Name:

Date:

WAVES
TEST 2

AS-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 Describe a laboratory experiment to investigate how the fundamental frequency of a stretched string depends on the tension in the string.

The stretched string has a mass per unit length of 1.5×10^{-3} kg m^{-1}.

Your detailed method should include:

- a labelled diagram of the experiment arrangement
- suitable estimates of any quantities involved in the experiment
- how you would use the data to demonstrate the relationship between fundamental frequency and tension.

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

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(Total 6 marks)

2 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)

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

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

(1)

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

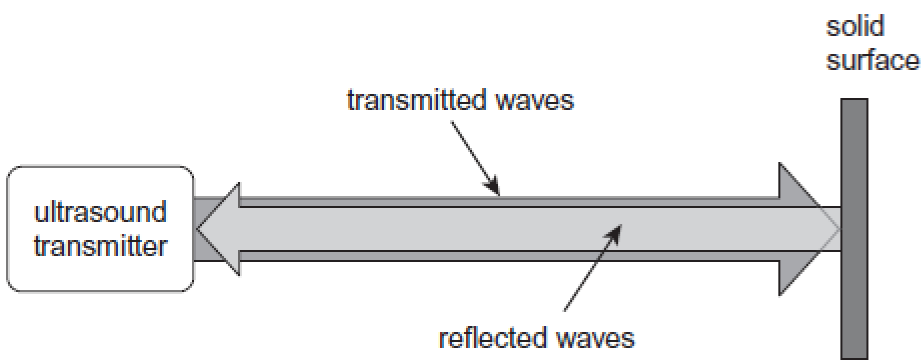
(2)

(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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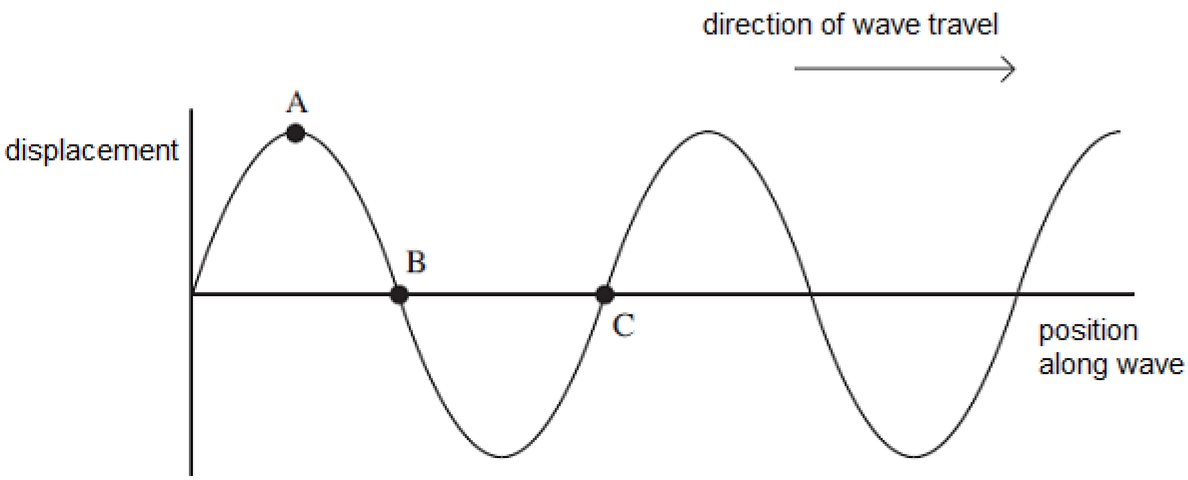
(3)

(Total 8 marks)

4 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.

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(1)

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

wavelength ____________________ m

(2)

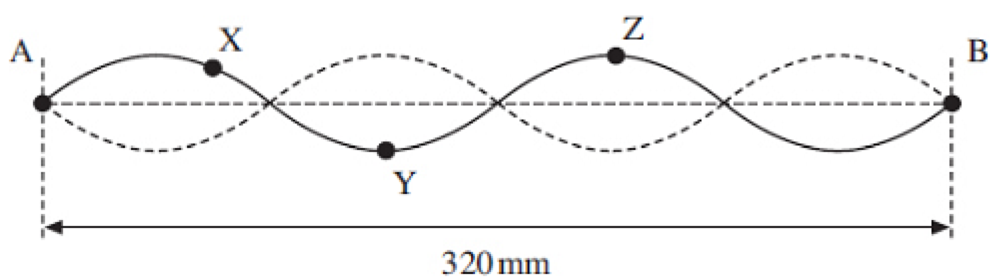
(Total 9 marks)

5

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**.

