

Questions

Q1.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

A string is stretched between two fixed points and set into oscillation.

The frequency of the vibrating string is **not** dependent on

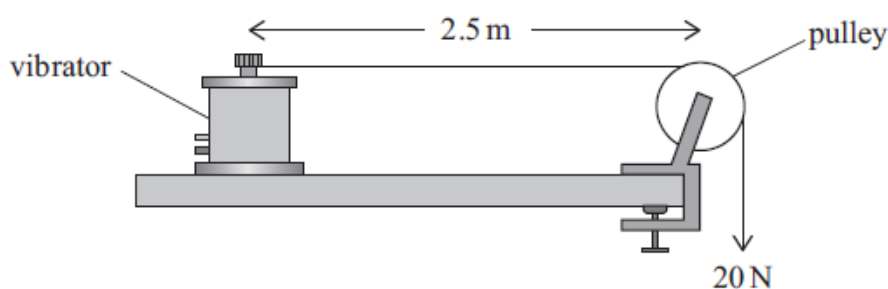
- ☒ **A** the amplitude of the string's vibration.
- ☐ **B** the length of the string.
- ☐ **C** the mass per unit length of the string.
- ☐ **D** the tension in the string.

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct (☐). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☐).

A student investigated stationary waves on a string, using the apparatus shown.



The vibrating length of the string has a mass of 0.005 kg and a length of 2.5 m.

Which of the following gives the speed of a transverse wave on this string in m s^{-1} ?

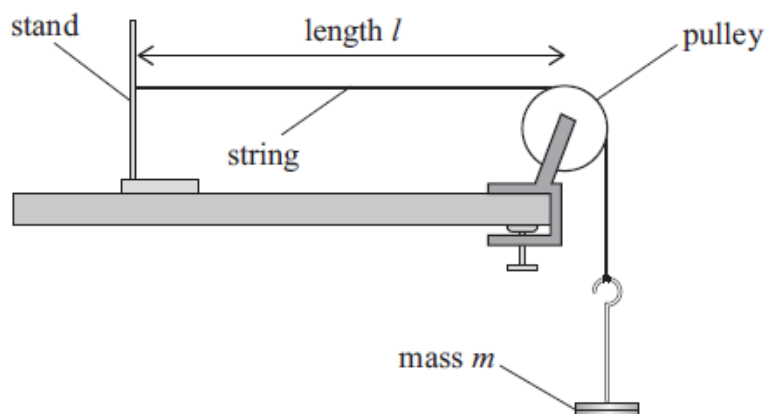
- ☐ A $\sqrt{\frac{20}{2.5}}$
- ☐ B $\sqrt{\frac{20 \times 2.5}{0.005}}$
- ☐ C $\sqrt{\frac{20 \times 0.005}{2.5}}$
- ☐ D $\sqrt{\frac{20}{0.005}}$

(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

A student sets up the apparatus shown.



When the string is plucked, it vibrates with a frequency f .

Which of the following single changes would increase f ?

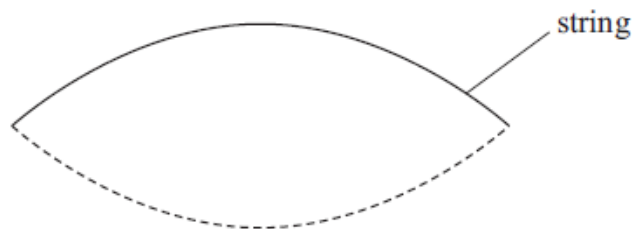
- ☐ A decreasing the length l
- ☐ B decreasing the mass m
- ☐ C increasing the cross-sectional area of the string
- ☐ D increasing the mass per unit length of the string

(Total for question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct (☐). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☐).

A string vibrates between two fixed points. The diagram shows the stationary wave formed on the string when the string vibrates with frequency f .



The tension in the string is doubled. The frequency of vibration is adjusted until the same shape of standing wave forms on the string.

Which of the following expressions gives the frequency f of the new standing wave?

- ☐ A $\frac{f}{\sqrt{2}}$
- ☐ B $\sqrt{2} \times f$
- ☐ C $\frac{f}{2}$
- ☐ D $2 \times f$

(Total for question = 1 mark)

Q5.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

A student investigates how different variables affect the speed of waves on a vibrating string.

