

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 ☐.

Which of the following is **not** a correct statement about stationary waves?

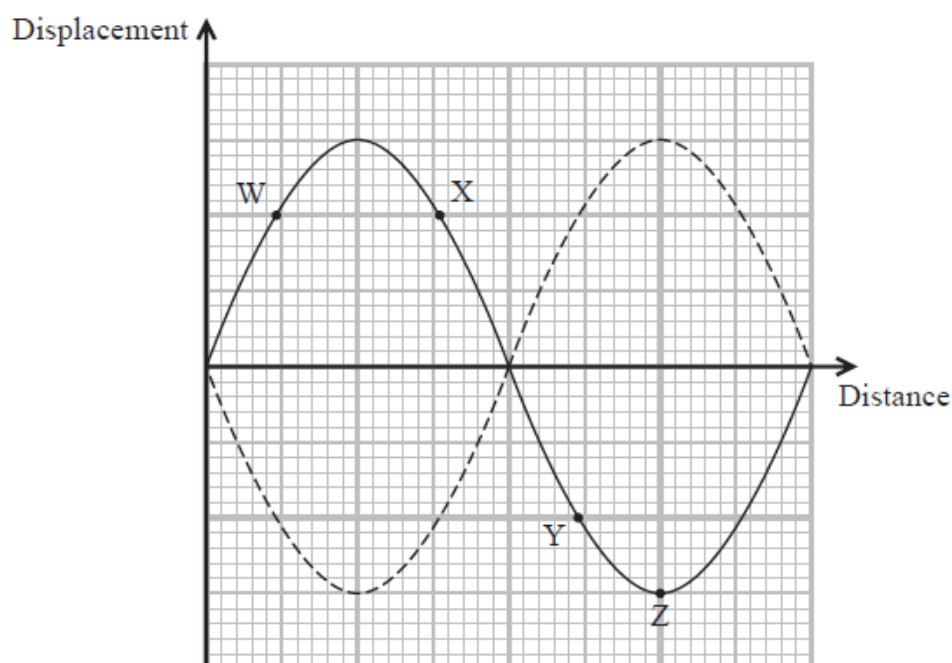
- ☐ **A** All points between two adjacent nodes are in phase.
- ☐ **B** Antinodes are points of maximum amplitude.
- ☐ **C** The distance between adjacent nodes is equal to one wavelength.
- ☐ **D** The net energy transfer along a stationary wave is zero.

(Total for question = 1 mark)

Q2.

Select one answer from A to D and put a cross in the box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The diagram shows how the displacement varies with distance along a stationary wave at two instants of time.



Which of the following statements is correct?

- ☐ **A** Points W and X are in antiphase.
- ☐ **B** Points W and Y are in phase.
- ☐ **C** Points X and Y are in phase.
- ☐ **D** Points X and Z are in antiphase.

(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 ☐.

This question refers to the standing wave pattern on a string as shown.



Which of the following sections of the string would be in phase with each other?

- ☐ **A** VW and WX
- ☐ **B** WX and XY

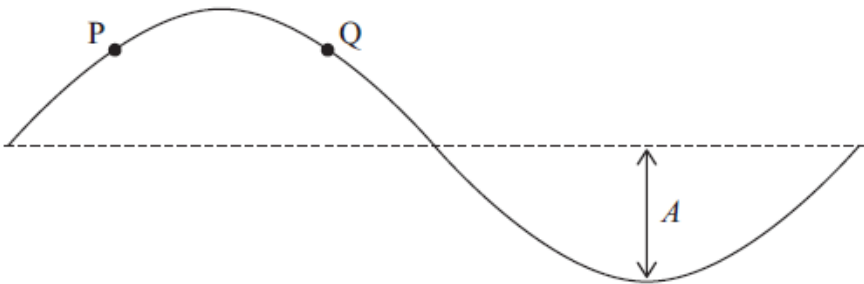
- ☐ **C** VW and XY
- ☐ **D** No sections are in phase.

