

Mark Scheme

Q1.

Question Number	Answer	Mark
	A is the correct answer B is not the correct answer as it can be altered to change frequency (CP 5) C is not the correct answer as it can be altered to change frequency (CP 5) D is not the correct answer as it can be altered to change frequency (CP 5)	(1)

Q2.

Question Number	Answer	Mark
	The only correct answer is B $\left(\sqrt{\frac{20 \times 2.5}{0.005}}\right)$ A is not correct because this does not include mass C is not correct because this is tension $\times$ mass per unit length D is not correct because has no length included	1

Q3.

Question Number	Answer	Mark
	The only correct answer is A (decreasing the length l) B is not correct because lower tension would decrease the frequency C is not correct as strings with greater diameter vibrate with lower frequency D is not correct as strings with greater mass per unit length vibrate with lower frequency	1

Q4.

Question Number	Answer	Mark
	The only correct answer is B ($\sqrt{2} \times f$) A is not correct because this would be the value of tension was halved C is not correct because this would be the value if the tension were reduced by a factor 4 D is not correct because this would be the value if the tension were increased by a factor 4	1

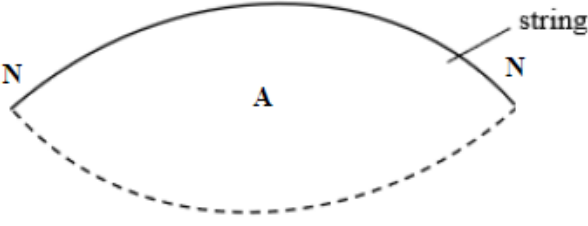
Q5.

Question Number	Answer	Mark
	D is the correct answer as $v = \sqrt{T/\mu}$ and increasing T increases v A is not the correct answer as this would only alter the wavelength of the wave B is not the correct answer as this does not affect the speed of the wave C is not the correct answer as this would decrease the speed of the wave	(1)

Q6.

Question Number	Answer	Mark
a	Difficult to judge/measure the exact position of node Or Ruler is not close to the string (so there might be parallax error) (1)	1
bi	Calculates gradient by best fit or plotted points from graph (1) Recognises distance between adjacent nodes = $\lambda/2$ Or Recognises that speed of waves on the string = $2 \times$ gradient (1) Use of $v = \sqrt{\frac{T}{\mu}}$ to find T (1) Use of $T = mg$ with $g = 9.81 \text{ Nkg}^{-1}$ (accept $W = mg$) (1) $m = 0.21 \text{ kg}$ (1) <u>Example of calculation</u> Gradient = $\frac{2.7 \text{ m}}{0.080 \text{ s}} = 33.75 \text{ ms}^{-1}$ Speed = $2 \times$ gradient = 67.5 ms^{-1} $v = \sqrt{T/\mu}, 67.5 \text{ ms}^{-1} = \sqrt{\frac{T}{4.5 \times 10^{-4} \text{ kg m}^{-1}}}$ $T = 2.05 \text{ N}$ $m = \frac{W}{g} = \frac{T}{g} = \frac{2.05 \text{ N}}{9.81 \text{ Nkg}^{-1}} = 0.209 \text{ kg}$	5
bii	Straight line with shallower gradient drawn, starting from origin (1) Line has a gradient of around $0.7 \times$ line drawn (1) (Graph line if continued to the last value for $1/f$ should be between 1.8 and 2.0m for d).	2
Total for question		8

Q7.

