Question Number	Answer	Mark
1(a)	**Coherent:** Waves of constant phase relationship **Standing wave:** no (net) transfer of energy OR pattern of nodes and antinodes OR points of maximum displacement and zero displacement	**1** **1**
(b)	**QO** **Work must be clear and organised in a logical sequence** Calculation to show a path of 24 cm or 42 cm OR paths of 2λ and 3.5 λ Path difference is 1 ½ λ OR divide path difference by 12 Waves at X in antiphase /180º out of phase/π radians out of phase destructive interference **Example of answer** One path length = 18 cm + 6 cm = 24 cm Other path length = 30 cm + 12 cm = 42 cm Path difference = 42cm – 24 cm = 18 cm Number of wavelengths = 18/12 = 1.5	 **1** **1** **1** **1**
(c)	Food moves through hot and cold spots Over time period all parts of food receive similar amount of energy.	**1** **1**
	Total for question	**8**

Question Number	Answer	Mark
2	Point A is half a wavelength from X (1) At Y arrow drawn vertically downwards (1) B marked at one of three positions of max displacement (1)	
	Total for question	**3**

Question Number	Answer	Mark
3 (a)(i)	Node correctly placed (1)	**1**
(a)(ii)	Arrow at Y moving up (1) Arrow at Z moving down (1)	**2**
(b)	Identifies a factor of 3 (1) Fundamental frequency = 0.5 Hz (1)	**2**
	Total for question	**5**

Question Number	Answer	Mark
4(a)	Waves must have same frequency or wavelength (1) Waves must have same amplitude (1) Waves must be 180^{o}, ½ wavelength, half a cycle, π radians apart or in antiphase (1)	**3**
(b)	Noise of a vibrating object has a constant pitch/frequency (1) Speech/sound varies in pitch and/or amplitude (1) The idea of the difficult of matching a changing signal (1)	**3**
	Total for question	**6**

Question Number	Answer	Mark
5(a)	5% of 60 W (is 3 W) (1) Use of $I = P / 4\pi r^2$ (1) OR Uses $I = P / 4\pi r^2$ with 60 W Finds 5% of this answer Intensity = 0.038 W m $^{-2}$ (1) (accept 0.04 W m $^{-2}$)	**3**
(b)	**QWC – Work must be clear and organised in a logical manner using technical wording where appropriate** **Any three** Fluorescent lamp much more efficient OR filament lamp is less efficient(1) Sensible attempt to process the values given (1) Indicates that less than 25% of national power used for lighting (1) Reduction in wasted energy as thermal energy (1) Reduction in CO_2 emission or preserves fossil fuel resources (1) (Just saying filament lamp is inefficient does not score 1st mark)	**Max 3**
	Total for question	**6**

Question Number	Answer	Mark
6(a)	Use of distance = speed × time (1) Recognising distance travelled is twice the measurement or halves the time given (1) Distance = 4.1 m (1) **Example of calculation** Distance = (330 m s $^{-1}$ × 25 × 10 $^{-3}$ s) ÷ 2 Distance = 4.125 m	**3**
(b)	One pulse must return before the next one is sent **OR** So that time interval between transmitted and received pulses can be measured **OR** No overlap between pulses **OR** No interference between pulses	**1**
	Total for question	**4**

Question Number	Answer	Mark
7(a)	LED 1 colour green LED 2 colour orange LED 3 colour red All three correct	**1**
(b)	Least energetic photon Use of $E = hf$ or hc/λ must see correct value of h (1) Use of $f = 4.41 \times (10^{14})$ Hz or equivalent λ (1) $E = 2.92 \times 10^{-19}$ J (1) (E = 1.83 eV gets full credit) **Example of calculation** $E = 6.63 \times 10^{-34}$ J s $\times$ 4.41×10^{14} Hz $E = 2.92 \times 10^{-19}$ J	**3**
	Total for question	**4**

Question Number	Answer	Mark
8(a)	Use of distance = speed x time **(1)** Time = 1.7×10^{-8} s **(1)** Example of calculation $t = s \div v$ $= 5.0 \text{ m} \div 3.0 \times 10^{8} \text{ m s}^{-1}$ Time = 1.67×10^{-8} s	**2**
8(b)	Pulses, so the reflected signal is received before next one is sent **Or** otherwise there wouldn't be a way of telling which bit of reflected IR originated with which bit of emitted IR **Or** so that reflected pulses can be distinguished from each other **(1)**	**1**
8(c)	Accept any sensible reason, Examples: could interfere with what is being looked at light from the background could interfere with the signal **(1)**	**1**
	Total for question 12	**4**

Question Number	Answer		Mark
***9(a)**	**(QWC – Work must be clear and organised in a logical manner using technicalwording where appropriate)** a standing/stationary wave Waves from the generator are reflected at the end **Or** waves are travelling in both directions (When the two) waves (meet they) superpose/undergo superposition 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 producing nodes and antinodes	**(1)** **(1)** **(1)** **(1)**	**4**
9 b)	Wavelength = 2 × 1.8 m Use of speed = wavelength x frequency Speed = 1200 m s^{-1} Example of calculation λ = 2 × 1.8 m v = 330 Hz × 3.6 m v = 1188 m s^{-1}	**(1)** **(1)** **(1)**	**3**
9(c)(i)	Point is a node, so zero amplitude OR Point is a node, so string not moving So no energy absorbed **Or** Waves continue to move after superposition	**(1)** **(1)**	**2**
9(c)(ii)	(Original frequency x 2) = 660 Hz	**(1)**	**1**
9(c)(iii)	Captured twice per cycle = 1320 Hz (allow ecf from (c) (iii)) If more than 1320 Hz will be captured at points other than max amplitude	**(1)** **(1)**	**2**
9(d)	Scale divisions of 20 Hz **Or** Wide pointer **Or** nominal output (only) Lack of precision (scale related) **Or** Lack of accuracy (output related)	**(1)** **(1)**	**2**
	Total for question 18		**14**