Stationary waves

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Stationary Waves
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: **53 minutes**

Score: **/44**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Fig. 4.1 shows an arrangement for producing stationary waves in a tube that is closed at one end.

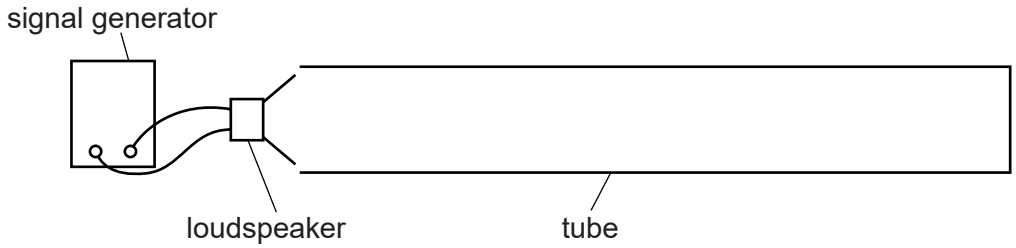

Fig. 4.1

(a) Explain how waves from the loudspeaker produce stationary waves in the tube.

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.....[3]

(b) One of the stationary waves that may be formed in the tube is represented in Fig. 4.2.

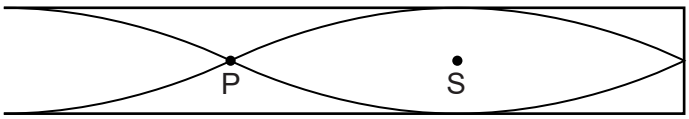

Fig. 4.2

(i) Describe the motion of the air particles in the tube at

1. point P,

.....[1]

2. point S.

.....[1]

(ii) The speed of sound in the tube is 330 m s^{-1} and the frequency of the waves from the loudspeaker is 880 Hz. Calculate the length of the tube.

length = ... m [3]

2 **(a)** Use the principle of superposition to explain the formation of a stationary wave.

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.....[3]

(b) Describe an experiment to determine the wavelength of sound in air using stationary waves. Include a diagram of the apparatus in your answer.

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.....[3]

(c) The variation with distance x of the intensity I of a stationary sound wave is shown in Fig. 6.1.

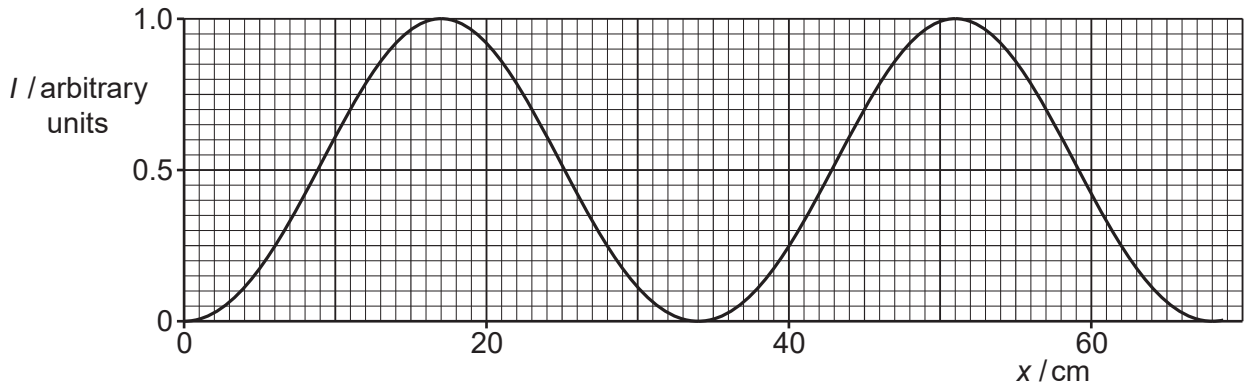

Fig. 6.1

(i) On the x-axis of Fig. 6.1, indicate the positions of all the nodes and antinodes of the stationary wave. Label the nodes **N** and the antinodes **A**. [1]

(ii) The speed of sound in air is $340\,m\,s^{-1}$.

