LONDON SCIENCE COLLEGE

Name:

Date:

WAVES
TEST 3

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

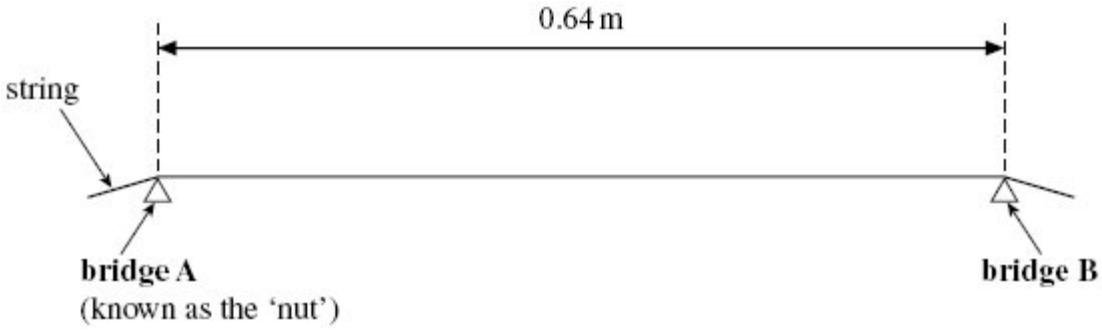
Information

- The marks for the questions are shown in brackets

1 **Figure 1** 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 1**, sketch the stationary wave produced when the string is vibrating in its fundamental mode.

Figure 1



(1)

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

answer = _____ m

(2)

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

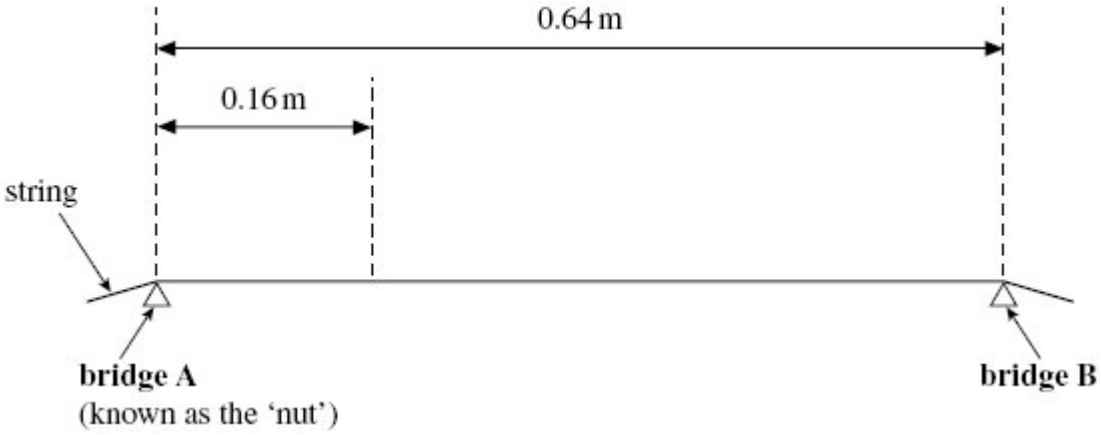
answer = _____ m s^{-1}

(2)

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

(i) On **Figure 2**, sketch the stationary wave produced and label all nodes that are present.

Figure 2



(2)

(ii) Calculate the frequency of the overtone.

answer = _____ Hz

(1)

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

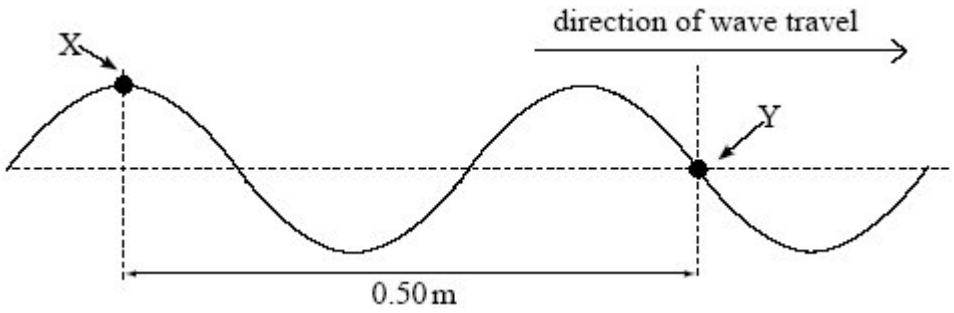
_____

_____

(1)

(Total 9 marks)

2 (a) The diagram below represents a progressive wave travelling from left to right on a stretched string.