(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 ☐.

The diagram shows a wave of amplitude A on a string.
P and Q are two points on the string.



The wave on the string is a stationary wave.

Which row of the table is correct?

	Phase difference between P and Q	Amplitude of oscillation of P and Q
☐ A	0°	equal to A
☐ B	0°	less than A
☐ C	90°	equal to A
☐ D	90°	less than A

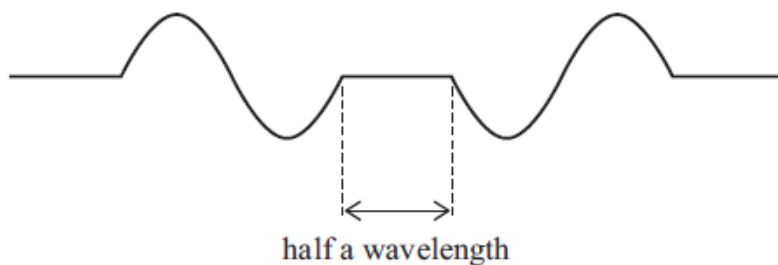
(Total for question = 1 mark)

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 ☒.

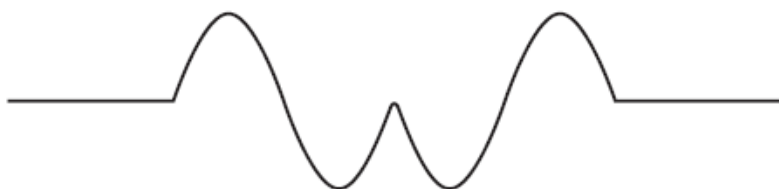
Two waves on a string move towards each other at the same speed. Both waves have the same wavelength.

The diagram shows the string when the waves are half a wavelength apart.

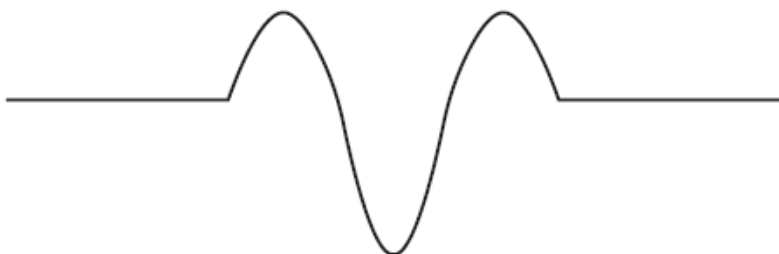


Which of the following shows the string when both waves have moved a distance of half a wavelength?

☒ A



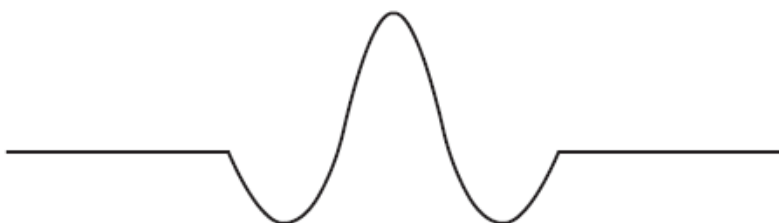
☒ B



☒ C



☒ D



(Total for question = 1 mark)

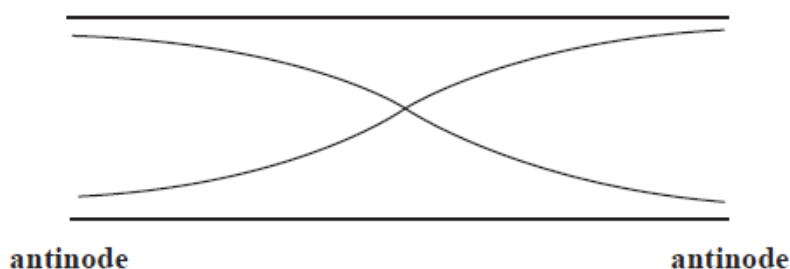
Q6.