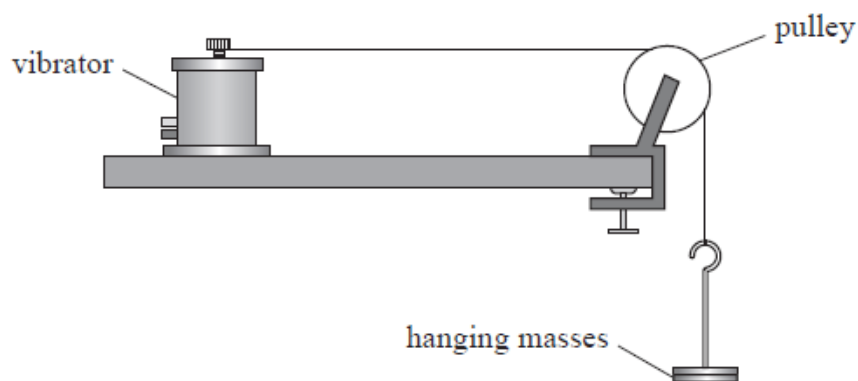
Which of the following would increase the speed of waves along the string?

- ☐ **A** increasing the frequency
- ☐ **B** increasing the length of the string
- ☐ **C** increasing the mass per unit length of the string
- ☐ **D** increasing the tension in the string

(Total for question = 1 mark)

Q6.

A student investigated stationary waves on a string, using the apparatus shown.



The frequency f of the vibrator was adjusted until a stationary wave was formed with a node at each end. This was repeated for various stationary waves on the string. A metre rule was used to measure the distance d between adjacent nodes on the string.

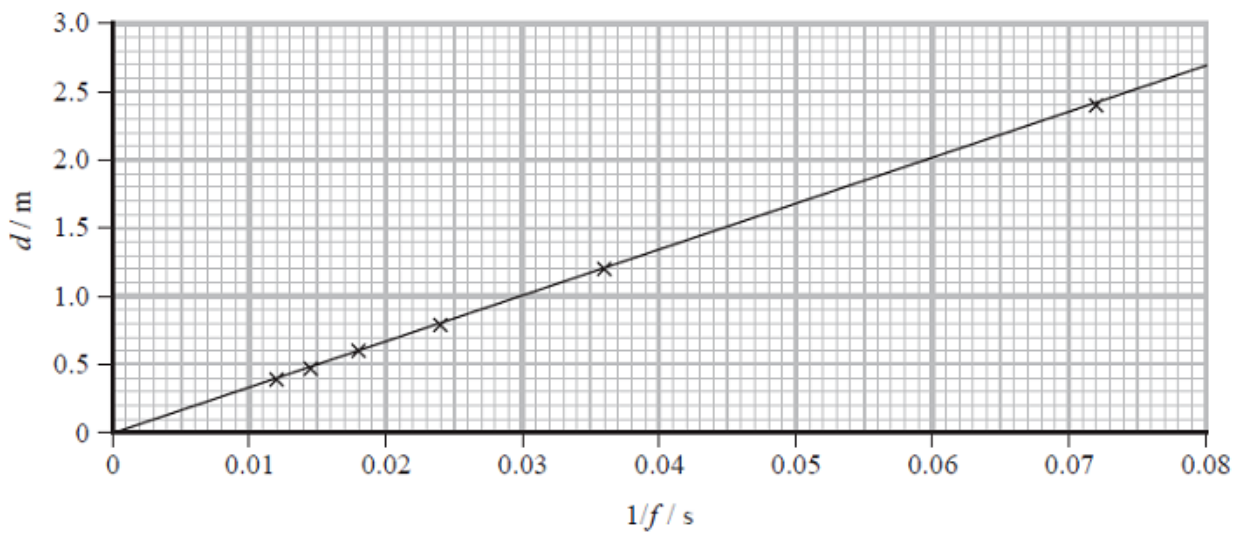
(a) The resolution of the metre rule was 1 mm, but the measurements were recorded to the nearest 0.5 cm.

Suggest why.

(1)

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(b) The student plotted a graph of d against $1/f$ as shown.



