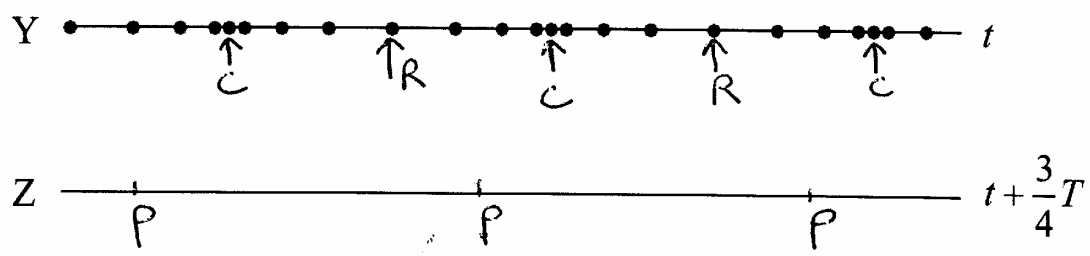
Question Number	Answer		Mark
***1(a)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) • Two waves travelling in opposite directions **Or** a wave meets its reflection • Superposition occurs (do not credit superimposition) **Or** reference to both constructive and destructive interference • Producing points where the waves are in phase and points where they are in antiphase **OR** producing points of zero amplitude and points of maximum amplitude **OR** Nodes and antinodes produced	**(1)** **(1)** **(1)**	**3**
1(b)	Use of $v = f\lambda$ (ignore powers of 10 errors) λ = 1.2 m **Or** 120 cm f = 275 Hz (accept 275 s^{-1}) <u>Example of calculation</u> λ = 1.2 m f = 330 m s^{-1} / 1.2 m f = 275 Hz	**(1)** **(1)** **(1)**	**3**
1(c)	Remove: the frequencies with the highest amplitude **Or** the frequencies which are loudest **Or** frequencies f_2 and f_3 Reduces volume/loudness/sound/amplitude of vuvuzela (compared to commentator) (If all the frequencies removed) the speech of commentator would be affected **Or** (If all the frequencies removed) vuvuzela not heard at all (Do not award third mark if it is suggested that **all** sound is removed)	**(1)** **(1)** **(1)**	**3**
1(d)(i)	Antiphase: one wave 180º/ π /half a cycle out of phase with another wave (ignore references to wavelength – correct or incorrect; 'out of phase' not sufficient) Destructive interference is when two waves cancel each other out / produce zero amplitude/intensity The waves have the same frequency **Or** The waves have the same amplitude	**(1)** **(1)** **(1)**	**3**
1(d)(ii)	It would not work because: all of the sound would be cancelled **Or** amplitude of noise not constant (accept frequency not constant; accept (too) many frequencies)	**(1)**	**1**
	Total for question 19		**13**

Question Number	Answer		Mark
2(a)	Use of $v = f\lambda$ f = 7.3 Hz [accept 7.3 s^{-1}, do not accept fractions] <u>Example of calculation</u> f = 330 m s^{-1} / 45 m f = 7.3 Hz	**(1)** **(1)**	**2**
2(b)	Diffraction / it diffracts **Either** an explanation of diffraction in general: Idea that the waves spread out (not bending) OR a diagram showing diffraction **OR** An explanation of why the tiger is heard: diffraction is significant for an obstacle (not a gap) of a size similar to the wavelength OR a diagram showing diffraction over a hill	**(1)** **(1)**	**2**
	Total for question 12		**4**

Question Number	Answer		Mark
3(a)	Tick in Ultrasound box only	**(1)**	**1**
3 (b)	A polarised wave is when the oscillations/vibrations are in one plane only which includes direction of travel (of the wave). **Or** A polarised wave is when the oscillations/vibrations are in one direction only which is perpendicular to the direction of travel (of the wave). **Or** Describes polarisation as a process where oscillations/vibrations in many planes are reduced to oscillations/vibrations in one plane [References to displacement are only acceptable in the context of varying displacement] Longitudinal waves oscillate/vibrate in one direction which is the direction of travel of the wave / parallel to the direction of travel of the wave.	**(1)** **(1)**	**2**
	Total for question 13		**3**