A recorder is a musical instrument with a mouthpiece at one end, as shown.



(a) When a musician blows into the mouthpiece, a stationary wave is produced in the air column inside the recorder.

(i) The stationary wave has antinodes at both ends of the air column as shown.



Calculate the frequency of the sound produced by this stationary wave.

speed of sound in air = 330 m s^{-1}

length of recorder = 23.6 cm

(3)

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Frequency =

(ii) The recorder is made from three separate sections that slide together as shown.



A musician plays the recorder and produces the same frequency sound as in (i).

The temperature of the air increases. As the temperature of the air increases, the speed of sound also increases.

Explain how the musician can adjust the recorder to produce the same frequency sound as in (i).

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(b) On a violin, a stationary wave is created when a string is plucked. A violin string has a fixed length but the tension can be adjusted.

When a string is plucked, it produces a sound with a frequency of 432 Hz. This string is adjusted to produce a sound of frequency 440 Hz.

Calculate the percentage increase in the tension in the string.

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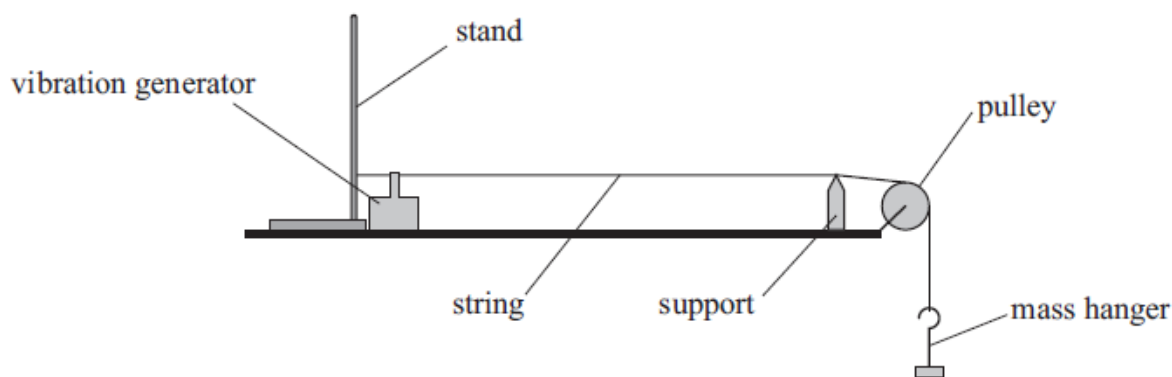
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Percentage increase =

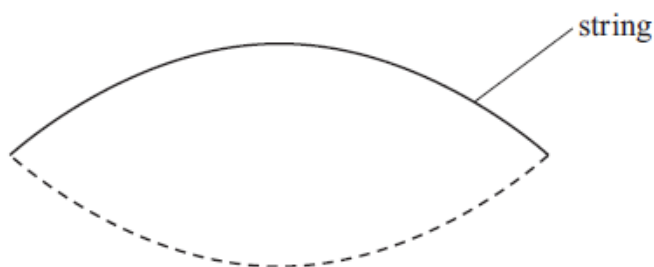
(Total for question = 9 marks)

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 $\frac{1}{4l^2\mu}$

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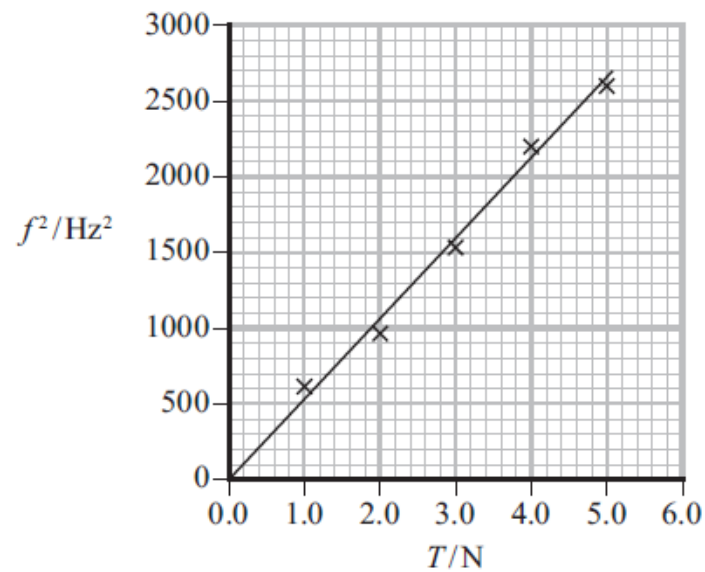
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(ii) The student's graph is shown below.



