Q1. Two points on a progressive wave are one-eighth of a wavelength apart. The distance between them is 0.5 m, and the frequency of the oscillation is 10 Hz. What is the minimum speed of the wave?

A 0.2 m s^{-1}

B 10 m s^{-1}

C 20 m s^{-1}

D 40 m s^{-1}

(Total 1 mark)

Q2. Sound waves cross a boundary between two media X and Y. The frequency of the waves in X is 400 Hz. The speed of the waves in X is 330 m s^{-1} and the speed of the waves in Y is 1320 m s^{-1}. What are the correct frequency and wavelength in Y?

	Frequency / Hz	**Wavelength / m**	
A	100	0.82	
B	400	0.82	
C	400	3.3	
D	1600	3.3	

(Total 1 mark)

Q3. Read through the following passage and answer the questions that follow it.

Measuring the speed of sound in air

After the wave nature of sound had been identified, many attempts were made to measure its speed in air. The earliest known attempt was made by the French scientist Gassendi in the 17th century. The procedure involved timing the interval between seeing the flash of a gun and hearing the bang from some distance away. Gassendi assumed that, compared with the speed of sound, the speed of light is infinite. The value he obtained for the speed of sound was 480 m s^{-1}. He also realised that the speed of sound does not depend on frequency.

A much better value of 350 m s^{-1} was obtained by the Italian physicists Borelli and Viviani using the same procedure. In 1740 another Italian, Bianconi, showed that sound travels faster when the temperature of the air is greater.

In 1738 a value of 332 m s^{-1} was obtained by scientists in Paris. This is remarkably close to the currently accepted value considering the measuring equipment available to the scientists at that time. Since 1986 the accepted value has been 331.29 m s^{-1} at 0 °C.

(a) Suggest an experiment that will demonstrate the wave nature of sound (line 1).

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(1)

(b) Using Gassendi's value for the speed of sound (line 6), calculate the time between seeing the flash of a gun and hearing its bang over a distance of 2.5 km.

time = ... s

(1)

(c) Explain why it was necessary to assume that 'compared with the speed of sound, the speed of light is infinite' (line 5).

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(1)

(d) Explain **one** observation that could have led Gassendi to conclude that 'the speed of sound does not depend on frequency' (line 7).

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(2)

(e) Explain how the value obtained by Borelli and Viviani was 'much better' than that obtained by Gassendi (line 8).

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(1)

(f) The speed of sound c in dry air is given by

$$c = k\sqrt{\theta + 273.15}$$

where θ is the temperature in °C, and k is a constant.

Calculate a value for k using data from the passage.

k = ... $\text{m s}^{-1}\ K^{-1/2}$

(2)

(g) State the steps taken by the scientific community for the value of a quantity to be 'accepted' (line 13).

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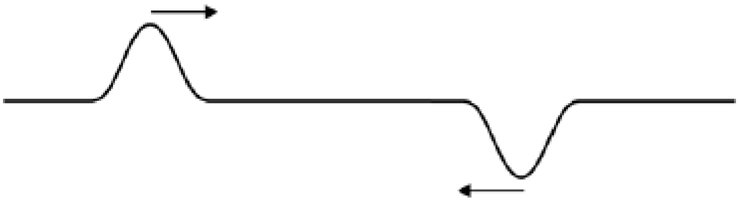
(2)
(Total 10 marks)

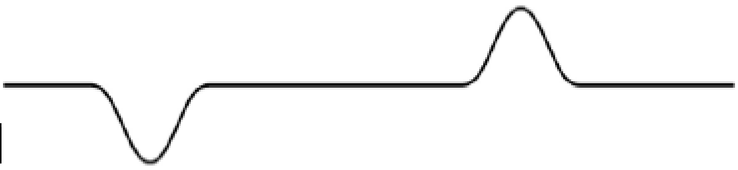
Q4. The diagram shows two pulses on a string travelling towards each other.



Which of the following diagrams shows the shape of the string when the pulses have passed through each other?

A

B



C

D

(Total 1 mark)

Q5. Ultrasound waves are used to produce images of a fetus inside a womb.

(a) Explain what is meant by the frequency of a wave.

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(1)

(b) Ultrasound is a longitudinal wave. Describe the nature of a longitudinal wave.