Use Fig. 6.1 to determine the frequency of the sound wave.

frequency = ... Hz [3]

3 **(a)** State the *principle of superposition*.

.....

.....

.....[2]

(b) An arrangement that can be used to determine the speed of sound in air is shown in Fig. 6.1.

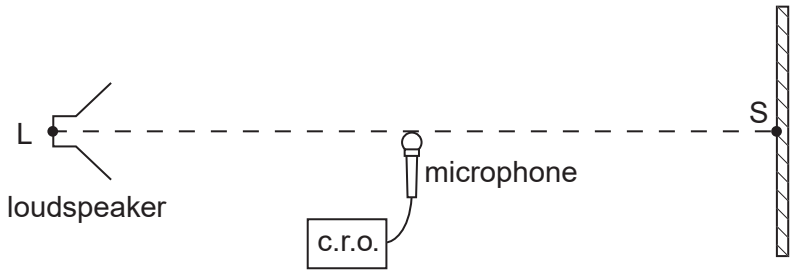

Fig. 6.1

Sound waves of constant frequency are emitted from the loudspeaker L and are reflected from a point S on a hard surface.
The loudspeaker is moved away from S until a stationary wave is produced.

Explain how sound waves from L give rise to a stationary wave between L and S.

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.....[2]

(c) A microphone connected to a cathode ray oscilloscope (c.r.o.) is positioned between L and S as shown in Fig. 6.1. The trace obtained on the c.r.o. is shown in Fig. 6.2.

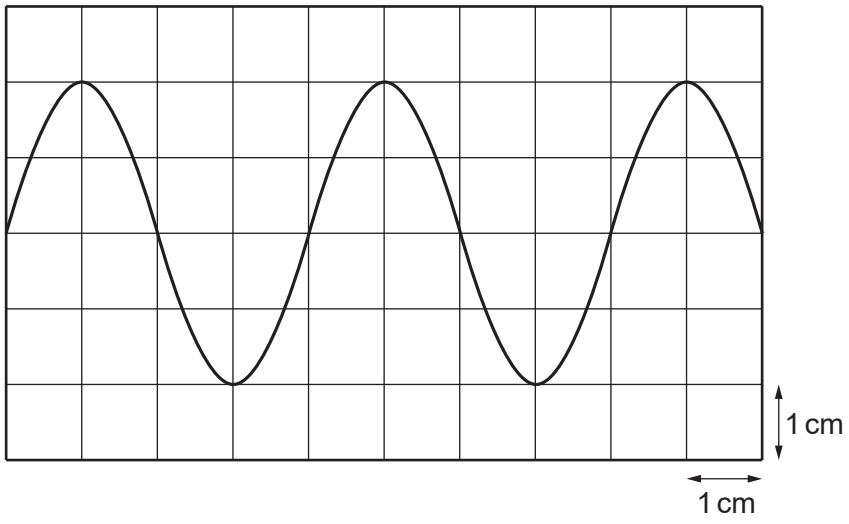

Fig. 6.2

The time-base setting on the c.r.o. is 0.10 ms cm^{-1}.

(i) Calculate the frequency of the sound wave.

frequency = ... Hz [2]

(ii) The microphone is now moved towards S along the line LS. When the microphone is moved 6.7 cm, the trace seen on the c.r.o. varies from a maximum amplitude to a minimum and then back to a maximum.

1. Use the properties of stationary waves to explain these changes in amplitude.

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.....

.....[1]

2. Calculate the speed of sound.

speed of sound = ... $m\,s^{-1}$ [3]

4 **(a)** State two features of a stationary wave that distinguish it from a progressive wave.

1. .....

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2. .....

.....

[2]

(b) A long tube is open at one end. It is closed at the other end by means of a piston that can be moved along the tube, as shown in Fig. 4.1.

