz tone.	• Determines both 198.1 OR 193.9 Hz. OR When the string is vibrating at exactly 196 Hz, there is no beat.	• Justifies increase in frequency in part (ii). OR Justifies decrease in tension in part (iii).	• Complete answer.
(d)(i) (ii)	The phenomenon is **resonance** – the wine glass is being shaken at its natural frequency, so the oscillation builds up. The frequency of the violin **matches the natural frequency** of the wine glass. So there are **few energy losses**, causing a **maximum amplitude** and the wine glass to rattle on the shelf. She could stop the wine glass from vibrating by altering the natural frequency of the glass, e.g. by putting water in it, or by adding a cushioning material that absorbs some of the sound energy.	• Identifies resonance. OR Gives a practical way to avoid the rattle	• Outlines resonance	• Completely explains resonance including any way to stop the wine glass from rattling.

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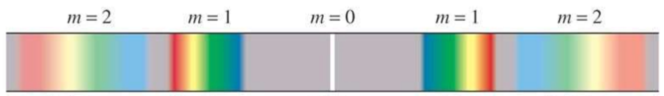
THREE (a)	Diffraction is the spreading out of waves as they go through a gap (or bending around an obstacle).	• Identifies diffraction as spread of waves through a gap.		
(b)	Waves from multiple slits overlap and superpose. If the waves didn't spread out, they wouldn't **overlap** and interfere. The waves only arrive **in phase** and reinforce at the places where the **path difference** from successive slits is a **whole number** of wavelengths ($n\lambda$). The light is bright in these places. When n is not a whole number, even if the phase difference, φ , between two adjacent slits is small, then the phase difference between subsequent slits will be increasing multiples of φ. **With many sources** there will waves from different slits arriving in antiphase and the overall interference will cause **many more points of destructive interference** resulting in a **wide dark region** between the bright fringes.	• ONE aspect correct. - Explains the need for waves to overlap for interference, hence diffraction. - Path difference of whole λ produce maxima. - Waves in phase produce maxima. - Explains dark sections due to waves arriving out of phase to cancel	• **Justifies** why there are maxima / minima. • PD of whole λ , in phase, produce maxima (or vice versa). NOT (n = 0.5, 1.5, 2.5…..)	• Complete answer. Overlap/point sources interfere. PD of whole λ , in phase, produce maxima. Formation of a wide dark region.
(c)	$\tan\theta = \frac{1.75}{1.43}$ $= 1.2238$ $\theta = 50.75°$ $n\lambda = d\sin\theta$ $2\left(6.43\times10^{-7}\right) = d\sin 50.75°$ $d = 1.66\times10^{-6}$ m	• Substitutes approximation formula correctly, wrong ans. Allow $\frac{x}{2} = 0.875$ if $n = 1$.	• One error in calculation. OR Uses the approximation formula. $d = 1.05 \times 10^{-6}$ m	• Correct calculation.

(d)	Violet, which is at one end of the spectrum, has the shortest wavelength, and therefore **the smallest path difference** ($n\lambda$) of a whole wavelength, hence arriving in phase to its 1st order maxima at the **smallest angle** ($n\lambda = d \sin\theta$), and is therefore **closer to the central maxima**. Red, which is at the other end of the spectrum, has the longest wavelength, and therefore the largest path difference ($n\lambda$) of a whole wavelength, hence arriving in phase to its 1st order maxima at the largest angle ($n\lambda = d \sin\theta$), and is therefore further from the central maxima. So, the pattern on the screen, on each side of the centre would be a **complete spectrum with violet closer to the centre** and red on the outside for each order.	• ONE aspect correct. - States a complete spectrum is seen (V inside R outside). - Path difference of whole λ result in waves being in phase. - Path difference of whole λ produce maxima. - Waves in phase produce maxima.	• Correct reasoning for spectrum (violet inside, red outside) (for red $n\lambda\uparrow = d \sin \theta$  	

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 12	13 – 18	19 – 24