(i) Calculate the wavelength of the wave.

answer _____ m

(1)

(ii) The frequency of the wave is 22 Hz. Calculate the speed of the wave.

answer _____ m s^{-1}

(2)

(iii) State the phase difference between points X and Y on the string, giving an appropriate unit.

answer _____

(2)

(b) Describe how the displacement of point Y on the string varies in the next half-period.

_____

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

3 Complete the first column in the table to show which of the waves listed are transverse and which are longitudinal.
Complete the second column to show which waves can be polarised.

type of wave	transverse or longitudinal	can be polarised (answer yes or no)
light		
microwaves		
ultrasound		

(Total 3 marks)

4 **Figure 1** represents a stationary wave formed on a steel string fixed at P and Q when it is plucked at its centre.

Figure 1

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

_____

_____

_____

_____

_____

(3)

(b) (i) The stationary wave in **Figure 1** 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)

(ii) On **Figure 2**, 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.

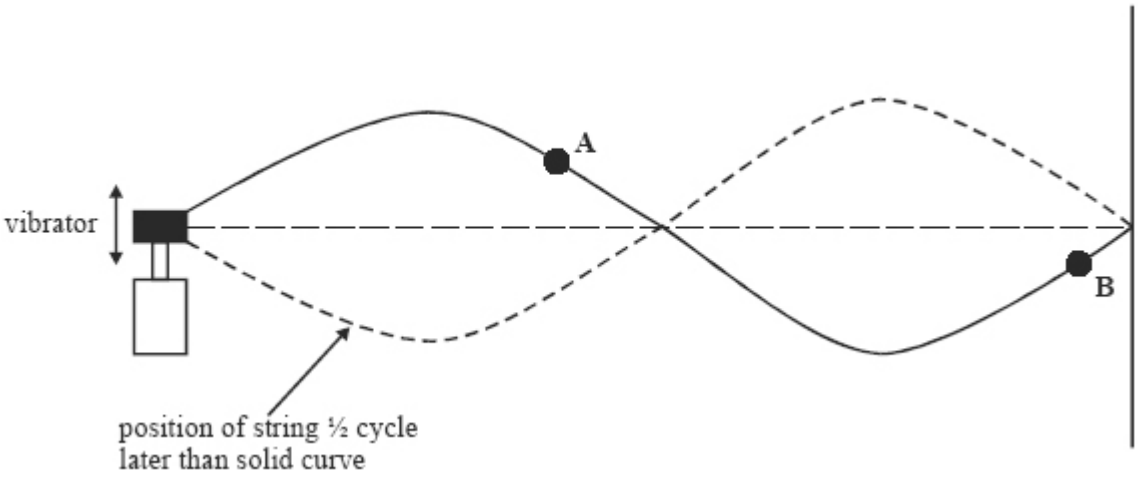
Figure 2

(2)

(Total 7 marks)

5 In testing a particular type of guitar string, a string is stretched and vibrated for a long period of time using a mechanical vibrator as shown in **Figure 1**. The right-hand end of the string is fixed. A stationary wave is produced on the string; the string vibrates in two loops.

Figure 1



(a) State the conditions that are necessary for a stationary wave to form on the string.

_____

_____

_____

_____

(3)

(b) Explain how you know that the wave on the string is transverse.

_____

(1)

(c) Compare the *amplitude and phase* of the oscillations of points **A** and **B** on the string.

