MUS HW 2 Musical Notes

43 min
43 marks

1. Which of the following statements about standing waves is true?

A particles between adjacent nodes all have the same amplitude.

B particles undergo no disturbance at an antinode.

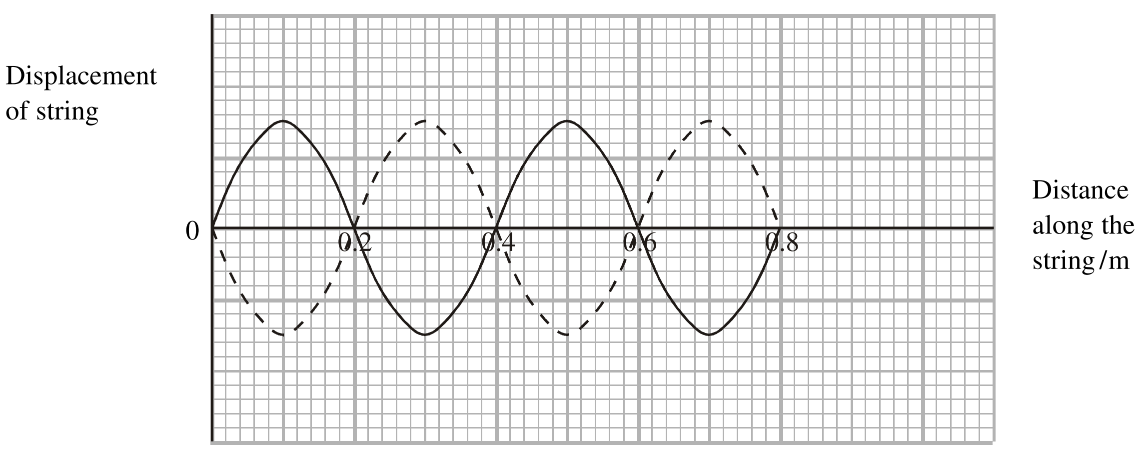
C particles immediately either side of a node are moving in opposite directions.

D particles between adjacent nodes are out of phase with each other.

(Total 1 mark)

2. The cello is a stringed musical instrument that may be played either by stroking the strings with a bow or by plucking the strings with the fingers.

(a) One of the attached strings on the cello has a vibrating length of 0.80 m. The string is made to oscillate as a stationary wave by means of a bow and the following pattern of oscillations is seen. The position of the string at two different times is shown.



(i) Explain how the movement of the bow causes this wave pattern.

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(3)

(ii) Using the diagram calculate the wavelength of the wave.

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Wavelength = ...

(2)

(iii) State two differences between the wave on the string and the sound wave it produces.

1 ....

....

2 ....

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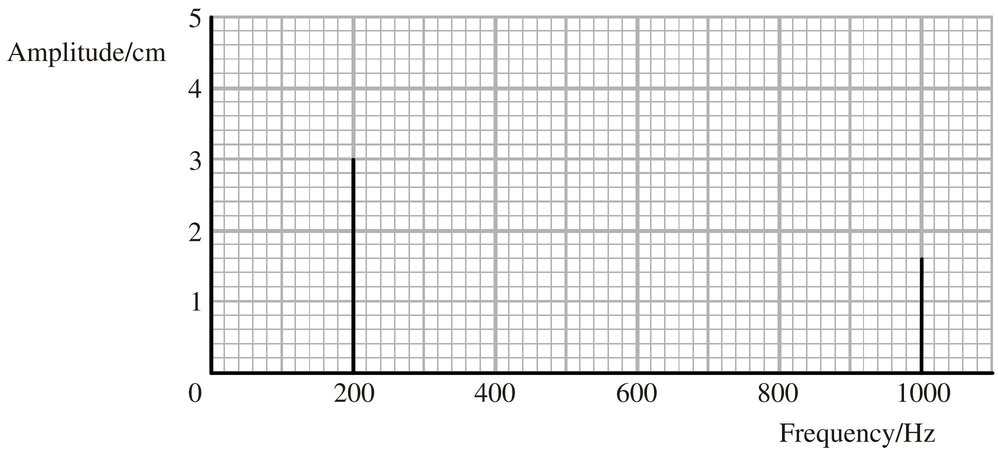
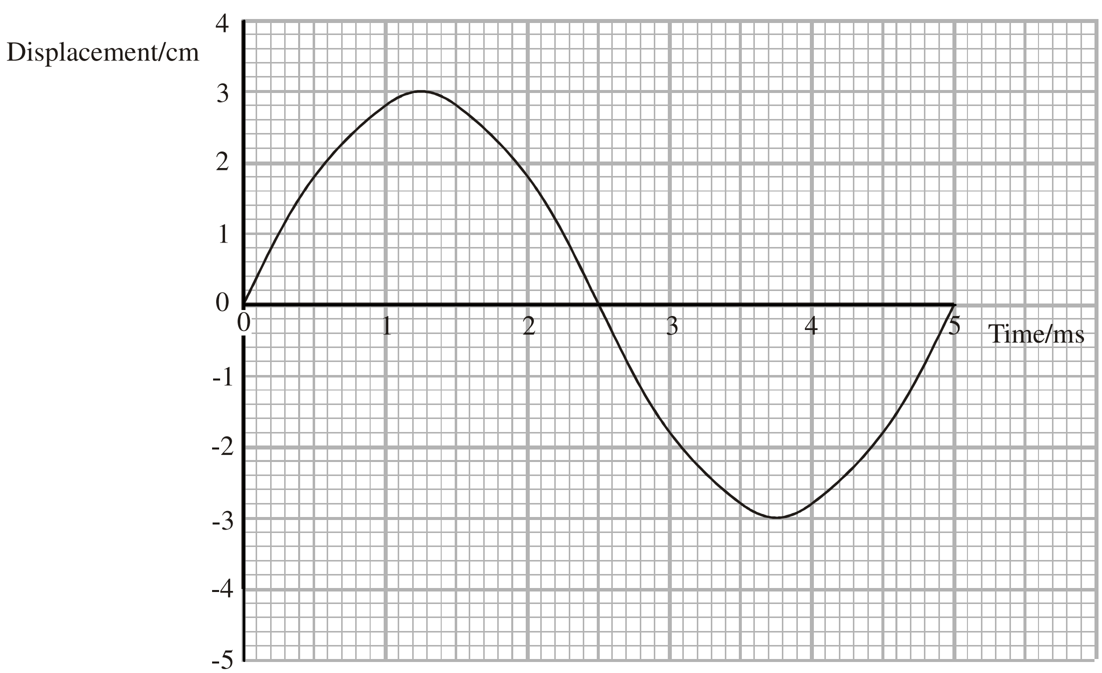
(2)

