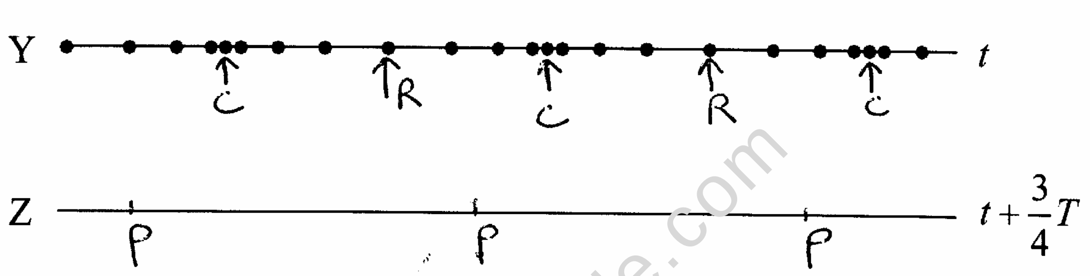
Wave Basics MS1

Question Number	Answer	Mark
1(a)	When car travelling towards gun, (detected) wavelength is smaller/decreased **Or** When car travelling away from gun (detected) wavelength is larger/increased **(1)** When travelling towards gun (observed) frequency is higher/increased **(1)** When travelling away from gun (observed)frequency is lower/decreased **(1)** Greater speed (of car) gives a greater change in frequency. **(1)**	**4**
1(b)	Use of $v = s / t$ **(1)** Calculates difference in times or difference in distances **(1)** Correct use of factor 2 **(1)** v = 29.7 m s^{-1} **(1)** <u>Example of calculation</u> $\Delta t = (3.333 \times 10^{-7}\ s) - (3.315 \times 10^{-7}\ s) = 1.8 \times 10^{-9}\ s$ $1.8 \times 10^{-9}\ s \div 2 = 9 \times 10^{-10}\ s$ $s = (9 \times 10^{-10}\ s \times 3 \times 10^{8}\ m\ s^{-1}) = 0.27\ m$ $v = 0.27\ m \div 0.0091\ s = 29.7\ m\ s^{-1}$	**4**
1(c)	Infrared/lidar has shorter wavelength than microwave/radar **Or** microwave/radar has a longer wavelength than infrared/lidar **(1)** Shorter wavelength has less diffraction (accept spread out, divergent) **Or** Longer wavelength has greater diffraction (accept spread out, divergent) **(1)** Infrared/lidar can be aimed more accurately **Or** infrared/lidar will not pick up reflections from other cars **Or** microwave/radar more likely to pick up multiple reflections **(1)**	**3**
	Total for question	**11**

Question Number	Answer		Mark
2(a)	Time for return trip divided by 2 Multiply by speed of light (accept *c* or value)	(1) (1)	**2**
2(b) (i)	Use of $s = vt$ with speed of light Pulse length = 0.06 m or 6 cm <u>Example of calculation</u> $s = 3.0 \times 10^8 \text{ m s}^{-1} \times 2.0 \times 10^{-10}$ s = 0.060 m or 6.0 cm	(1) (1)	**2**
2(b) (ii)	Distance is to the nearest km but pulse length is to the nearest mm, so acceptable (accept pulse length to nearest cm) Not acceptable because 6.0 cm pulse is longer than 3.8 cm, **Or** The distance is calculated from a difference over 40 years, so it is over a metre, so it is acceptable compared to 6.0 cm	(1) (1)	**2**
2(b) (iii)	So they can tell which received pulse matches which sent pulse (Ignore: 'so one pulse is received before the next is sent') (Accept so they can identify the start of a pulse or reference to another feature or the pulse profile)	(1)	**1**
2 (c) (i)	Use of $P = E/t$ Power = 1.2×10^9 W <u>Example of calculation</u> $P = 115 \times 10^{-3}$ J / 100×10^{-12} s = 1.15×10^9 W	(1) (1)	**2**
2(c) (ii)	Diffraction would cause the beam to spread out **and** weaken the signal further The aperture is much larger than the wavelength So diffraction is minimised/zero	(1) (1) (1)	**3**
	Total for question		**12**