(i) Determine the total mass of the hanging masses used in the investigation.

mass per unit length of string = $4.5 \times 10^{-4} \text{ kg m}^{-1}$

(5)

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Total mass of hanging masses =

(ii) The string was replaced with one that had twice the mass per unit length.

The length of the string and the mass of the hanging masses did not change.

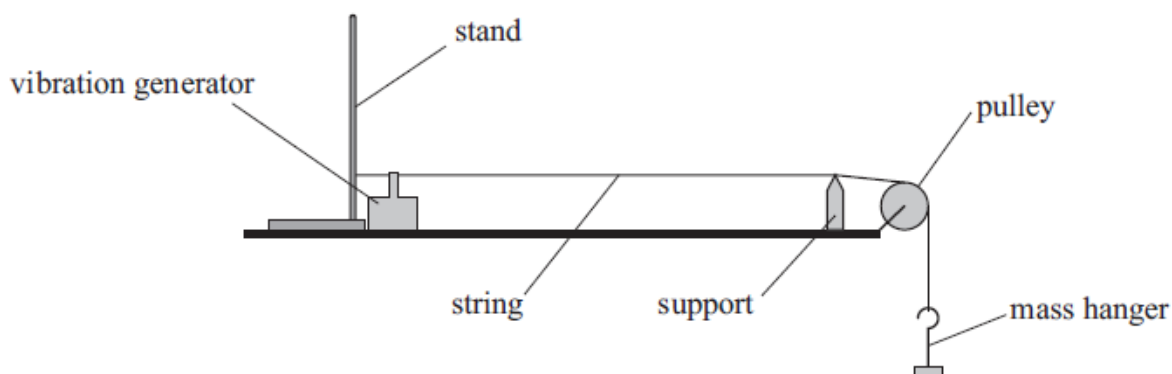
Add a line to the graph to show how d varied with $1/f$ for the new string.

(2)

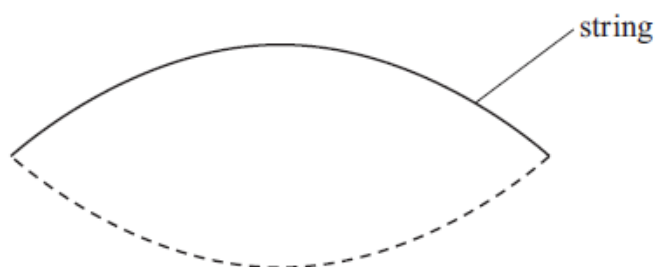
(Total for question = 8 marks)

Q7.

A student investigated stationary waves on a vibrating string using the apparatus shown.



The student adjusted the frequency of the vibration generator until a standing wave formed on the string, as shown below.



(a) Label each node on the standing wave with a letter N, and each antinode with a letter A.

(1)

(b) Explain how a standing wave forms on the string.

(3)

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(c) The student added masses to the hanger to vary the tension T in the string. He adjusted the frequency f of the vibration generator until the same shape of standing wave formed. He recorded T and the corresponding value of f .

The student repeated the procedure for different values of T . The length l of the string between the vibration generator and the support was kept constant.

The mass per unit length of the string is μ .

The student plotted a graph of f^2 on the y-axis against T on the x-axis.

(i) Explain why the graph is a straight line with a gradient of $\frac{1}{4l^2\mu}$

(3)

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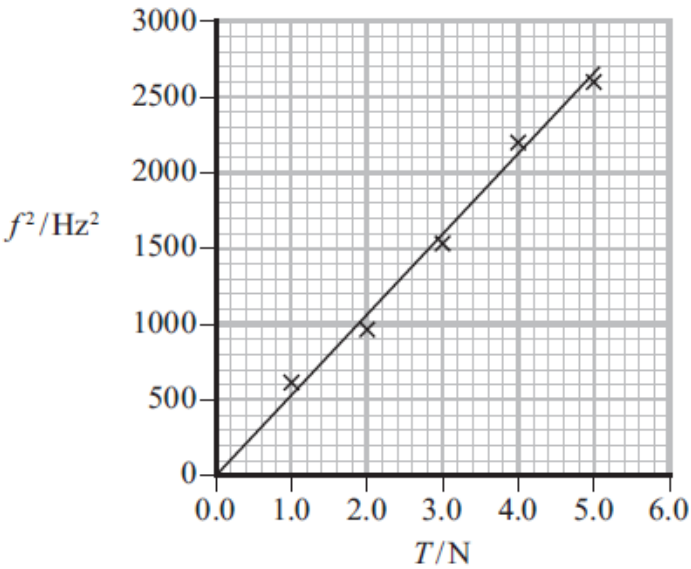
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(ii) The student's graph is shown below.