Determine the mass per unit length μ of the string.

$$l = 0.85 \text{ m}$$

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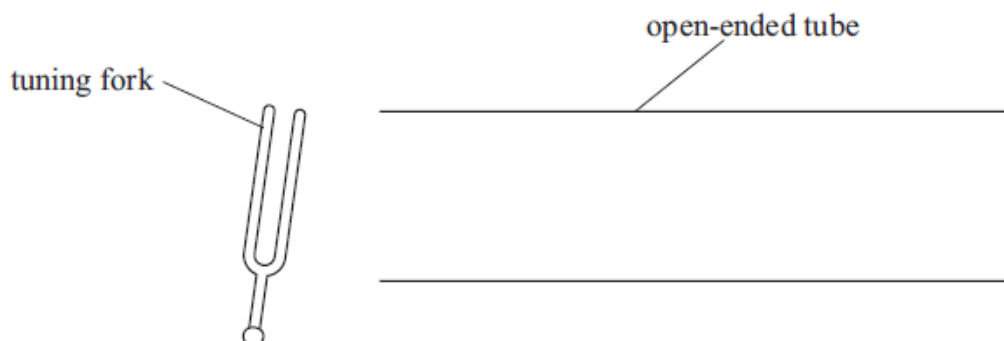
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$$\mu = \dots\dots\dots$$

(Total for question = 10 marks)

Q8.

A vibrating tuning fork is placed near to the open end of a tube that is closed at the other end, as shown.



*(a) Describe how a stationary wave is formed inside the tube.

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(b) When the length of the tube was 20.4 cm, the simplest possible stationary wave was formed inside the tube.

(i) Calculate the frequency of the sound produced by the tube.

speed of sound in air = 340 m s^{-1}

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Frequency =

(ii) The actual frequency of the sound produced by the tube is slightly less than the calculated value.

Suggest why.

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(Total for question = 11 marks)

Q9.

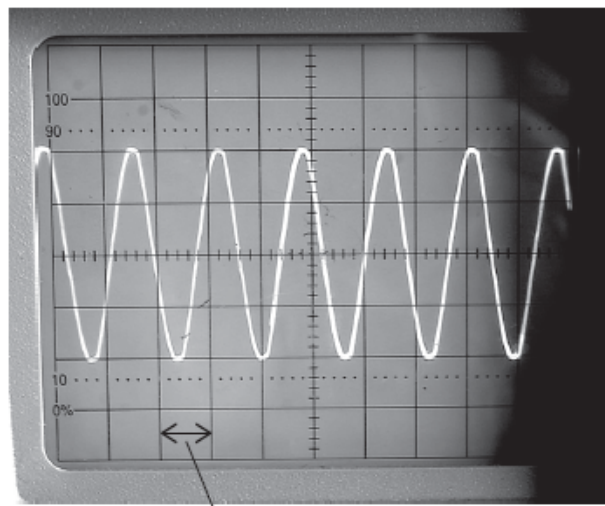
The photograph shows a musical instrument called panpipes.



(Source: © barisonal/Getty Images)

The instrument is made using pipes of different lengths. Blowing air across the top of one of the pipes produces a sound.

(a) A student connected a microphone to an oscilloscope. She then placed the microphone near to one of the pipes. The photograph below shows the oscilloscope screen when the pipe was producing a sound.