Question Number	Answer	Mark
3(a)	(Motion of person causes) a change in frequency/wavelength **(1)** Compared to the signal from X directly **(1)** Correctly states change in frequency/wavelength for motion described **(1)**	**3**
3(b)	Pulse-echo gives the distance of an object **Or** Pulse-echo gives the position of an object **Or** Pulse-echo can detect a person who is not moving **Or** Pulse-echo can detect inanimate objects **Or** Doppler only works with moving objects Accept any sensible physics based suggestion that doesn't also apply to the Doppler system **(1)**	**1**
	Total for Question	**4**

Question Number	Answer		Mark
4(a)	The vibration generator is vibrating along the axis of the spring **Or** the displacements in the photograph are all along the axis of the spring **Or** there are compressions and rarefactions The displacement/vibration is parallel to the direction of propagation of the waves produced by the generator **Or** The displacement/vibration is the same as the direction of travel of the waves	**(1)** **(1)**	**2**
4(b)	A point with zero amplitude **Or** a point where the displacement is always zero	**(1)**	**1**
4(c)	Waves from the generator are reflected at the end **Or** waves are travelling in both directions When the two waves meet they superpose/interfere 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 (producing nodes and antinodes not sufficient as nodes have been identified already)	**(1)** **(1)** **(1)**	**3**
4(d)	Determines wavelength from photograph (0.14 m) Use of velocity = frequency x wavelength Velocity = 4.8 (m s^{-1}) [max 1 mark only if wrong wavelength] <u>Example of calculation</u> $\lambda = 0.72 \text{ m} \div 5$ $v = f\lambda$ $v = 34 \text{ Hz} \times 0.14 \text{ m}$ $v = 4.8 \text{ m s}^{-1}$	**(1)** **(1)** **(1)**	**3**
4(e)	Use of velocity = distance / time Divides by 42 to find the time for the pulse to travel one length of the spring / multiplies length by 42 to find total distance / applies factor of 2 correctly Velocity = 4.9 m s^{-1}	**(1)** **(1)** **(1)**	**3**
4(f)	**Max 3, at least 1 from each of similarities and differences** **Similarities** Both are standing/stationary waves Both have a node at either end The wave velocity in the second is 0.36 m x 14 Hz = 5.0 m s^{-1}, so the velocity is about the same **Differences** In the first the length of the spring is 5 wavelengths but here it is 2 wavelengths **Or** the wavelength is longer for the second spring **Or** first wave has more nodes/antinodes than second wave **Or** the nodes/antinodes are closer together in the first photograph Second wave is a transverse wave (not just 'not longitudinal') **Or** the displacement is perpendicular to the direction of propagation of the waves **Or** the displacement is perpendicular to the spring axis **Or** first wave has compressions and rarefactions (and second wave doesn't)	**(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for Question		**15**

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)	**1**
5(c)	Two positions of compressions labelled P or C, approximately 1 or 2 correct wavelengths apart (1) Positioned half way from a true R to the next true C (1)  [Diagram for Q11 showing possible markings of C, R and P	**2**
	Total for question	**6**

Question Number	Answer	Mark
6(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**
6(a)(ii)	Substitution into speed = distance/time (1) Use of t = 0.8 × 10^{-4} s **OR** halving distance found with t = 1.6 × 10^{-4} s (1) Distance = 0.12 m (1) (answer of 0.24 m scores 1) <u>Example of calculation</u> Distance = speed × time Distance = 1500 m s^{-1} × 0.8 × 10^{-4} s Distance = 0.12 m	**3**
6(a)(iii)	The idea that one pulse must return before the next is sent (1) (ignore references to interference/stationary waves)	**1**