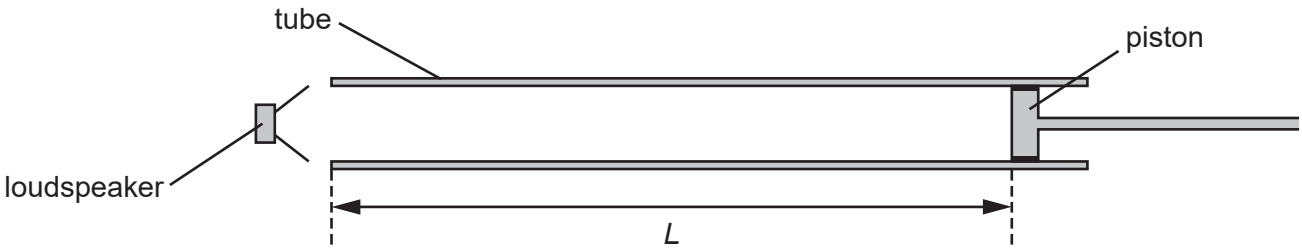

Fig. 4.1

A loudspeaker producing sound of frequency 550 Hz is held near the open end of the tube.
The piston is moved along the tube and a loud sound is heard when the distance *L* between the piston and the open end of the tube is 45 cm.
The speed of sound in the tube is 330 m s^{-1}.

(i) Show that the wavelength of the sound in the tube is 60 cm.

[1]

(ii) On Fig. 4.1, mark all the positions along the tube of

1. the displacement nodes (label these with the letter N),

2. the displacement antinodes (label these with the letter A).

[3]

(c) The frequency of the sound produced by the loudspeaker in **(b)** is gradually reduced.

Determine the lowest frequency at which a loud sound will be produced in the tube of length L = 45 cm.

frequency = ... Hz [3]

5 A uniform string is held between a fixed point P and a variable-frequency oscillator, as shown in Fig. 5.1.

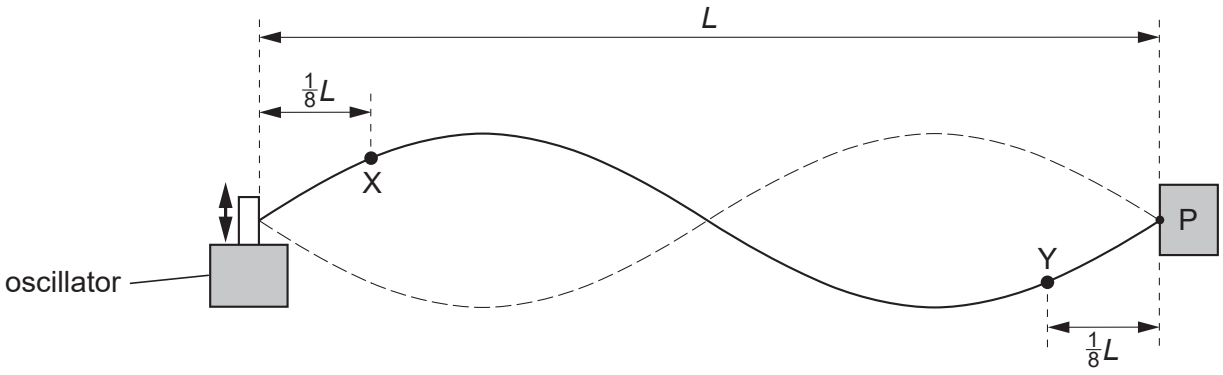

Fig. 5.1

The distance between point P and the oscillator is L.

The frequency of the oscillator is adjusted so that the stationary wave shown in Fig. 5.1 is formed.

Points X and Y are two points on the string.

Point X is a distance $\frac{1}{8}L$ from the end of the string attached to the oscillator. It vibrates with frequency f and amplitude A.

Point Y is a distance $\frac{1}{8}L$ from the end P of the string.

(a) For the vibrations of point Y, state

(i) the frequency (in terms of f),

frequency = ... [1]

(ii) the amplitude (in terms of A).

amplitude = ... [1]

(b) State the phase difference between the vibrations of point X and point Y.

phase difference = ... [1]

(c) **(i)** State, in terms of *f* and *L*, the speed of the wave on the string.

speed = ... [1]

(ii) The wave on the string is a stationary wave.

Explain, by reference to the formation of a stationary wave, what is meant by the speed stated in **(i)**.

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..... [3]