Question Number	Answer		Mark
4(a)	Units of LHS $m\ s^{-1}$ (1) Units of T = $kg\ m\ s^{-2}$ (1) Units of $\mu = kg\ m^{-1}$ (1)	**(1)** **(1)** **(1)**	**3**
4(b)(i)	Waves travel in both directions along wire **OR** reference to being reflected (not bounce) Waves superpose / interference effect / superposition occurs (not superimpose) Producing nodes and antinodes **OR** node is produced where waves are 180º out of phase / antiphase **OR** antinode is produced where waves are in phase **OR** node produced at a point of destructive interference **OR** antinode produced at a point of constructive interference **OR** produces points/ positions of constructive interference and points/ positions of destructive interference	**(1)** **(1)** **(1)**	**3**
4(b)(ii)	$\lambda = 4$ m	**(1)**	
4(b)(iii)	Substitution into the formula ignoring powers of ten $v = 173\ m\ s^{-1}$ <u>Example of calculation</u> $v = \sqrt{(150\ N / 0.005\ kg\ m^{-1})}$ $v = 173\ m\ s^{-1}$	**(1)** **(1)**	**2**
4(b)(iv)	Some of the marks may be gained from diagrams which show length remaining constant. Nodes and antinodes do not need to be labelled. Assume a sequence of diagrams shows increasing frequency. • Wave speed const • (As frequency increases) wavelength decreases Then **max 3** from • At most frequencies there is no standing wave / as frequency changes from a standing wave the wave no longer occurs / Standing waves only occur at some frequencies • At higher frequencies there are more nodes / antinodes / loops (Not 'more waves') • There is always a node at either end **Or** No of nodes = no of antinodes plus one • Amplitude is less if there is a greater number of nodes • Length = n $\lambda/2$ / after first standing wave, they occur when frequency x 2, x 3, x 4 etc / for frequency nf_0	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**Max 4**
	Total for question 21		**13**

Question Number	Answer	Mark
5(a)	The vibrations/oscillations/movement of the molecules is parallel to /along same line as energy/ wave travels /in the same direction as the wave travels (1)	**1**
5(b)(i)	Any two compressions accurately marked (1)	**1**
5(b)(ii)	Any two rarefactions(one could be at left hand end) accurately marked (1)	**1**
5(b)(iii)	Any correct answer e.g. centre of compression to centre of adjacent compression	**1**
5(c)	Two positions of compressions labelled P or C, approximately 1 or 2 correct wavelengths apart Positioned half way from a true R to the next true C  [Diagram for Q11 showing possible markings of C, R and P	**2**
	Total for question 11	**6**

Question Number	Answer	Mark
6(a	Use of $v=f\lambda$ with c = 3.00×10^8 ms^{-1} (1) kHz to Hz (1) wavelength = 1520 m (1) (accept 1500 m) Example of calculation $\lambda = 3 \times 10^8$ $ms^{-1}/198000$ λ = 1515 m	**3**
6(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Correct mention of diffraction (not defraction) (1) Large(r) wavelengths give large(r) diffraction or vv/ diffraction is the spreading of wave(fronts) (1) This idea applied to the context i.e.related to a building or hill, referencing size **and** lack of 'shadow'/more complete coverage (1)	**3**
	Total for question 12	**6**

Question Number	Answer	Mark
7(a)(i)	(Ultrasound because) they are above the audible range/frequency (1) ('not in the range' or 'out of the range', is not precise enough, need the clear idea that it is above the audible range. Accept greater than 20,000 Hz)	**1**
7(a)(ii)	Substitution into speed = distance/time (1) Use of $t = 0.8 \times 10^{-4}$ s **OR** halving distance found with $t = 1.6 \times 10^{-4}$ s (1) Distance = 0.12 m (1) (answer of 0.24 m scores 1) Example of calculation Distance = speed × time Distance = 1500 m $s^{-1} \times 0.8 \times 10^{-4}$ s Distance = 0.12 m	**3**
7(a)(iii)	The idea that one pulse must return before the next is sent (1) (ignore references to interference/stationary waves)	**1**
7(b)(i)	X rays cause ionisation OR can damage DNA/cells/tissue OR cause mutation (1) (do not allow 'causes cancer')	**1**
7(b)(ii)	**Max 2** X rays transverse, US longitudinal OR X rays can be polarised, US can't (1) X rays travel in vacuum, US doesn't (1) X ray Electromagnetic, US mechanical (1) X rays have (much) higher f /shorter λ / greater speed. (1)	**2**
	Total for question 13	**8**

Question Number	Answer	Mark
8(a)	ANY THREE Sound waves are longitudinal waves (1) Air molecules vibrate (1) Parallel to the direction of travel of the wave (1) In a series of compressions and rarefactions (1)	**3**
(b)	Frequency is the number of cycles/oscillations/waves per second/per unit time OR number of cycles/oscillations/waves passing a point per second.	**1**
(c)	Use of $v = f\lambda$ $V = 3000$ m s^{-1} **Example of answer** $v = 1500$ m s$^{-1} \times 2$ Hz $v = 3000$ m s^{-1}	**1** **1**
(d)	Animals detect infrasound / lower frequencies than humans / vibrations through the ground Infrasound travels faster than the tidal wave	**1** **1**
	Total for question	**8**