Amplitude _____

Phase _____

(2)

(d) The length of the string is 1.2 m and the speed of the transverse wave on the string is 6.2 m s^{-1}.

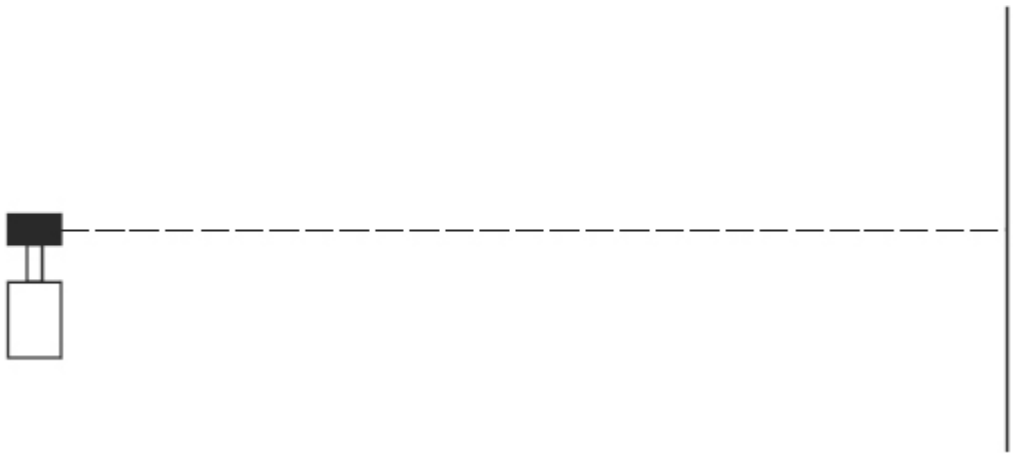
Calculate the vibration frequency of the vibrator in Hz.

Vibration frequency _____Hz

(3)

(e) (i) The frequency of the vibrator is tripled.
Sketch the new shape of the stationary wave on **Figure 2.**

Figure 2



(ii) Show on your diagram three points P, Q and R that oscillate in phase.

(2)

(Total 11 marks)

6 The sound quality of a portable radio is improved by adjusting the orientation of the aerial. Which statement is a correct explanation of this improvement?

A The radio waves from the transmitter are polarised.

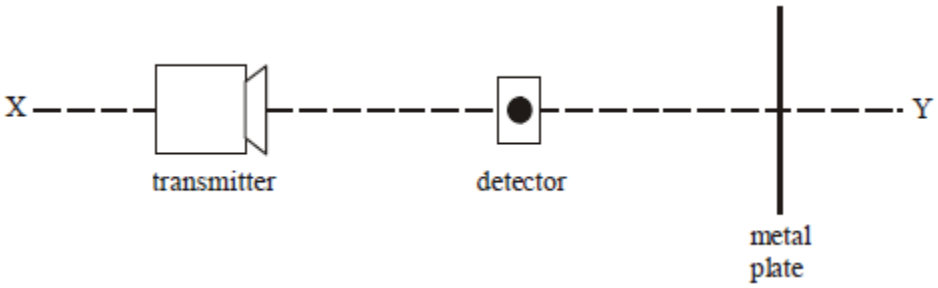
B The radio waves from the transmitter are unpolarised.

C The radio waves become polarised as a result of adjusting the aerial.

D The radio waves become unpolarised as a result of adjusting the aerial.

(Total 1 mark)

7 A microwave transmitter is used to direct microwaves of wavelength 30 mm along a line XY. A metal plate is positioned at right angles to XY with its mid-point on the line, as shown.



When a detector is moved gradually along XY, its reading alternates between maxima and minima. Which one of the following statements is **not** correct?

A The distance between two minima could be 15 mm.

B The distance between two maxima could be 30 mm.

C The distance between a minimum and a maximum could be 30 mm.

D The distance between a minimum and a maximum could be 37.5 mm.