1 division

Calculate an accurate value for the frequency of the sound wave.

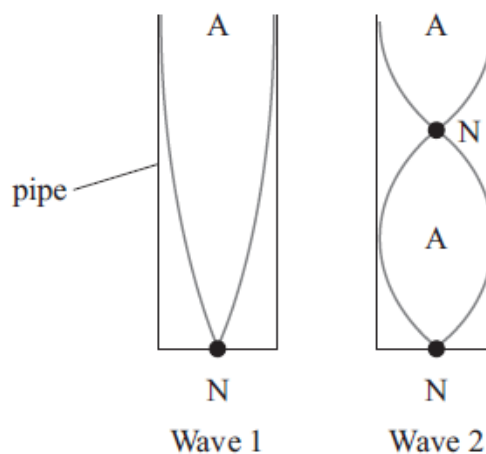
1 division = 1.5 ms

(3)

Frequency =

(b) Each pipe is open at the top and closed at the bottom. When air is blown across the open end, a stationary wave is formed in the pipe.

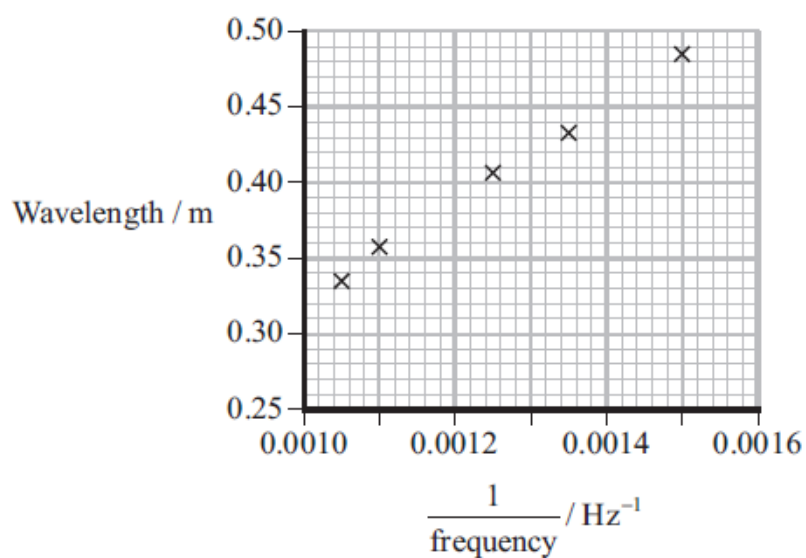
The student was able to produce two sounds from the same pipe. The diagram shows the nodes N and antinodes A in the stationary waves that caused each sound.



Explain how the frequency of wave 1 compares with the frequency of wave 2.

(3)

(c) The student determined the frequency and wavelength of sound waves produced in different pipes and plotted the graph shown.

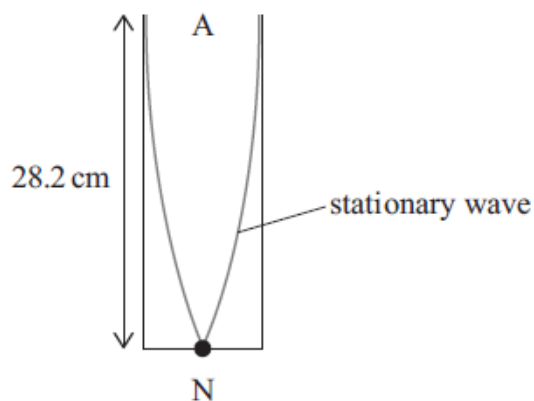


Determine a value for the speed of sound.

(2)

Speed of sound =

(d) On another day the speed of sound was 340 ms^{-1} . The student produced a stationary wave using the longest pipe. The pipe has a length of 28.2 cm, as shown.



Determine the frequency of this wave.

(3)

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Frequency =

(Total for question = 11 marks)

Q10.

The human ear can only hear two sounds as separate frequencies when the difference in frequency between the sounds is greater than 0.3%.