(b) The cello string is then plucked and the waveform of the resulting sound is analysed by an oscilloscope. It is found to consist of two frequencies of different amplitudes. The frequency spectrum is shown below.



The waveform of the 200 Hz wave has been drawn on the axes below. On the same axes sketch the waveform of the 1000 Hz wave.

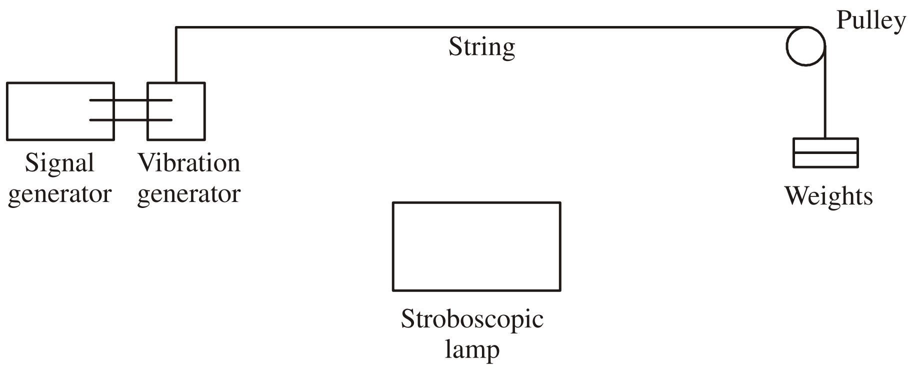


(2)
(Total 9 marks)

3. Some Physics students studying standing waves decide to play a trick on visitors to their Open Evening.

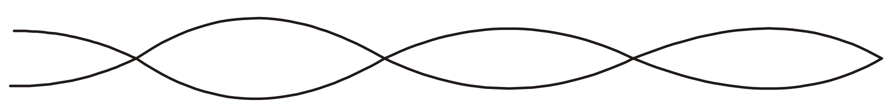
They set up the apparatus shown in Figure 1 in a dark corner of their laboratory.

Figure 1



They switch on the vibration generator and the stroboscopic lamp, which flashes on and off. The frequency of the flashing is adjusted until the illuminated portion of the string appears as in Figure 2.

Figure 2



The visitors are invited to put their fingers between the two ‘strings’ they think they see and are taken by surprise when it is impossible.

Explain how standing waves have been produced on the string.

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(3)

Mark one node with N and one antinode with A on Figure 2.

(1)

Add a labelled line to Figure 2 to show the wavelength.

(1)

The string vibrates at a frequency of 170 Hz. The stroboscopic lamp is flashing on and off at a frequency of 340 Hz. Explain why the string appears to be in two different positions at the same time as shown in Figure 2.

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(2)

Calculate the speed of the waves in the string.