(Total 1 mark)

8 By approximately how many times is the wavelength of audible sound waves greater than the wavelength of light waves?

A 10^2

B 10^6

C 10^{10}

D 10^{14}

(Total 1 mark)

9 A stationary wave is formed by two identical waves of frequency 300 Hz travelling in opposite directions along the same line. If the distance between adjacent nodes is 0.60 m, what is the speed of each wave?

A 180 m s^{-1}

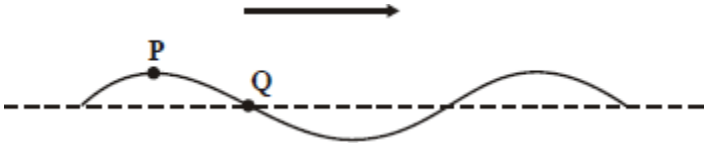
B 250 m s^{-1+}

C 360 m s^{-1}

D 500 m s^{-1}

(Total 1 mark)

10 The diagram shows a snapshot of a wave on a rope travelling from left to right.



At the instant shown, point **P** is at maximum displacement and point **Q** is at zero displacement. Which one of the following lines, **A** to **D**, in the table correctly describes the motion of **P** and **Q** in the next half-cycle?

	P	Q
A	falls then rises	rises
B	falls then rises	rises then falls
C	falls	falls
D	falls	rises then falls

(Total 1 mark)

11 The speed of sound in water is 1500 m s^{-1}. For a sound wave in water having frequency 2500 Hz, what is the minimum distance between two points at which the vibrations are $\frac{\pi}{3}$ rad out of phase?

A 0.05 m

B 0.10 m

C 0.15 m

D 0.20 m

(Total 1 mark)

12 Which one of the following properties of light waves do polarising sunglasses depend on for their action?

Light waves may

A interfere constructively.

B interfere destructively.

C be polarised when reflected from a surface.

D be polarised by the lens in the eye.

(Total 1 mark)

13 Which line, **A** to **D**, in the table shows correct relationships for the respective wavelengths, λ_L, λ_S, and frequencies, f_L, f_S, of light waves and sound waves?

	wavelengths	**frequencies**
A	$\lambda_L << \lambda_S$	$f_L >> f_S$
B	$\lambda_L << \lambda_S$	$f_L << f_S$
C	$\lambda_L >> \lambda_S$	$f_L >> f_S$
D	$\lambda_L >> \lambda_S$	$f_L << f_S$

(Total 1 mark)

14 Two points on a progressive wave differ in phase by $\frac{\pi}{4}$. 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}

C 10 m s^{-1}

C 20 m s^{-1}

D 40 m s^{-1}

(Total 1 mark)

15 Which line, **A** to **D**, in the table gives a correct difference between a progressive wave and a stationary wave?

	progressive wave	**stationary wave**
A	all the particles vibrate	some of the particles do not vibrate
B	none of the particles vibrate with the same amplitude	all the particles vibrate with the same amplitude
C	all the particles vibrate in phase with each other	none of the particles vibrate in phase with each other
D	some of the particles do not vibrate	all the particles vibrate in phase with each other

(Total 1 mark)

16 Stationary waves are set up on a length of rope fixed at both ends. Which one of the following statements is true?

A Between adjacent nodes, particles of the rope vibrate in phase with each other.

B The mid point of the rope is always stationary.

C Nodes need not necessarily be present at each end of the rope.

D Particles of the rope at adjacent antinodes always move in the same direction.

(Total 1 mark)

17 A wave of frequency 5 Hz travels at 8 km s^{-1} through a medium. What is the phase difference, in radians, between two points 2 km apart?