Determine the mass per unit length μ of the string.

$l = 0.85 \text{ m}$

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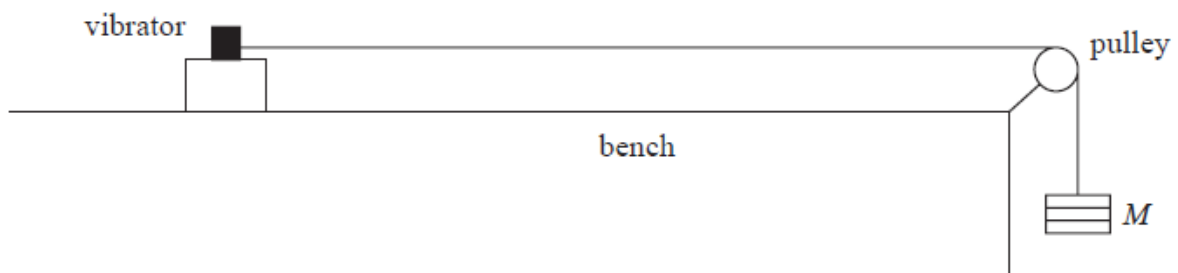
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$\mu =$

(Total for question = 10 marks)

Q8.

A student investigated stationary waves on a stretched string. The string was attached to a vibrator and a mass M , as shown.



(a) Explain how a stationary wave forms on the string.

(3)

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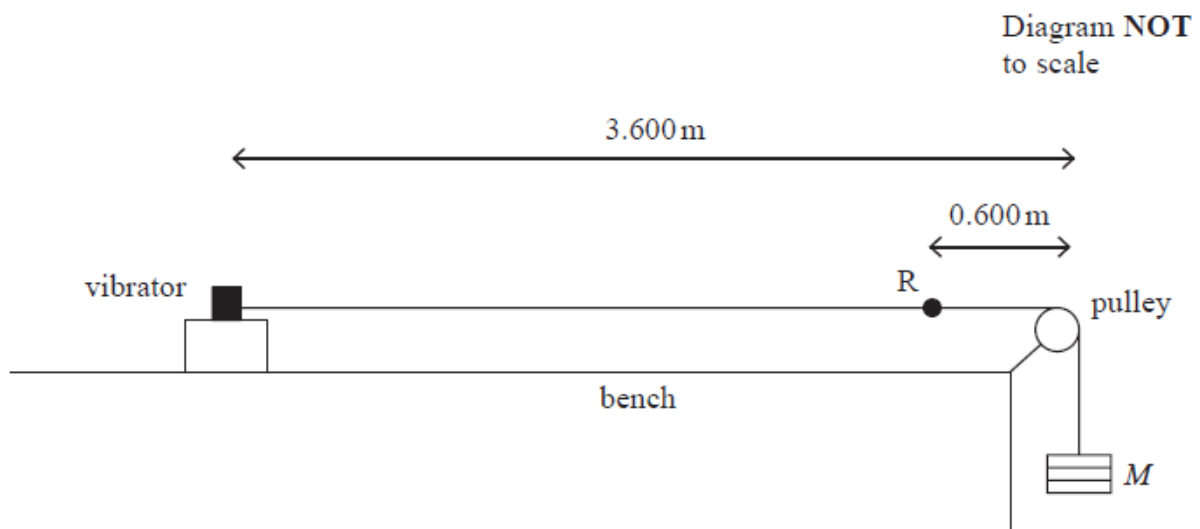
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(b) The frequency of the stationary wave was 30.0 Hz. The distance between the vibrator and the pulley was 3.600 m. Point R is 0.600 m from the pulley, as shown.