Question Number	Answer	Mark
(a)	Nodes labelled at both ends and Antinode labelled in the middle of the string 	(1) 1
(b)	Waves / vibrations <u>reflect</u> from the end(s) of the string superposition / interference occurs	(1) (1) (1) 3
(c)(i)	Equates $f\lambda$ with $\sqrt{\frac{T}{\mu}}$ Equates λ to $2l$ $f^2 = \frac{1}{4l^2\mu} \cdot T$ compares with $y = mx (+c)$	(1) (1) (1) 3

(c)(ii)	Determines $\frac{\Delta f^2}{\Delta T}$ Uses gradient = $\frac{1}{4l^2\mu}$ $\mu = 6.4 \times 10^{-4} \text{ kg m}^{-1}$ to $6.7 \times 10^{-4} \text{ kg m}^{-1}$ <u>Example calculation</u> Gradient = $\frac{2500}{4.7} = 532$ $532 \text{ Hz}^2 \text{ N}^{-1} = \frac{1}{4 \times (0.85 \text{ m})^2 \times \mu}$ $\mu = \frac{1}{4 \times (0.85 \text{ m})^2 \times 532 \text{ Hz}^2 \text{ N}^{-1}} = 6.50 \times 10^{-4} \text{ kg m}^{-1}$	(1) (1) (1) 3
Total for question		10

Q8.

Question Number	Answer	Mark
a	Wave <u>reflected</u> at the pulley Superposition/interference (takes place)	(1) (1) (1) 3
b	Use of $W = mg$ Use of $v = \sqrt{T/\mu}$ Use of $v = f\lambda$ to find λ $\lambda = 1.2$ (m) node to node distance = $\lambda/2$, so there is a node at R Or See $\lambda/2 = 0.6$ m, so there is a node at R (MP4 requires evidence of calculation) <u>Example of calculation</u> Tension in string = $W = mg = (0.300 \text{ kg}) (9.81 \text{ N kg}^{-1}) = 2.94\text{N}$ $v = \sqrt{T/\mu} = \sqrt{\frac{2.94 \text{ N}}{2.27 \times 10^{-2} \text{ kg m}^{-1}}} = 36.0 \text{ m s}^{-1}$ $\lambda = \frac{v}{f} = \frac{(36.0 \text{ m s}^{-1})}{(30 \text{ Hz})} = 1.20 \text{ m}$ node to node distance = $\lambda/2$, so node to node distance = 0.60 m.	(1) (1) (1) (1) (1) 5
ci	S and T are in antiphase Or 180° out of phase Or π radians out of phase S and T are in adjacent node-to-node regions Or S and T are in adjacent loops	(1) (1) 2
cii	S has a greater amplitude than T S is at an antinode and T is between a node and antinode Or S is at an antinode and T is not Or T is closer to a node than S (MP2 dependent on MP1)	(1) (1) 2
Total for question		12

Q9.

Question Number	Answer	Mark
a	(Two) waves travelling in opposite directions Or wave meeting its reflection (1) Nodes are points of zero/minimum amplitude and antinodes are points of maximum amplitude (1) Nodes linked to destructive interference and antinodes linked to constructive interference (1)	3
b	Equates $v = f\lambda$ and $v = \sqrt{T/\mu}$ (1) Rearranges to give $f^2 = \frac{T}{\mu\lambda^2}$ Or $f^2 = \frac{T}{\mu(2L)^2}$ (1) Replaces T with W in equation (1) Where μ and λ are constants Or where μ and L are constants (1) $f^2 \propto W$ Or no “c” in “$y=mx+c$” Or y-intercept is 0 Or in the format $y = mx$ (1) (MP5 is dependent on some correct working leading to an equation) (Award MP4 if stated that $\frac{1}{\mu\lambda^2} = \text{constant}$ or equivalent in terms of l)	5
c	(Connect signal generator to) cathode ray oscilloscope (1) Or record movement of the string with a video camera (Measure time period T and) calculate $f = 1/T$ (1)	2
d	Use of $v = \sqrt{T/\mu}$ (1) Identifies that $\lambda = 2L$ (1) $\mu = 4.3 \times 10^{-4} \text{ kg m}^{-1}$ (1) Example of calculation $f\lambda = \sqrt{T/\mu}$, $659 \text{ Hz} \times (2 \times 0.328 \text{ m}) = \sqrt{(80.0 \text{ N} / \mu)}$, $\mu = 4.3 \times 10^{-4} \text{ kg m}^{-1}$	3
Total for question		13