Sounds with a difference in frequency less than 0.3% are heard as the same frequency.

(a) Two sounds with frequencies of 880 Hz and 882 Hz are produced.

(i) Show that the person hears these two sounds as the same frequency.

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*(ii) When listening to these two sounds at the same time, the loudness of the sound increases and decreases repeatedly.

Explain why. Your answer should refer to coherence and phase difference.

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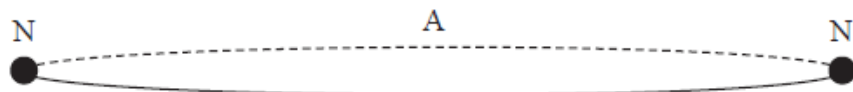
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(b) A wire is stretched between two fixed points. The wire is made to vibrate and a stationary wave is created. This produces a sound wave in the air.

The fixed ends of the wire act as nodes (N). There is an antinode (A) in the middle of the wire, as shown.



A wire of length 18.7 cm produces a sound with a frequency of 882 Hz.
The tension in the wire is adjusted until the frequency of the sound is 880 Hz.

Calculate the decrease in tension required to cause this change in frequency.

mass per unit length of wire = $5.08 \times 10^{-3} \text{ kg m}^{-1}$

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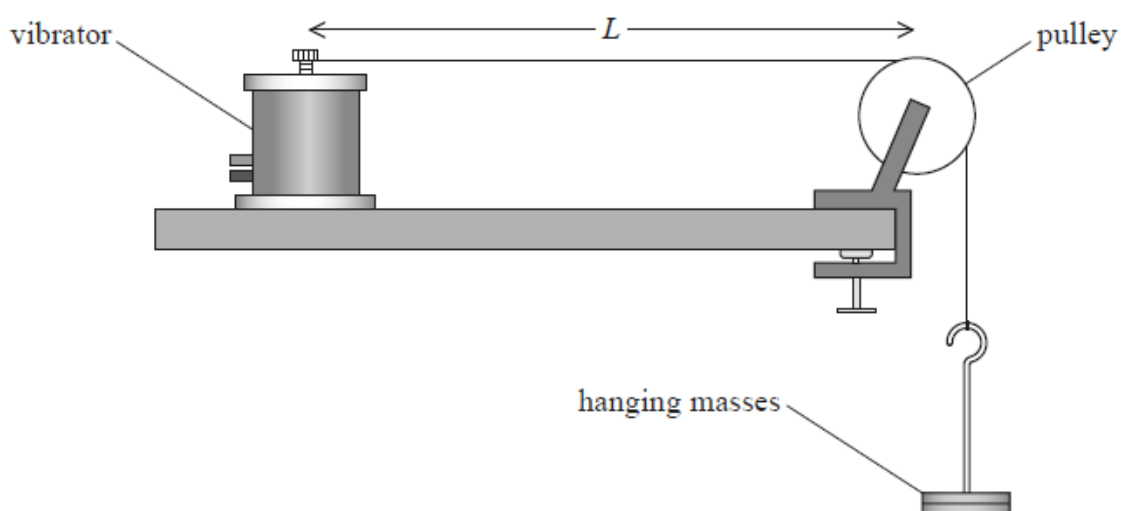
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Decrease in tension =

(Total for question = 12 marks)

Q11.

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.

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(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)

Q12.

The photograph shows a musical instrument called a violin.



The violin has four strings. Each string is held in a fixed position by a peg and at the bridge.

When a string is plucked, a stationary wave forms on the string.

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

(3)

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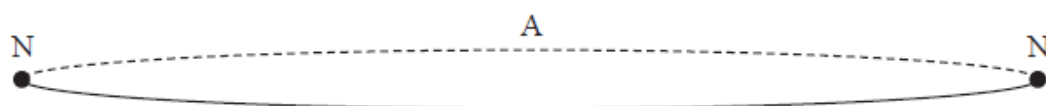
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(b) The simplest stationary wave that can be formed on the string has a node (N) at each end and an antinode (A) at the centre, as shown.



