1)

Figure 4 represents a stationary wave formed on a steel string fixed at **P** and **Q** when it is plucked at its centre.

Figure 4

(a) Explain why a stationary wave is formed on the string.

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(3 marks)

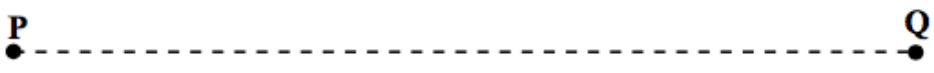
(b) (i) The stationary wave in **Figure 4** has a frequency of 150 Hz. The string **PQ** has a length of 1.2 m.
Calculate the wave speed of the waves forming the stationary wave.

Answer ..... $m\,s^{-1}$

(2 marks)

(b) (ii) On **Figure 5**, draw the stationary wave that would be formed on the string at the same tension if it was made to vibrate at a frequency of 450 Hz.

Figure 5



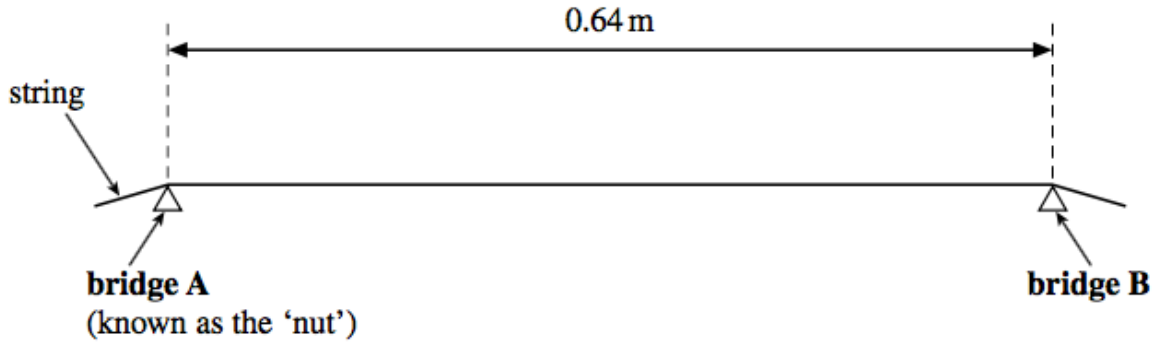
(2 marks)

2)

Figure 4 shows a side view of a string on a guitar. The string cannot move at either of the two bridges when it is vibrating. When vibrating in its fundamental mode the frequency of the sound produced is 108 Hz.

(a) (i) On **Figure 4**, sketch the stationary wave produced when the string is vibrating in its fundamental mode.

Figure 4



(1 mark)

(a) (ii) Calculate the wavelength of the fundamental mode of vibration.

answer = ... m

(2 marks)

(a) (iii) Calculate the speed of a progressive wave on this string.

answer = ... $m\,s^{-1}$

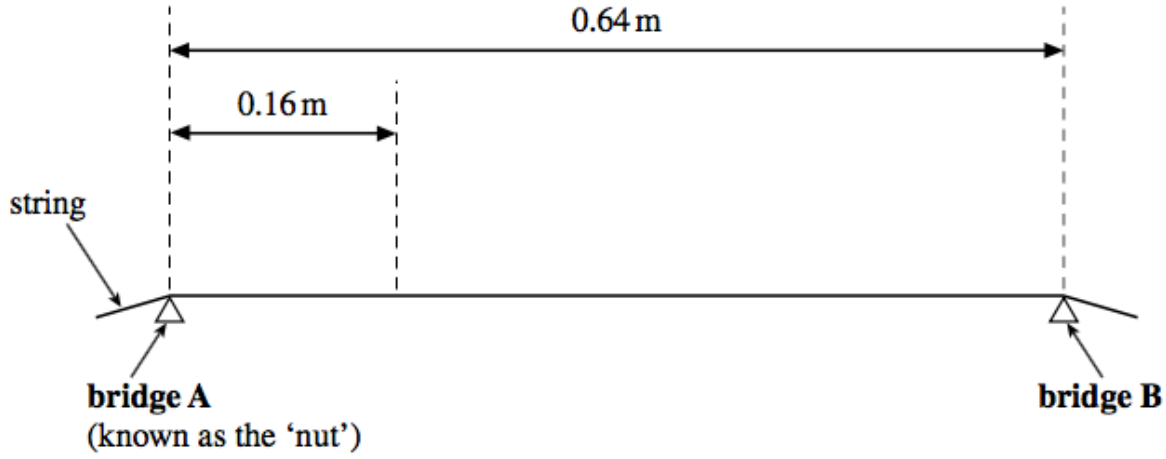
(2 marks)

(b) While tuning the guitar, the guitarist produces an overtone that has a node 0.16 m from **bridge A**.

(b) (i) On **Figure 5**, sketch the stationary wave produced and label all nodes that are present.

(2 marks)

Figure 5



(b) (ii) Calculate the frequency of the overtone.

answer = ... Hz

(1 mark)

(c) The guitarist needs to raise the fundamental frequency of vibration of this string. State **one** way in which this can be achieved.

