8	**D is the correct answer as decreasing the distance between the central maximum and the first order maximum would require sinθ to be reduced (presuming that the distance from the diffraction grating to the screen is unchanged), and $\lambda = \frac{d\ sin\theta}{n}$** A is not the correct answer as this does not affect sinθ B is not the correct answer as this would increase the distance between the central maximum and first order maximum C is not the correct answer as more lines per mm would make d smaller, so as $d = \frac{n\lambda}{sin\theta}$, which would make sinθ increas	**(1)**

10	**B is the correct answer** A is not the correct answer as X and Z are in antiphase C is not the correct answer as Y and Z have the same frequency D is not the correct answer as point Z is an antinode	**(1)**

6	**A is the correct answer as $v = \sqrt{(T/\mu)}$, where $T = Mg$ and μ = mass m per unit length, where length = $4L/3$** B is not the correct answer as this suggests the overall length of the string is $2L/3$ C is not the correct answer as this suggests the overall length of the string is L D is not the correct answer as this suggests the overall length of the string is $L/3$	**(1)**

2	**The only correct answer is A (distance between adjacent lines on the diffraction grating)** B is not the correct answer as the distance between the diffraction grating and the screen is not represented by any letter in this equation. C is not the correct answer as this is 1/d D is not the correct answer as this is n in the equation.	**1**

7	**B is the correct answer** A is not the correct answer as distance has not been doubled C is not the correct answer as time has been doubled, instead of halved D is not the correct answer as distance has been doubled and time halved	**(1)**

6	**B is the correct answer** A is not the correct answer as the wavelength is 2/3 of the length VY C is not the correct answer as the wavelength is 2/3 of the length VY D is not the correct answer as the wavelength is 2/3 of the length VY	**(1)**

3	**D is the correct answer** A is not the correct answer as waves on a string are transverse B is not the correct answer as waves on a string are transverse C is not the correct answer as waves on a vibrating string are not progressive	**(1)**

8	**The only correct answer is A** $(20 \times 10^{-6})\,v$ $= \left(\frac{10\ \mu s\ \times 4}{2}\right) \times v$	**1**
	***B** is not correct because incorrect reading from graph* ***C** is not correct because no division by 2* ***D** is not correct because multiplication by 2 instead of dividing*	

Question Number	Answer	Mark
***16(a)(i)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Cold spots formed at nodes **and** hot spots formed at antinodes (1) **Either** Nodes formed where waves meet in antiphase (1) resulting in zero/minimum <u>amplitude</u> (1) **Or** Antinode formed where waves meet in phase (1) resulting in maximum <u>amplitude</u> (1) (For MP2 and MP3 allow cold spot for nodes and hot spot for antinodes)	**3**
16(a)(ii)	Use of $v=f\lambda$ with $v = 3.0 \times 10^8$ (1) Using $\lambda = 2.8$ cm (1) $f = 1.1 \times 10^{10}$ Hz (1) <u>Example of Calculation:</u> $f = \frac{3\times10^8\ \text{ms}^{-1}}{0.028\ \text{m}} = 1.07 \times 10^{10}$ Hz	**3**
16(a)(iii)	The positions of nodes and antinodes within the food are constantly changing (1) **Or** The standing wave is constantly changing position (1) **Or** Points of max **or** min amplitude are constantly changing position (1) **Or** The amplitude of the standing wave at one point in the food is constantly changing (1)	**1**

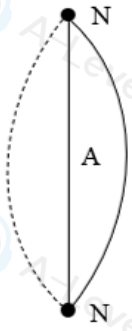
*16(b)(i)	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Constructive interference (1) Waves arrive in phase (1) As they have zero path difference **Or** point O is equidistant from both slits (1)	**3**
16(b)(ii)	Maxima where path difference is nλ. (1) Minima where path difference is (n + ½) λ. (1)	**2**
	Total for question 16	**12**

14(a)	Oscillations / vibrations are perpendicular to the direction of energy transfer **Or** Oscillations / vibrations are perpendicular to the direction of wave travel (allow propagation for wave travel) **(1)**	**1**

14(b)(i)	Uses appropriate trigonometry to determine θ **(1)** Use of $n\lambda = d\sin\theta$ to calculate d **(1)** Calculate $\frac{1}{d}$ **(1)** Number of lines per mm = 260 **(1)** Example calculation $\theta = \tan^{-1}\left(\frac{0.22\text{ m}}{1.30\text{ m}}\right) = 9.61°$ $1 \times 650 \times 10^{-9}\text{ m} = d\sin(9.61°)$ $d = \frac{650 \times 10^{-9}\text{ m}}{\sin(9.61)} = 3.89 \times 10^{-6}\text{ m}$ No. of lines per mm = $\frac{10^{-3}}{3.89 \times 10^{-6}\text{ m}} = 257$	**4**

14(b)(ii)	The path difference (for light from different slits travelling to the screen) is one wavelength **(1)** (So) the waves are in phase at the screen **(1)** (So) constructive interference occurs (causing a maximum) **(1)**	**3**
	Total for question 14	**8**

15(a)	Oscillations / vibrations are perpendicular to the direction of energy transfer **Or** Oscillations / vibrations are perpendicular to the direction of wave travel (allow propagation for wave travel) **(1)**	**1**

15(b)	Shape of wave correct Node labelled at each end and antinode labelled in the middle (MP2 dependent on MP1) <u>Example of diagram</u>  	**(1)** **(1)**	**2**

15(c)	Use of $v = f\lambda$ Use of $v = \sqrt{\frac{T}{\mu}}$ Use of $\mu = \frac{m}{l}$ [with l = 1.5 m] Mass of string = 3.1 (g), so string B [Allow reverse working for full marks] <u>Example of calculation</u> $v = 196\ \text{Hz} \times 0.72\ \text{m} = 141\ \text{m s}^{-1}$ $\mu = \frac{41\ \text{N}}{(141\ \text{m s}^{-1})^2} = 2.06 \times 10^{-3}\ \text{kg m}^{-1}$ $\text{m} = 1.5\ \text{m} \times 2.06 \times 10^{-3}\ \text{kg m}^{-1} = 3.09 \times 10^{-3}\ \text{kg}$	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 15		**7**

Number			
11(a)	There is a constant phase relationship/difference	**(1)**	**1**
11(b)	(Reflected light) interferes / superposes (with the light from the laser)	**(1)**	**1**