

Stationary waves

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Stationary Waves
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: 57 minutes

Score: /47

Percentage: /100

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

1 (a) State what is meant by *diffraction* and by *interference*.

diffraction:

.....

interference:

.....

[3]

(b) Light from a source S_1 is incident on a diffraction grating, as illustrated in Fig. 6.1.

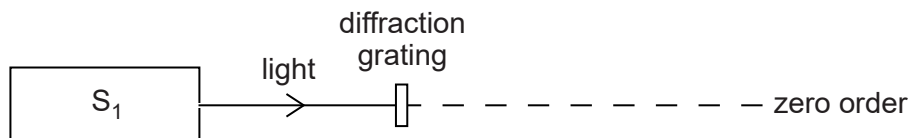


Fig. 6.1 (not to scale)

The light has a single frequency of 7.06×10^{14} Hz. The diffraction grating has 650 lines per millimetre.

Calculate the number of orders of diffracted light produced by the grating. Do not include the zero order.

Show your working.

number = [3]

(c) A second source S_2 is used in place of S_1 . The light from S_2 has a single frequency lower than that of the light from S_1 .

State and explain whether more orders are seen with the light from S_2 .

.....

..... [1]

- 2 (a) Two overlapping waves of the same type travel in the same direction. The variation with distance x of the displacement y of each wave is shown in Fig. 6.1.