Tension in string = 1.96 N

Mass per unit length of string = 6.00×10^{-4} kg m^{-1}

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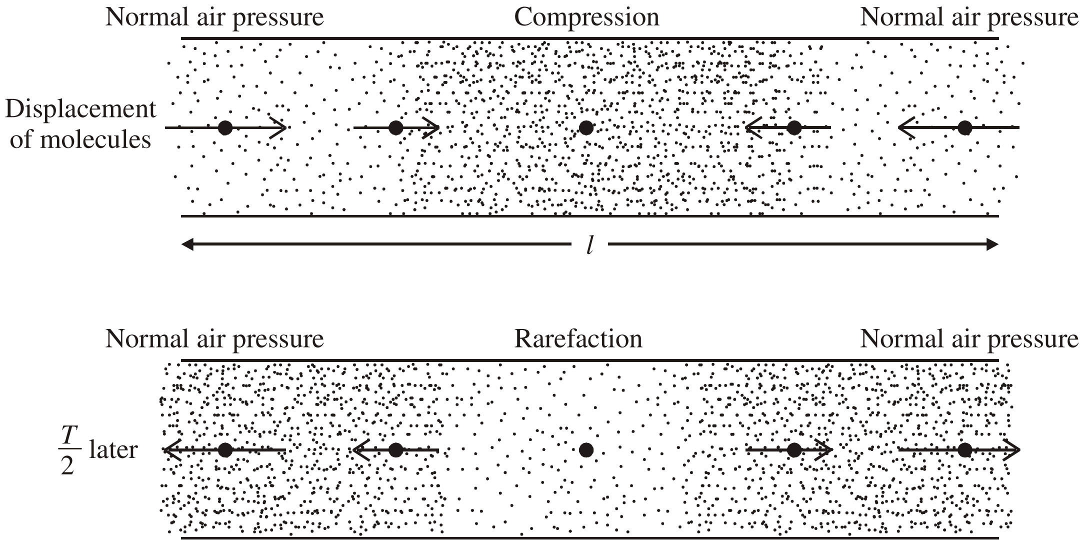
Speed = ...

(2)

(Total 9 marks)

4. A recorder, a common musical instrument, can be modelled as a tube of air open at both ends. The air at both ends therefore remains at normal air pressure. The diagrams below show how the air molecules in the recorder are displaced at two different moments during one cycle of the fundamental note. The two moments are separated by $T/2$, where T is the time period.



Explain whether the ends of the recorder have nodes or antinodes for pressure.

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(2)

Write down a relationship between the length l of the recorder and the wavelength λ of the fundamental note it produces.

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(1)

The length *l* of the recorder is 0.28 m. Calculate the fundamental frequency of the note it produces. Speed of sound in air = 330 m s^{-1}.

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Frequency = ...

(3)

Calculate the period *T* of the fundamental note.

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Period = ...

(2)

State one other frequency which might be present in the note produced by this recorder. Explain your choice in terms of nodes and antinodes for pressure along the recorder.

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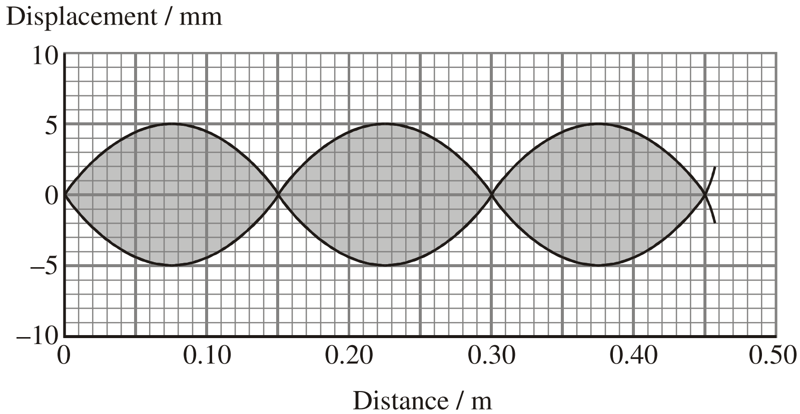
(3)
(Total 11 marks)

5. A stationary wave is produced on a stretched string by a vibration generator attached to one end. The graph shows part of the wave. The two full lines represent the extreme positions of the string.



State the wavelength of this wave.

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(1)

Mark a letter A on the graph to label an antinode.

(1)

The stationary wave is formed by the superposition of two waves travelling along the string in opposite directions. The frequency of the vibrator is 36.0 Hz. Calculate the speed of the travelling waves.

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Wave speed = ...

(2)

State the phase relationship between the two travelling waves at an antinode.

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(1)

Determine the amplitude of each of the travelling waves.

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Amplitude = ...

(1)
(Total 6 marks)

6. Describe with the aid of a diagram how you could produce stationary waves on a string.

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(3)

Explain how you could use a stationary wave to determine the speed of travelling waves on the string. You may be awarded a mark for the clarity of your answer.

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(4)
(Total 7 marks)