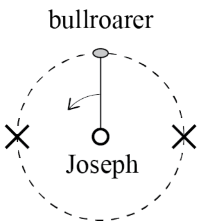
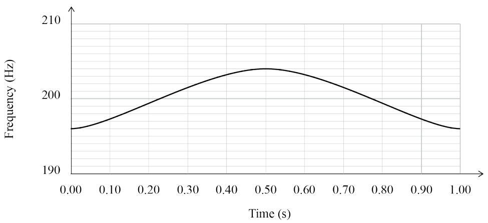
Assessment Schedule – 2018

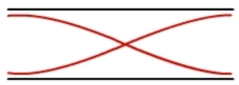
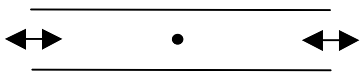
Physics: Demonstrate understanding of wave systems (91523)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$d\sin\theta = n\lambda$ $1.68\times10^{-6}\text{ m}\times\sin16.8° = n\lambda$ $\lambda = 486\text{ nm}$	Correct formula and substitution and answer.		
(b)	$d\sin\theta = n\lambda$ Wavelength and sin of angle are directly proportional. Since the angle is increasing, the wavelength of the next visible line will be larger, thus it must be the 656 nm line.	• Correctly identifies it is the 656 nm line. OR links increasing angle with increasing wavelength.	• Correctly identifies it is the 656 nm line. AND Correctly links increasing angle with increasing wavelength.	
(c)	Recognises that maximum order must be less than 90° and performs calculation. $d\sin\theta = n\lambda$ for $\sin\theta = 1$ $n = \frac{d}{\lambda} = \frac{1.68\times10^{-6}\text{ m}}{656\times10^{-9}\text{ m}} = 2.56$ Therefore, highest order is $n = 2$.	• Recognises the angle will be less than 90°. This includes: *answers of 2.56 unrounded,* *Calculates 2 but then states that 3,4,5 orders are visible.*	• Calculates the maximum order and correctly rounds to 2 (no decimal). OR • Calculates angle to first and second order maxima and shows that for the third order $\sin\theta$ has to be greater than 1 / angle can't be calculated.	
(d)	• **Maxima will be wider**, fewer sources are combining in superposition, so less perfect cancellation occurring in between maxima. • **Dimmer maxima**, only two sources of light so less energy combining at maxima. • Maxima will be located at the **same angles** as before, path differences will still be wavelength integers in the same locations since slit spacing has not changed.	• Two correct descriptions. OR One correct explanation for a description.	• Two correct descriptions including one explanation from: 1. Maxima at same angles because wavelengths, slit separation have not changed. 2. Dimmer maxima because fewer slits / sources allow less light / less energy through. 3. Wider maxima because less destructive interference between maxima.	Three correct descriptions AND • Comprehensive explanation for wider maxima showing understanding that brightness of fringe diminishes gradually as the phase / path difference changes gradually. OR Comprehensive explanation for dimmer maxima linking fewer sources to less waves combining constructively at maxima.

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	(Alternating) higher and lower pitch / freq / notes or pitch increases then decreases	• Correct.		
(b)(i)	$v = f\lambda. \quad \lambda = \frac{344 \text{ m s}^{-1}}{200 \text{ Hz}} = 1.72 \text{ m}$	• Correct wavelength.		
(ii)	Since the bullroarer is moving away from the distant observer, the centre of each new wave front is displaced further away from the observer. As a result, the wave fronts are further apart and the wavelength is larger.	Connects moving away with longer wavelength. OR Connects moving closer with shorter wavelength. OR Bullroarer is moving towards and away from the distant observer but not moving towards or away from Joseph. OR (λ is unchanged for Joseph : replacement for (b)(i) only.)	Connects longer wavelength with moving away causing the source to move between the production of waves / moving closer creating shorter wavelengths due to the source moving between the production of waves. OR Explains that as the bullroarer is moving away and towards observer the λ will increase then decrease, compared to bullroarer is never moving towards or away from the Joseph so λ constant.	
(c)	 No component of velocity of bullroarer in the direction of sound traveling towards observer / no relative motion between bullroarer and sound wave traveling towards observer.	• Correct positions, for Joseph and observer to measure the same frequency. (Evidence for (c) may be taken from (b) also.)	• Correct positions marked. At these positions, the component of velocity of the source towards / away from the observer is zero and therefore no Doppler effect is observed. (Evidence for (c) may be taken from (b) also.)	