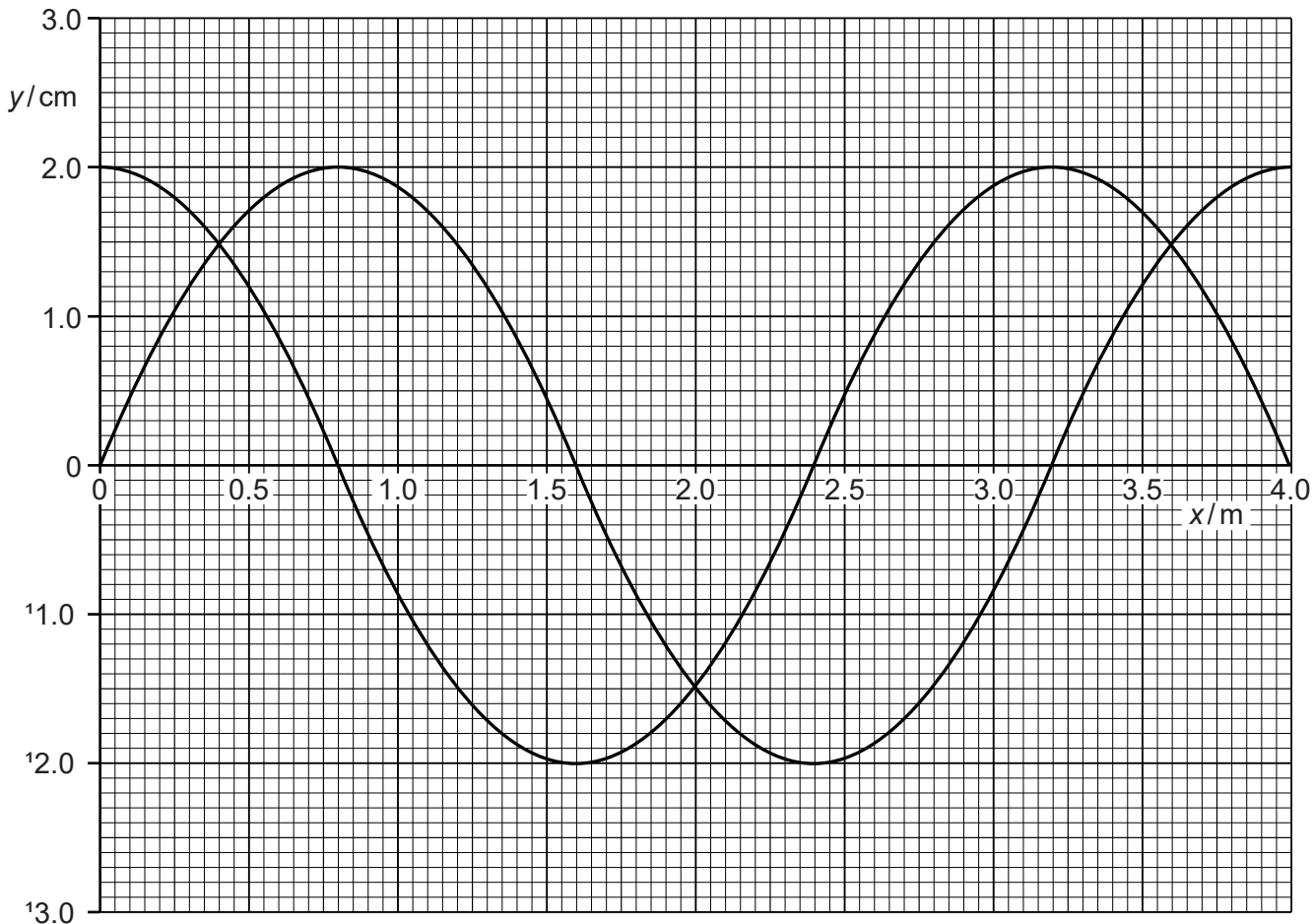


Fig. 6.1

The speed of the waves is 240 ms^{-1} . The waves are coherent and produce an interference pattern.

- (i) Explain the meaning of *coherence* and *interference*.

coherence:

.....

interference:

.....

[2]

- (ii) Use Fig. 6.1 to determine the frequency of the waves.

frequency = Hz [2]

(iii) State the phase difference between the waves.

phase difference = ° [1]

(iv) Use the principle of superposition to sketch, on Fig. 6.1, the resultant wave. [2]

(b) An interference pattern is produced with the arrangement shown in Fig. 6.2.

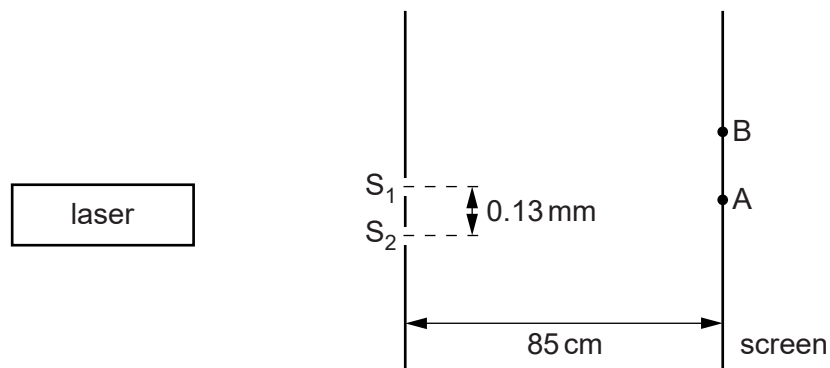


Fig. 6.2 (not to scale)

Laser light of wavelength λ of 546 nm is incident on the slits S_1 and S_2 . The slits are a distance 0.13 mm apart. The distance between the slits and the screen is 85 cm.

Two points on the screen are labelled A and B. The path difference between S_1A and S_2A is zero. The path difference between S_1B and S_2B is 2.5λ . Maxima and minima of intensity of light are produced on the screen.

(i) Calculate the distance AB.

distance = m [3]

(ii) The laser is replaced by a laser emitting blue light. State and explain the change in the distance between the maxima observed on the screen.

.....

 [1]

3 (a) Explain how stationary waves are formed.

.....

.....

..... [2]

(b) The arrangement of apparatus used to determine the wavelength of a sound wave is shown in Fig. 8.1.

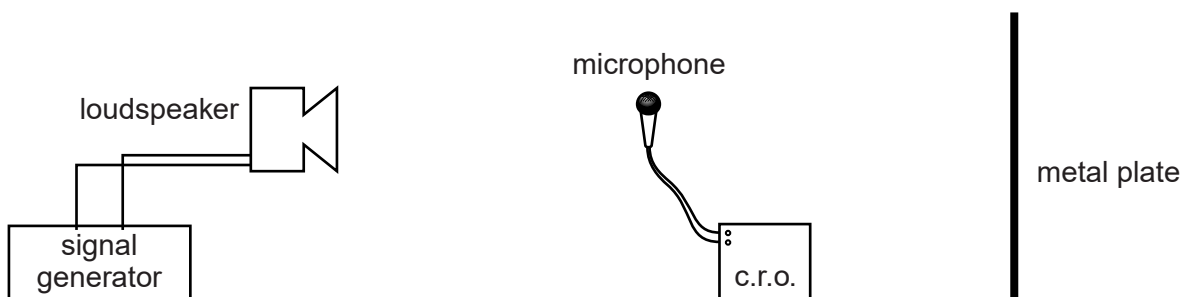


Fig. 8.1

The loudspeaker emits sound of one frequency. The microphone is connected to a cathode-ray oscilloscope (c.r.o.).