The frequency of this wave is called the fundamental frequency.

The strings on a violin have different fundamental frequencies, as shown in the table.

String	Fundamental frequency / Hz
1	196
2	294
3	440
4	659

The tension in one of the strings is 71.5 N. The length of the string is 32 cm and the mass per unit length of the string is $2.03 \times 10^{-3} \text{ kg m}^{-1}$.

Deduce whether this is string 1, 2, 3 or 4.

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(c) The stationary wave on the string causes sound waves to be transmitted through the air.

Describe the similarities and differences between the stationary wave on the string and the sound waves transmitted through the air.

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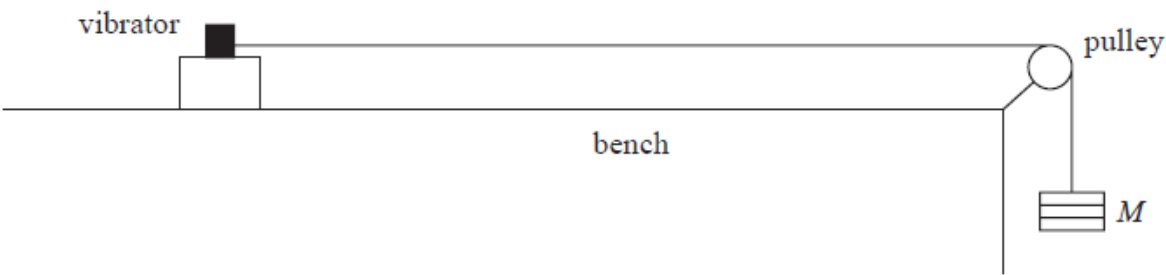
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(Total for question = 12 marks)

Q13.

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.

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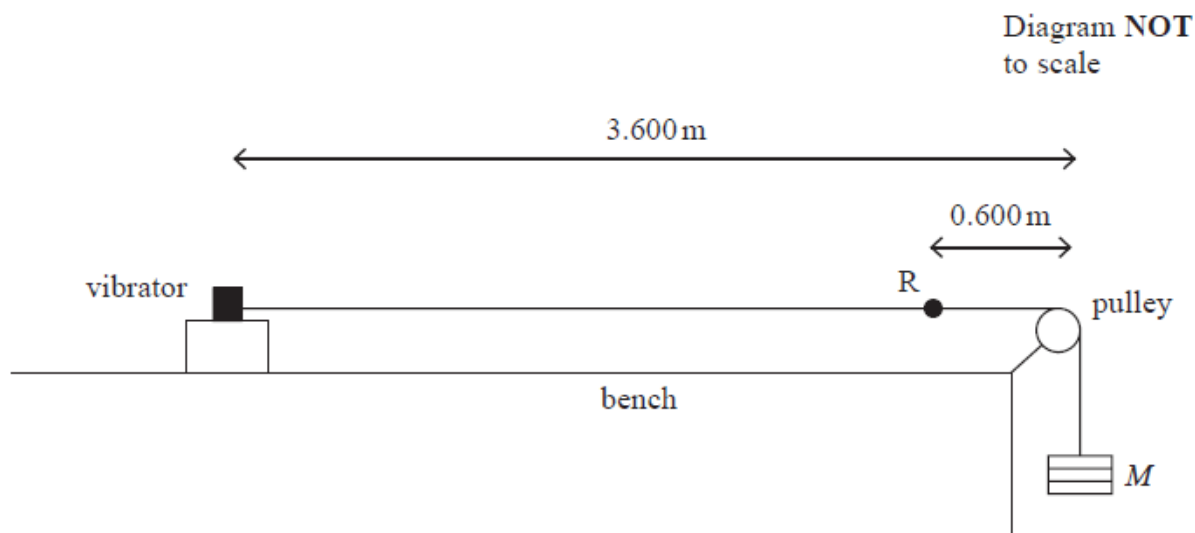
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(b) The frequency of the stationary wave was 30.0 Hz. The distance between the vibrator and