(d)	Calculates the maximum and minimum frequencies for the moving bullroarer. Travelling toward observer: $f' = f\frac{v_w}{v_w - v_s}$ $f' = 200 \times \frac{344}{344 - 6.28} = 204\text{ Hz}$ Travelling away from observer: $f' = f\frac{v_w}{v_w + v_s}$ $f' = 200 \times \frac{344}{344 + 6.28} = 196\text{ Hz}$ 	• Calculates either one of the shifted frequencies correctly. OR Cos graph with correct period but wrong frequencies. (Evidence for (d) may be taken from (b) also.)	• Both maximum and minimum frequencies calculated correctly (Evidence for (d) may be taken from (b) also.)	• All correct including starting position. Looks like a –cos graph!

Q	**Evidence**	**Achievement**	**Merit**	**Excellence**
THREE (a)	 OR  $L=\frac{\lambda}{2}$ $\lambda = 2L = 2\times 0.400 = 0.800$ m	• Correct drawing OR $L=\frac{\lambda}{2}$ $\lambda = 2L = 2\times 0.400 = 0.800$ m		
(b)	Each time the rod vibrates, the vibration is transferred to the air. So the frequency of the rod will be the same as the frequency of vibration in the air. The wavelength is determined by how far a vibration is able to move away from the source before the next vibration is made. Since the wave speed is different in the air than it is in the rod, the wavelengths will be different as well.	• Identifies the rod as the source of vibration for the air, thus frequencies will be the same. OR Links wavelength as being dependent on speed of wave travel in the medium.	• Identifies the rod as the source of vibration for the air, thus frequencies will be the same. AND Links wavelength as being dependent on speed of wave travel in the medium.	
(c)	$\lambda = 2\times 0.0230\text{ m} = 0.0460\text{ m}$ In tube / air: $v = f\lambda,\ f=\frac{344\text{ m s}^{-1}}{0.0460\text{ m}} = 7478.26\text{ s}^{-1}$ In steel rod: $v = f\lambda = 7478.26\text{ Hz}\times 0.800\text{ m}$ $= 5982.61\text{ m s}^{-1}$ $= 5980\text{ m s}^{-1}$	• Correct wavelength in air. OR Correct velocity calculation for steel using an incorrect wavelength in air. E.g. gets 11960 m s $^{-1}$	• All correct. Unrounded answer OK Can use $\frac{\lambda_{\text{rod}}}{\lambda_{\text{air}}}=\frac{v_{\text{rod}}}{v_{\text{air}}}$.	

(d)	Second harmonic in the rod will have double the frequency of the fundamental. The increase in frequency in the metal rod causes the same increase in frequency in the tube. The wavelength in the tube decreases, while **wave velocity in the tube is unchanged**. The tube is an open-closed pipe, and so must have a displacement antinode at one end, and a displacement node at the other end. Doubling the frequency of an odd harmonic produces an even harmonic frequency. Even harmonic frequencies cannot form standing waves in the tube.	• Frequency will be increased OR New frequency will not be a resonant frequency for the length of the tube. OR Standing wave will not form in the tube. OR Even harmonics cannot form in the tube.	• Recognises the increase in frequency in the metal rod causes the same increase in frequency in the tube, and calculates the new wavelength in the tube / states wavelength in the tube decreases.	• Recognises the change in frequency in the metal rod causes the same change in frequency in the tube, but the tube will not form the same standing wave pattern because: the pipe is an open-closed pipe. OR Recognises the increase in frequency in the metal rod causes the same increase in frequency in the tube, and calculates the new wavelength in the tube / states that wavelength in the tube decreases. Must also either state **that wave velocity in the tube is unchanged**, or state that the powder piles will be closer together.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
0	u	2u OR i OR c	3u OR i+u	4u OR 2u+i OR 2i OR c+u	2i+u OR c+i	2i+2u OR 3i	1u + 1i + 1c	2i + 1c

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 18	19 – 24