A 0

B $\frac{\pi}{2}$

C π

D $\frac{3\pi}{2}$

(Total 1 mark)

18 A source emits light of wavelength 600 nm as a train of waves lasting 0.01 μs. How many complete waves are sent out?
speed of light = 3×10^8 m s^{-1}

A 5×10^6

B 18×10^7

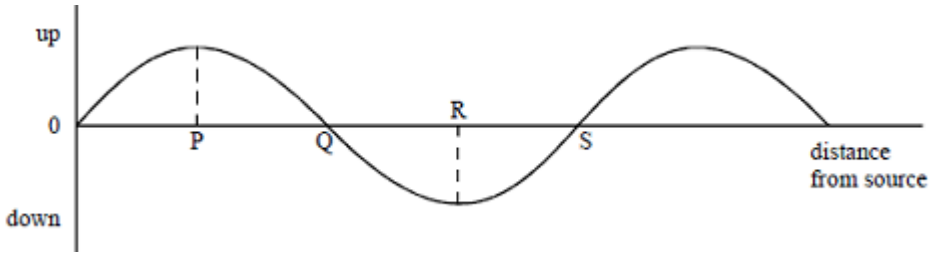
C 5×10^9

D 5×10^{22}

(Total 1 mark)

19

displacement



The graph shows, at a particular instant, the variation of the displacement of the particles in a transverse progressive water wave, of wavelength 4 cm, travelling from left to right. Which one of the following statements is **not** true?

A The distance PS = 3 cm.

B The particle velocity at Q is a maximum.

C The particle at S is moving downwards

D Particles at P and R are in phase.

(Total 1 mark)

20 The audible range of a girl's hearing is 30 Hz to 16 500 Hz. If the speed of sound in air is 330 m s^{-1}, what is the shortest wavelength of sound in air which the girl can hear?

A $\frac{30}{330}$ m

B $\frac{16500}{330}$ m

C $\frac{330}{16500}$ m

D $\frac{330}{30}$ m

(Total 1 mark)

21 Which one of the following types of wave **cannot** be polarised?

A radio

B ultraviolet

C microwave

D ultrasonic

(Total 1 mark)

22 A uniform wire fixed at both ends is vibrating in its fundamental mode. Which one of the following statements is **not** correct for all the vibrating particles?

A They vibrate in phase.

B They vibrate with the same amplitude.

C They vibrate with the same frequency.

D They vibrate at right angles to the wire.

(Total 1 mark)

23 A wave motion has period T, frequency f, wavelength λ and speed v. Which one of the following equations is **incorrect**?

A $1 = Tf$

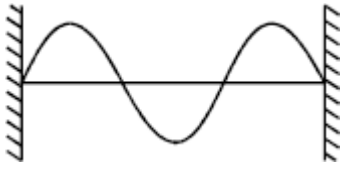
B $T = \frac{v}{\lambda}$

C $\lambda = \frac{v}{f}$

D $Tv = \lambda$

(Total 1 mark)

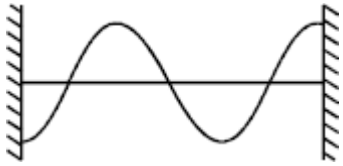
24



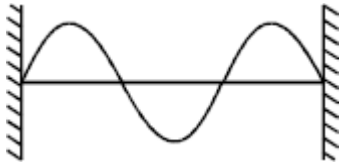
frequency of vibration = 50 Hz

The diagram above shows a stationary wave on a stretched string at a time $t = 0$. Which one of the diagrams, **A** to **D**, correctly shows the position of the string at a time $t = 0.010$ s?

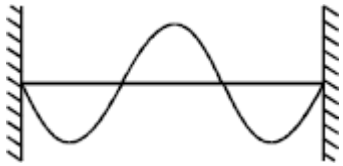
A



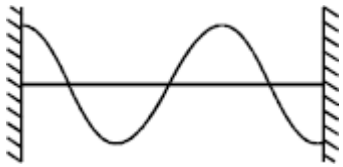
B



C



D



(Total 1 mark)

25 A progressive wave in a stretched string has a speed of 20 m s^{-1} and a frequency of 100 Hz. What is the phase difference between two points 25 mm apart?

A zero

B $\frac{\pi}{4}$ rad

C $\frac{\pi}{2}$ rad

D π rad

(Total 1 mark)

26 Which one of the following statements about stationary waves is true?

A Particles between adjacent nodes all have the same amplitude.

B Particles between adjacent nodes are out of phase with each other.

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

D There is a minimum disturbance of the medium at an antinode.

(Total 1 mark)