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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)

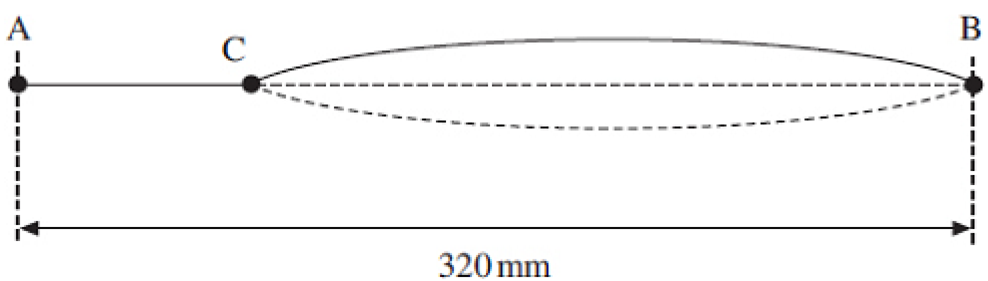
(ii) Calculate the time taken for the string at point **Z** to move from maximum displacement back to zero displacement.

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 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**.

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(1)

(ii) Calculate the wavelength of this stationary wave.

answer = ____________________ m

(2)

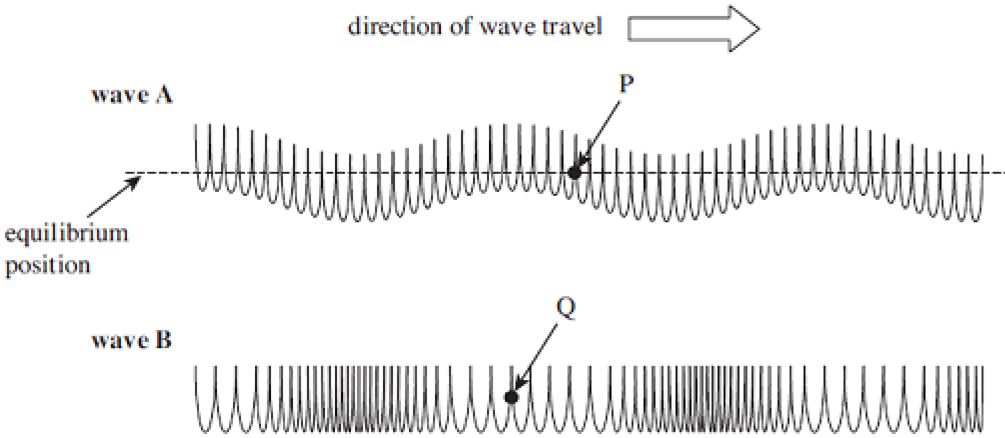
(iii) Calculate the frequency of this fundamental mode. The speed of the progressive wave remains at 125 ms^{-1}.

answer = ____________________ Hz

(1)

(Total 13 marks)

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



(a) State and explain which wave is longitudinal.

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(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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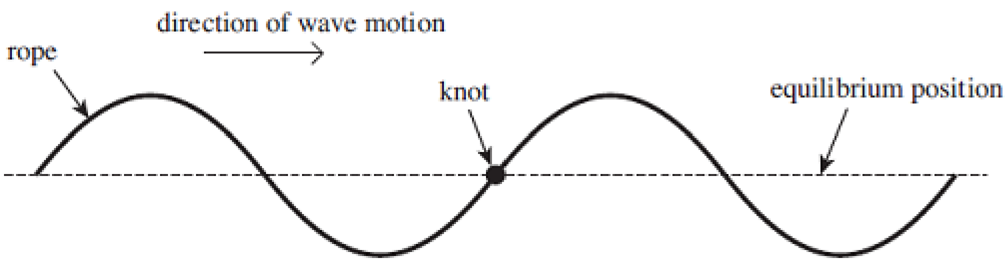
(2)

(Total 7 marks)

7 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 the same amplitude and frequency moves along the 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)

8 (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 the note produced when the same string is shortened or "stopped" to a length of 219 mm and the tension remains constant.

frequency ______________________ Hz

(2)

(Total 4 marks)

9 (a) Define the amplitude of a wave.

