Q1.A stationary wave is formed on a stretched string. Discuss the formation of this wave. Your answer should include:

- an explanation of how the stationary wave is formed
- a description of the features of the stationary wave
- a description of the processes that produce these features.

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

(Total 6 marks)

Q2.(a) Musical **concert pitch** has a frequency of 440 Hz.
A correctly tuned A-string on a guitar has a first harmonic (fundamental frequency) two octaves below concert pitch.

Determine the first harmonic of the correctly tuned A-string.

frequency..... Hz

(1)

(b) Describe how a note of frequency 440 Hz can be produced using the correctly tuned A-string of a guitar.

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(1)

(c) Describe the effect heard when notes of frequency 440 Hz and 430 Hz of similar amplitude are sounded together.

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(2)
(Total 4 marks)

Q3.Figure 1 and **Figure 2** show a version of Quincke's tube, which is used to demonstrate interference of sound waves.

Figure 1

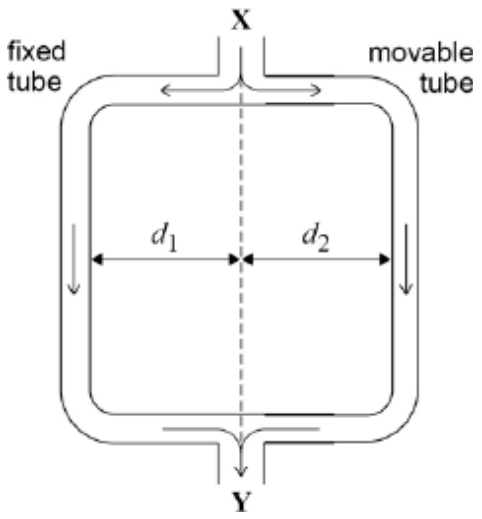
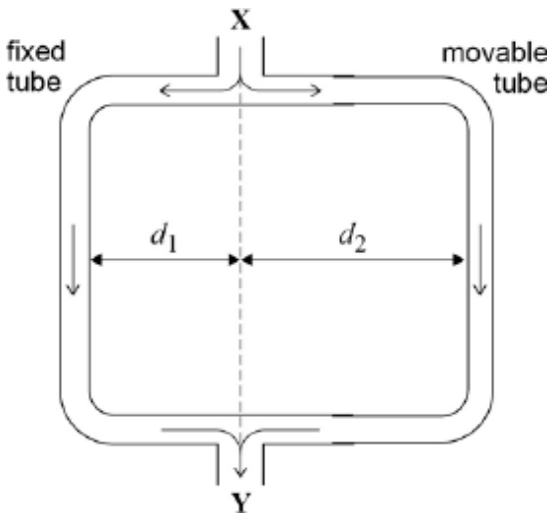


Figure 2



A loudspeaker at **X** produces sound waves of one frequency. The sound waves enter the tube and the sound energy is divided equally before travelling along the fixed and movable tubes. The two waves superpose and are detected by a microphone at **Y**.

(a) The movable tube is adjusted so that $d_1 = d_2$ and the waves travel the same distance from **X** to **Y**, as shown in **Figure 1**. As the movable tube is slowly pulled out as shown in **Figure 2**, the sound detected at **Y** gets quieter and then louder.

Explain the variation in the loudness of the sound at **Y** as the movable tube is slowly pulled out.

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(4)

(b) The tube starts in the position shown in **Figure 1**.

Calculate the minimum distance moved by the movable tube for the sound detected at **Y** to be at its quietest.

frequency of sound from loud speaker = 800 Hz
speed of sound in air = 340 m s^{-1}

minimum distance moved = ... m

(3)

(c) Quincke's tube can be used to determine the speed of sound.

State and explain the measurements you would make to obtain a value for the speed of sound using Quincke's tube and a sound source of known frequency.

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(4)

(Total 11 marks)

Q4. Which of the following is correct for a stationary wave?

A Between two nodes the amplitude of the wave is constant. ⬭

B The two waves producing the stationary wave must always be 180° out of phase. ⬭

C The separation of the nodes for the second harmonic is double the separation of nodes for the first harmonic. ⬭

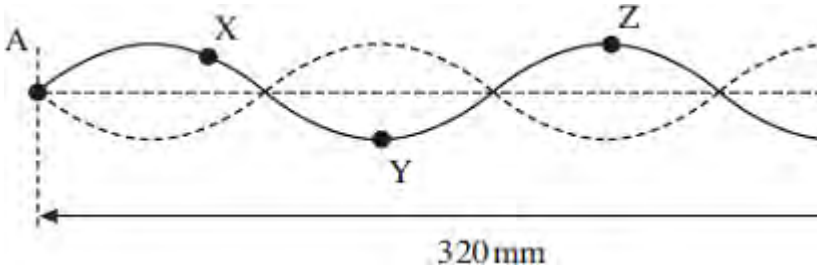
D Between two nodes all parts of the wave vibrate in phase. ⬭

(Total 1 mark)

Q5. When a note is played on a violin, the sound it produces consists of the fundamental and many overtones.