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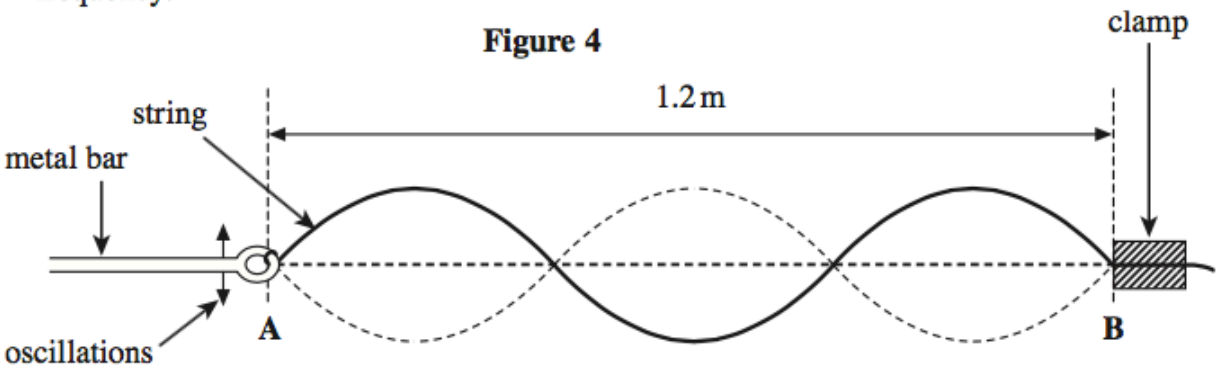
(1 mark)

3)

Figure 4 shows a stationary wave on a string. The string is tied onto a thin metal bar at **A** and fixed at **B**. A vibration generator causes the bar to oscillate at a chosen frequency.

Figure 4



Explain how a stationary wave is formed. Then describe the key features of the stationary wave shown in **Figure 4.**

The quality of your written answer will be assessed in this question.

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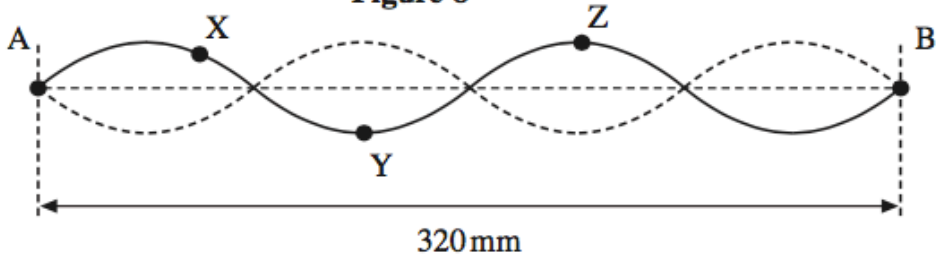
(6 marks)

4)

When a note is played on a violin, the sound it produces consists of the fundamental and many overtones.

Figure 8 shows the shape of the string for a stationary wave that corresponds to one of these overtones. The positions of maximum and zero displacement for one overtone are shown. Points **A** and **B** are fixed. Points **X**, **Y** and **Z** are points on the string.

Figure 8



(a) (i) Describe the motion of point **X**.

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(2 marks)

(a) (ii) State the phase relationship between

X and **Y** .....

X and **Z** .....

(2 marks)

(b) The frequency of this overtone is 780 Hz.

(b) (i) Show that the speed of a progressive wave on this string is about 125 $m\,s^{-1}$

(2 marks)

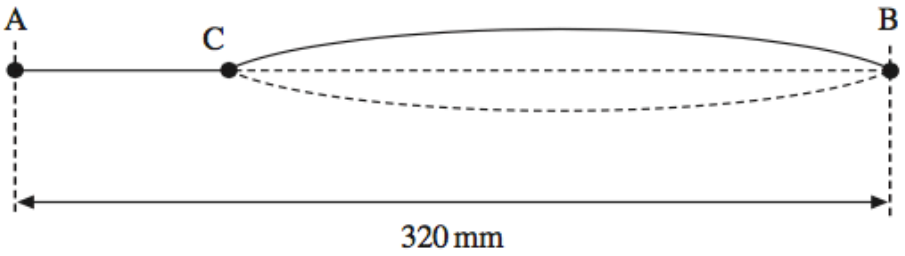
(b) (ii) Calculate the time taken for the string at point **Z** to move from maximum displacement back to zero displacement.

answer = ... s

(3 marks)

(c) The violinist presses on the string at **C** to shorten the part of the string that vibrates. **Figure 9** shows the string between **C** and **B** vibrating in its fundamental mode. The length of the whole string is 320 mm and the distance between **C** and **B** is 240 mm.

Figure 9



(c) (i) State the name given to the point on the wave midway between **C** and **B**.

.....

(1 mark)

(c) (ii) Calculate the wavelength of this stationary wave.

answer = ...m

(2 marks)

(c) (iii) Calculate the frequency of this fundamental mode. The speed of the progressive wave remains at $125\,m\,s^{-1}$.

answer = ...Hz

(1 mark)

5)

Discuss the formation of stationary waves on a string or rope. Your account should include:

- a labelled diagram of a stationary wave
- the conditions necessary for stationary waves to form
- a definition of the terms node and antinode
- an explanation of how nodes and antinodes form.

The quality of written communication will be assessed in your answer.

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(6 marks)