The waveform obtained on the c.r.o. for one position of the microphone is shown in Fig. 8.2.

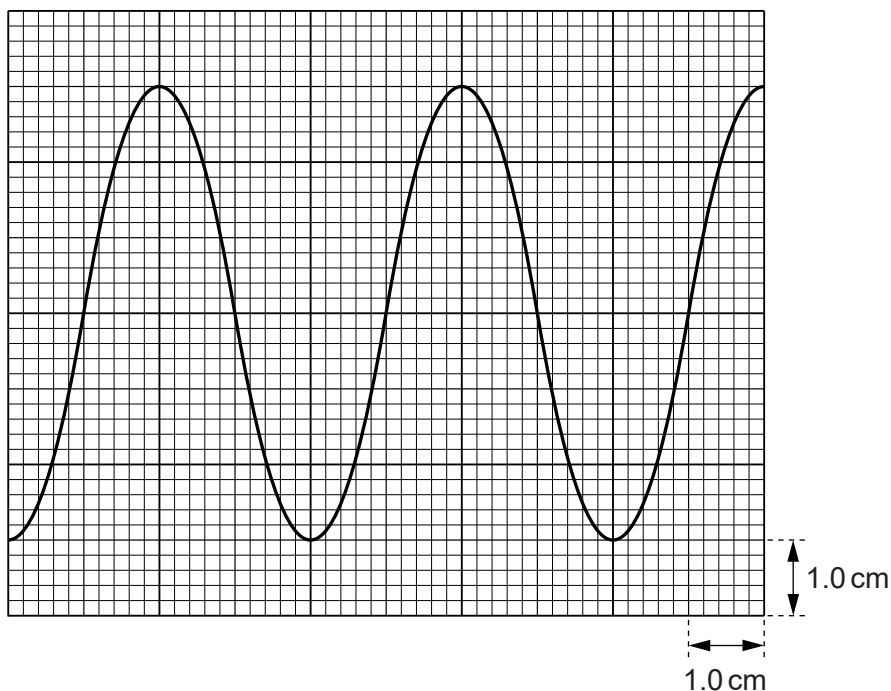


Fig. 8.2

The time-base setting of the c.r.o. is 0.20 ms cm^{-1} .

- (i) Use Fig. 8.2 to show that the frequency of the sound is approximately 1300 Hz.

[2]

- (ii) Explain how the apparatus is used to determine the wavelength of the sound.

.....
.....
.....
..... [2]

- (iii) The wavelength of the sound wave is 0.26 m. Calculate the speed of sound in this experiment.

speed = ms^{-1} [2]

- 4 A hollow tube is used to investigate stationary waves. The tube is closed at one end and open at the other end. A loudspeaker connected to a signal generator is placed near the open end of the tube, as shown in Fig. 6.1.