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(1)

(b) (i) Other than electromagnetic radiation, give **one** example of a wave that is transverse.

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(1)

(ii) State **one** difference between a transverse wave and a longitudinal wave.

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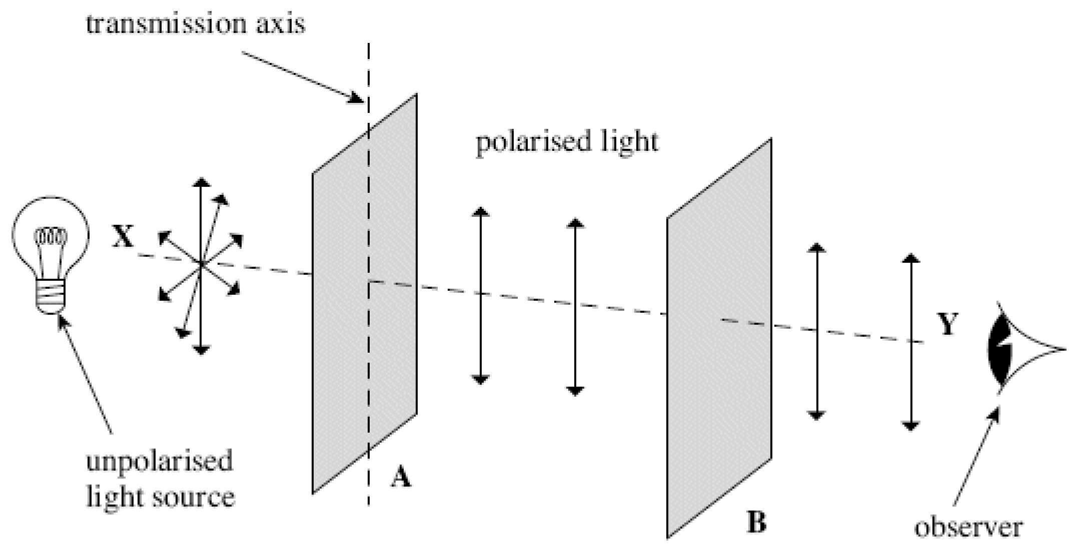
(1)

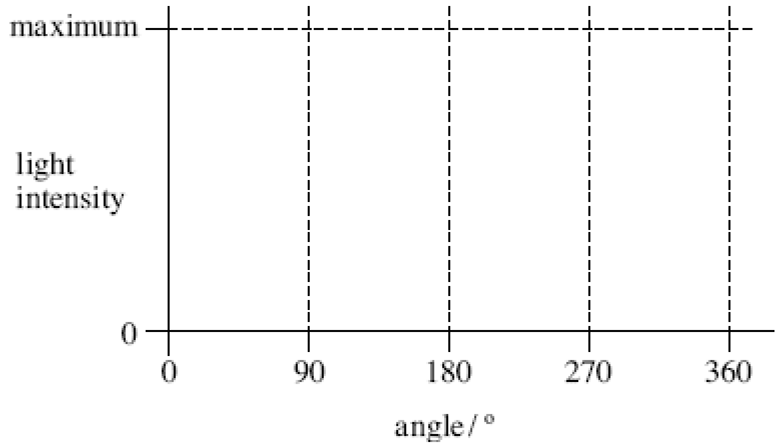
(c) The figure below shows two identical polarising filters, **A** and **B**, and an unpolarised light source. The arrows indicate the plane in which the electric field of the wave oscillates.

(i) If polarised light is reaching the observer, draw the direction of the transmission axis on filter **B** in the figure below.



(1)

(ii) The polarising filter **B** is rotated clockwise through 360º about line **XY** from the position shown in the figure above. On the axes below, sketch how the light intensity reaching the observer varies as this is done.



(2)

(d) State **one** application, other than in education, of a polarising filter and give a reason for its use.

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(2)
(Total 8 marks)

10 (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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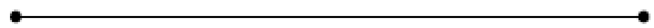
length of string ________________________ m

(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.

(2)

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

(4)

(Total 10 marks)