....

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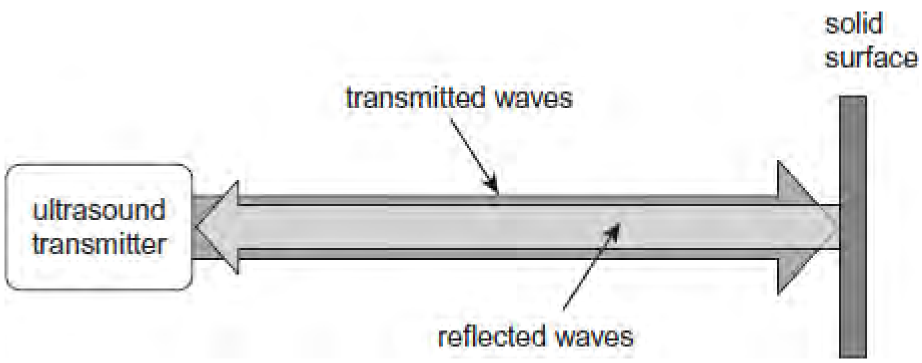
(2)

(c) In order to produce an image with sufficient detail, the wavelength of the ultrasound must be 0.50 mm. The speed of the ultrasound in body tissue is 1540 m s^{-1}.
Calculate the frequency of the ultrasound at this wavelength.
Give your answer to an appropriate number of significant figures.

frequency .... Hz

(2)

(d) A continuous ultrasound wave of constant frequency is reflected from a solid surface and returns in the direction it came from.



Assuming there is no significant loss in amplitude upon reflection, describe and explain the effect the waves have on the particles in the medium between the transmitter and the solid surface.

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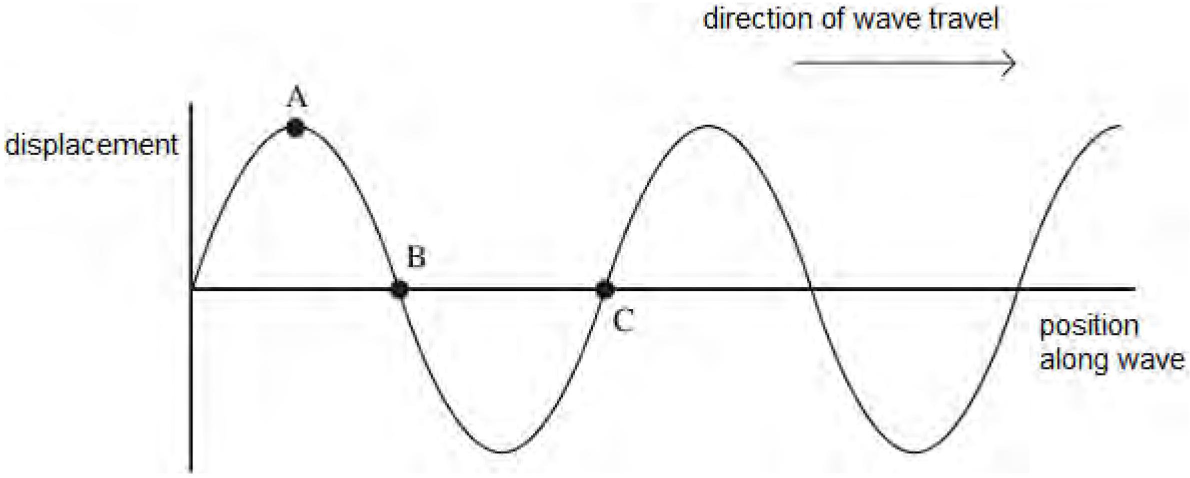
(3)

(Total 8 marks)

Q6. Earthquakes produce transverse and longitudinal seismic waves that travel through rock. The diagram below shows the displacement of the particles of rock at a given instant, for different positions along a transverse wave.



(a) State the phase difference between

(i) points **A** and **B** on the wave ....

(ii) points **A** and **C** on the wave ....

(2)

(b) Describe the motion of the rock particle at point **B** during the passage of the next complete cycle.

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(2)

(c) A scientist detects a seismic wave that is polarised. State and explain what the scientist can deduce from this information.