Figure 1 shows the shape of the string for a stationary wave hat 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 1



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

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(2)

(ii) State the phase relationship between

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

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

(2)

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

(i) Show that the speed of a progressive wave on this string is about 125 ms–1.

(2)

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

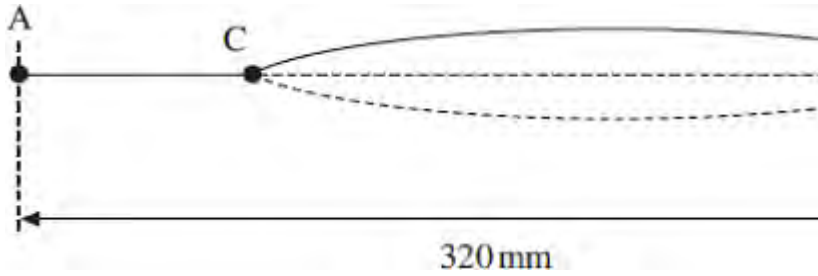
answer = ... s

(3)

(c) The violinist presses on the string at **C** to shorten the part of the string that vibrates.

Figure 2 shows the string between **C** and **B** vibrating in its fundamental mode. The length of the whole string is 320 mm and he distance between **C** and **B** is 240 mm.

Figure 2



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

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(1)

(ii) Calculate the wavelength of this stationary wave.

answer = ... m

(2)

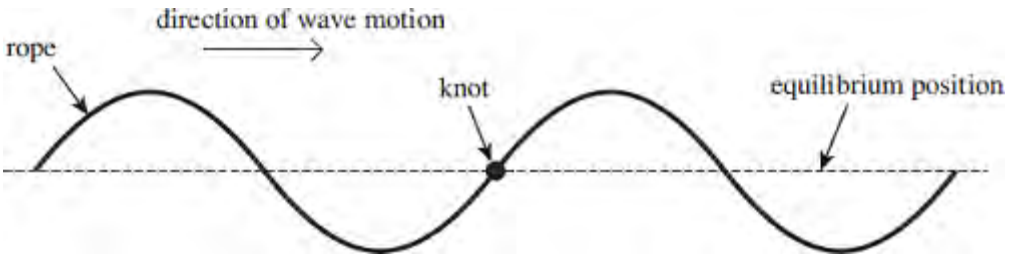
(iii) Calculate the frequency of this fundamental mode. The speed of the progressive wave remains at 125 ms−1.

answer = ...Hz

(1)

(Total 13 marks)

Q6. The figure below shows a continuous progressive wave on a rope. There is a knot in the rope.



(a) Define the amplitude of a wave.

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(2)

(b) The wave travels to the right.

Describe how the **vertical** displacement of the knot varies over the next complete cycle.

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(3)

(c) A continuous wave of he same amplitude and frequency moves along he rope from the right and passes through the first wave. The knot becomes motionless.

Explain how this could happen.

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(3)

(Total 8 marks)

Q7. (a) State **two** differences between stationary waves and progressive waves.

first difference .....

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second difference .....

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(2)

(b) A violin string has a length of 327 mm and produces a note of frequency 440 Hz.

Calculate the frequency of he note produced when he same string is shortened or “stopped” to a length of 219 mm and the tension remains constant.

frequency ..... Hz

(2)

(Total 4 marks)

Q8. (a) (i) A piano string has a tension of 681 N. It vibrates with a fundamental frequency (first harmonic) of 92.5 Hz and has a mass per unit length of 1.87×10^{-2} kg m^{-1}.

Calculate the length of the string.

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length of string ..... m

(3)

(ii) The figure below shows a string stretched between fixed ends.

Draw onto the figure the first overtone (second harmonic) mode of vibration.

(1)

(iii) State how you could make a string on a stringed instrument vibrate in this mode of vibration.

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(2)

(b) Describe how you would investigate the variation of the fundamental frequency (first harmonic) of a string with its leng h.

State which variable(s) you would need to control and how you would do so.

You may wish to assist your account by drawing a diagram.

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(4)

(Total 10 marks)