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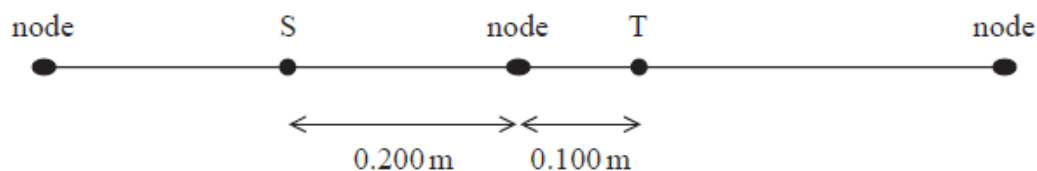
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(c) The mass M was changed and the frequency of the vibrator was adjusted, so that a different stationary wave formed on the string. Adjacent nodes were separated by 0.400 m. The diagram shows two points, S and T, on the string at an instant when the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



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

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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.

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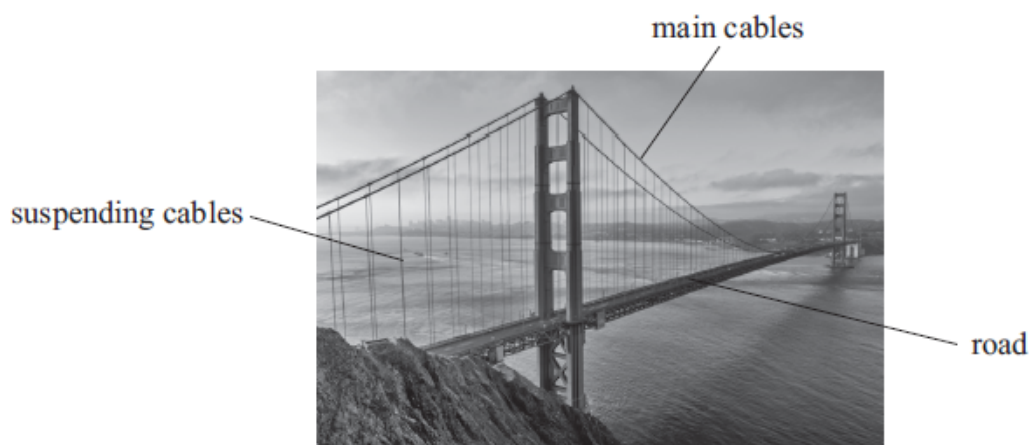
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(Total for question = 12 marks)

Q14.

The photograph shows the Golden Gate Bridge in San Francisco, USA.

The bridge has two main cables. Attached to these cables are smaller suspending cables, which support the road.



(Source: © Don White / Getty Images)

Wind causes each suspending cable to oscillate, so standing waves form on the suspending cables.

(a) Explain how a standing wave can form on a cable that is fixed at both ends. (3)

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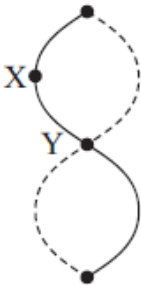
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(b) The diagram shows a standing wave on a cable that is fixed at both ends. X and Y are two points on the cable.



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(c) In strong winds, the Golden Gate Bridge emits a humming sound.

(i) One of the suspending cables on the bridge has a mass of 2.10×10^3 kg and a length of 87.0 m.

Show that the mass per unit length μ of the cable is about 24 kg m^{-1} .

(2)

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(ii) The lowest frequency of the humming sound produced by the bridge is 280 Hz.

The total mass of the road on the bridge is 140×10^6 kg.

The weight of the road is supported equally by 500 suspending cables.

The range of lengths of the suspending cables is from 3.5 m to 160 m.

The value of μ for all of the suspending cables is 24 kg m^{-1} .

Deduce whether the lowest frequency standing waves on the suspending cables could be producing the humming sound.

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(Total for question = 14 marks)