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(2)

(d) The *frequency* of the seismic wave is measured to be 6.0 Hz.

(i) Define the frequency of a progressive wave.

....

....

(1)

(ii) Calculate the wavelength of the wave if its speed is 4.5×10^3 m s^{-1}.

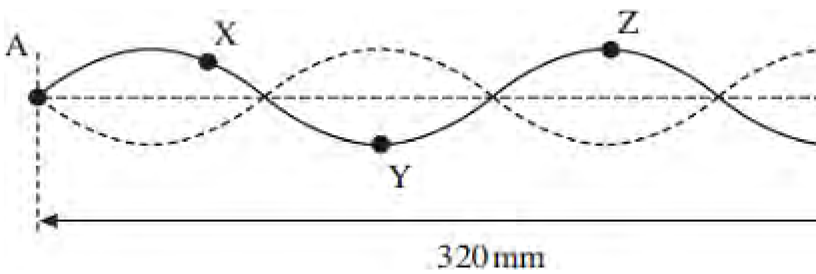
wavelength .... m

(2)
(Total 9 marks)

Q7. 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 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 1



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

....

....

....

.... **(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)

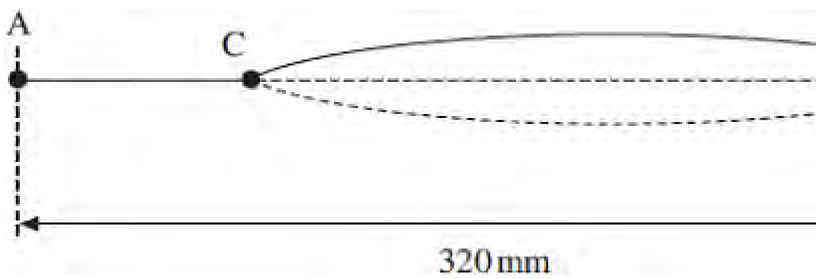
(ii) Calculate the time taken for the string at point **Z** to move from maximum displacement back to zero displacement.

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 the 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**.

....

(1)

(ii) Calculate the wavelength of this stationary wave.

answer = ... m

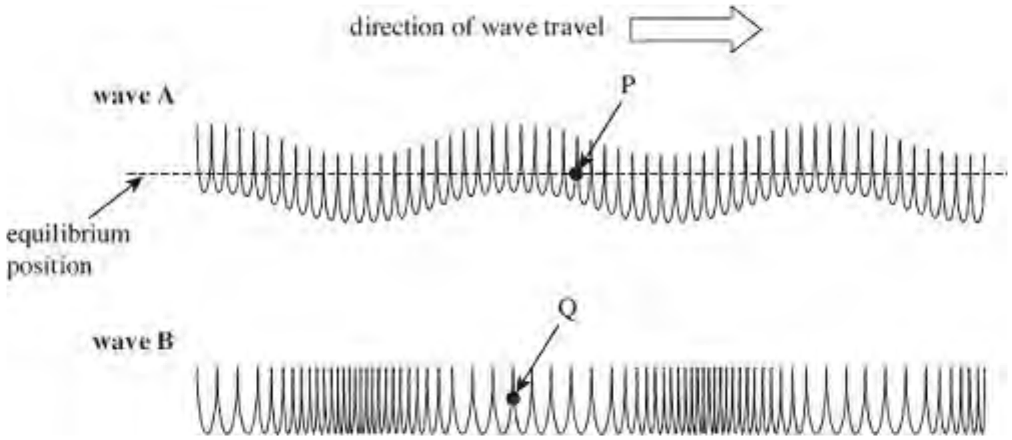
(2)

(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)

Q8. The figure below shows two ways in which a wave can travel along a slinky spring.



(a) State and explain which wave is longitudinal.

....

.... **(2)**

(b) On the figure above,

(i) clearly indicate and label the wavelength of **wave B** **(1)**

(ii) use arrows to show the direction in which the points **P** and **Q** are about to move as each wave moves to the right. **(2)**

(c) Electromagnetic waves are similar in nature to **wave A**.

Explain why it is important to correctly align the aerial of a TV in order to receive the strongest signal.

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.... **(2)**

(Total 7 marks)