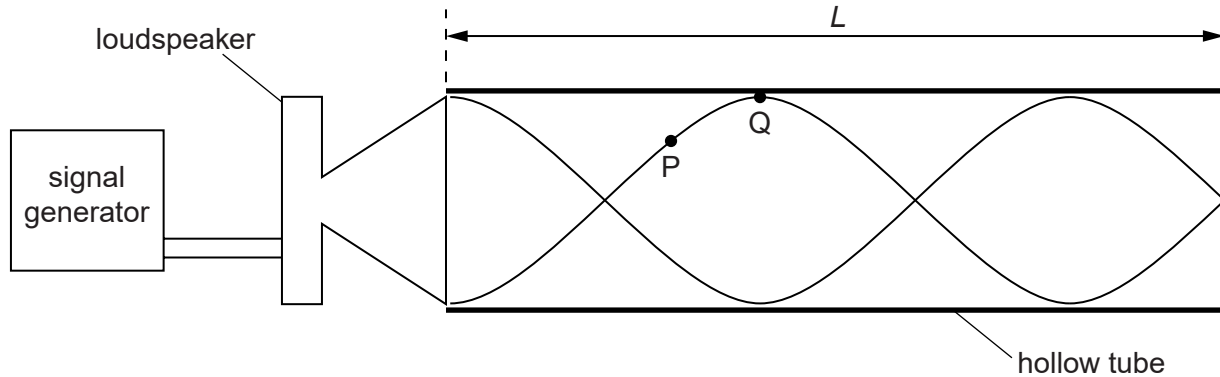


Fig. 6.1

The tube has length L . The frequency of the signal generator is adjusted so that the loudspeaker produces a progressive wave of frequency 440 Hz. A stationary wave is formed in the tube. A representation of this stationary wave is shown in Fig. 6.1.

Two points P and Q on the stationary wave are labelled.

- (a) (i) Describe, in terms of energy transfer, the difference between a progressive wave and a stationary wave.

.....
 [1]

- (ii) Explain how the stationary wave is formed in the tube.

.....

 [3]

- (iii) State the direction of the oscillations of an air particle at point P.

.....
 [1]

- (b) On Fig. 6.1 label, with the letter N, the nodes of the stationary wave. [1]

- (c) State the phase difference between points P and Q on the stationary wave.

phase difference = [1]

(d) The speed of sound in the tube is 330 m s^{-1} .

Calculate

(i) the wavelength of the sound wave,

wavelength = m [2]

(ii) the length L of the tube.

length = m [2]

5 Fig. 5.1 shows a string stretched between two fixed points P and Q.

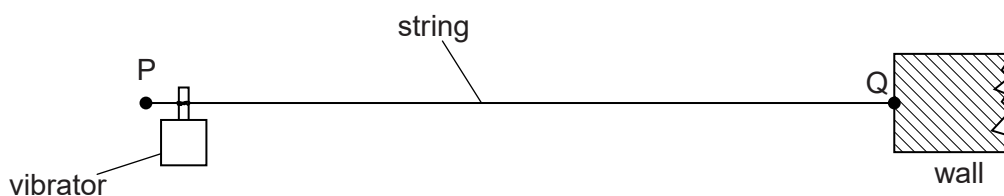


Fig. 5.1

A vibrator is attached near end P of the string. End Q is fixed to a wall. The vibrator has a frequency of 50 Hz and causes a transverse wave to travel along the string at a speed of 40 ms^{-1} .

(a) (i) Calculate the wavelength of the transverse wave on the string.

wavelength = m [2]

(ii) Explain how this arrangement may produce a stationary wave on the string.

.....

 [2]

(b) The stationary wave produced on PQ at one instant of time t is shown on Fig. 5.2. Each point on the string is at its maximum displacement.

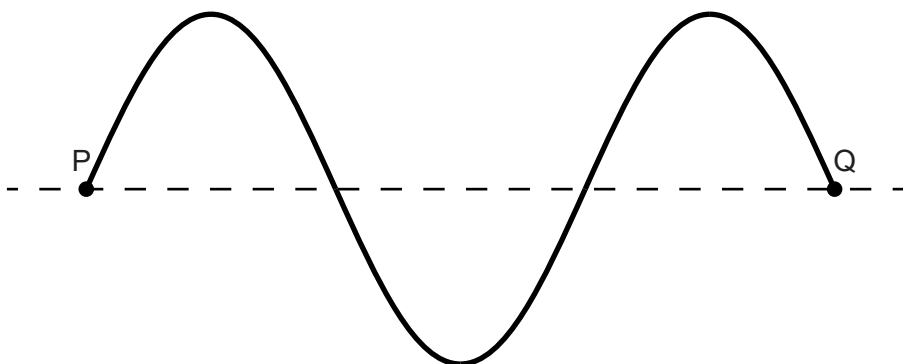


Fig. 5.2 (not to scale)

(i) On Fig. 5.2, label all the nodes with the letter **N** and all the antinodes with the letter **A**. [2]

(ii) Use your answer in **(a)(i)** to calculate the length of string PQ.

length = m [1]

(iii) On Fig. 5.2, draw the stationary wave at time $(t + 5.0 \text{ ms})$. Explain your answer.

.....[3]