Determine whether there was a node at point R.

$$M = 0.300 \text{ kg}$$

$$\text{mass per unit length of string} = 2.27 \times 10^{-3} \text{ kg m}^{-1}$$

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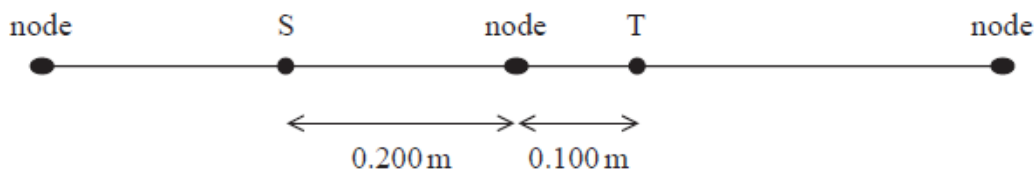
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(c) The mass M was changed and the frequency of the vibrator was adjusted, so that a different stationary wave formed on the string. Adjacent nodes were separated by 0.400 m. The diagram shows two points, S and T, on the string at an instant when the string was straight.



(i) Explain the phase relationship between points S and T.

(2)

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(ii) Explain how the amplitude of vibration of the string at point S compares with the amplitude of vibration of the string at point T.

(2)

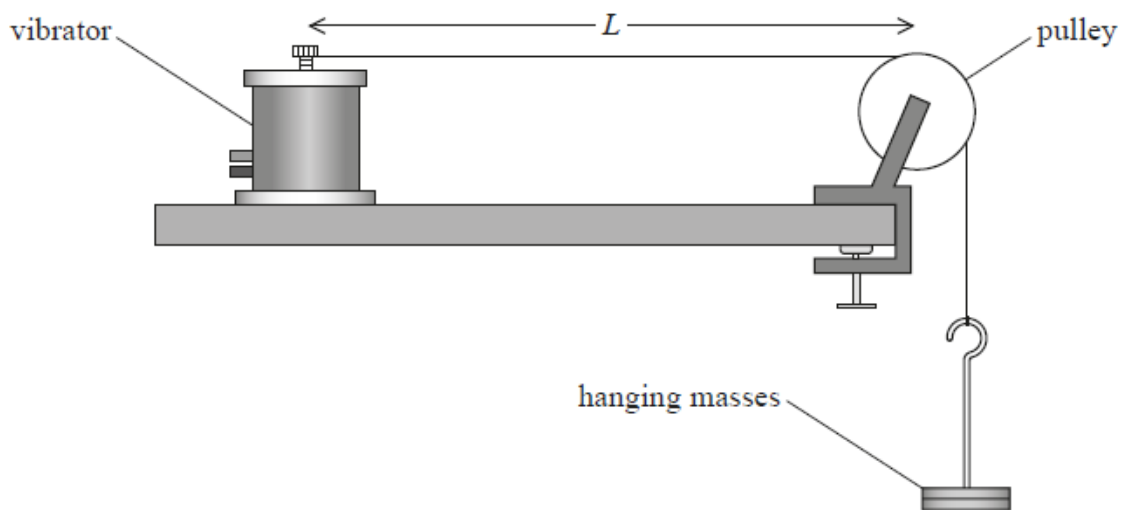
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(Total for question = 12 marks)

Q9.

A student investigated how the frequency of vibration of a string varies with the tension in the string. The student connected masses to one end of the string and attached the other end to a vibrator as shown.



(Source: http://www.schoolphysics.co.uk/age16-19/Sound/text/Vibrating_strings/index.html)

A signal generator was connected to the vibrator. The signal generator was adjusted until a stationary wave was produced on the string. The stationary wave had nodes at both ends of the vibrating length of the string, L , and an antinode in the middle.

(a) Explain how nodes and antinodes are created on a string.

(3)

(b) The student changed the weight W applied to the string and adjusted the frequency f of the signal generator until the same stationary wave was set up on the string.

The student plotted a graph of f^2 against W .

Explain why the graph was a straight line through the origin.

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(c) Describe a method that can be used to confirm that the frequency value stated on the signal generator is correct.

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(d) When W is 80.0 N, f is 659 Hz.

Calculate the mass per unit length of the string.

length $L = 0.328$ m

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Mass per unit length =

(Total for question = 13 marks)