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.

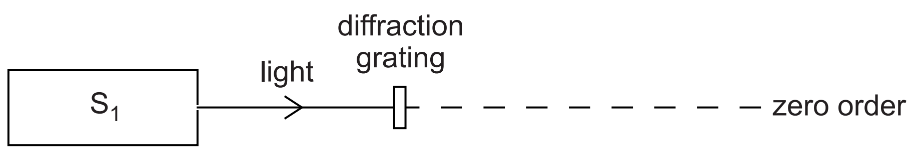

Fig. 6.1 (not to scale)

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.

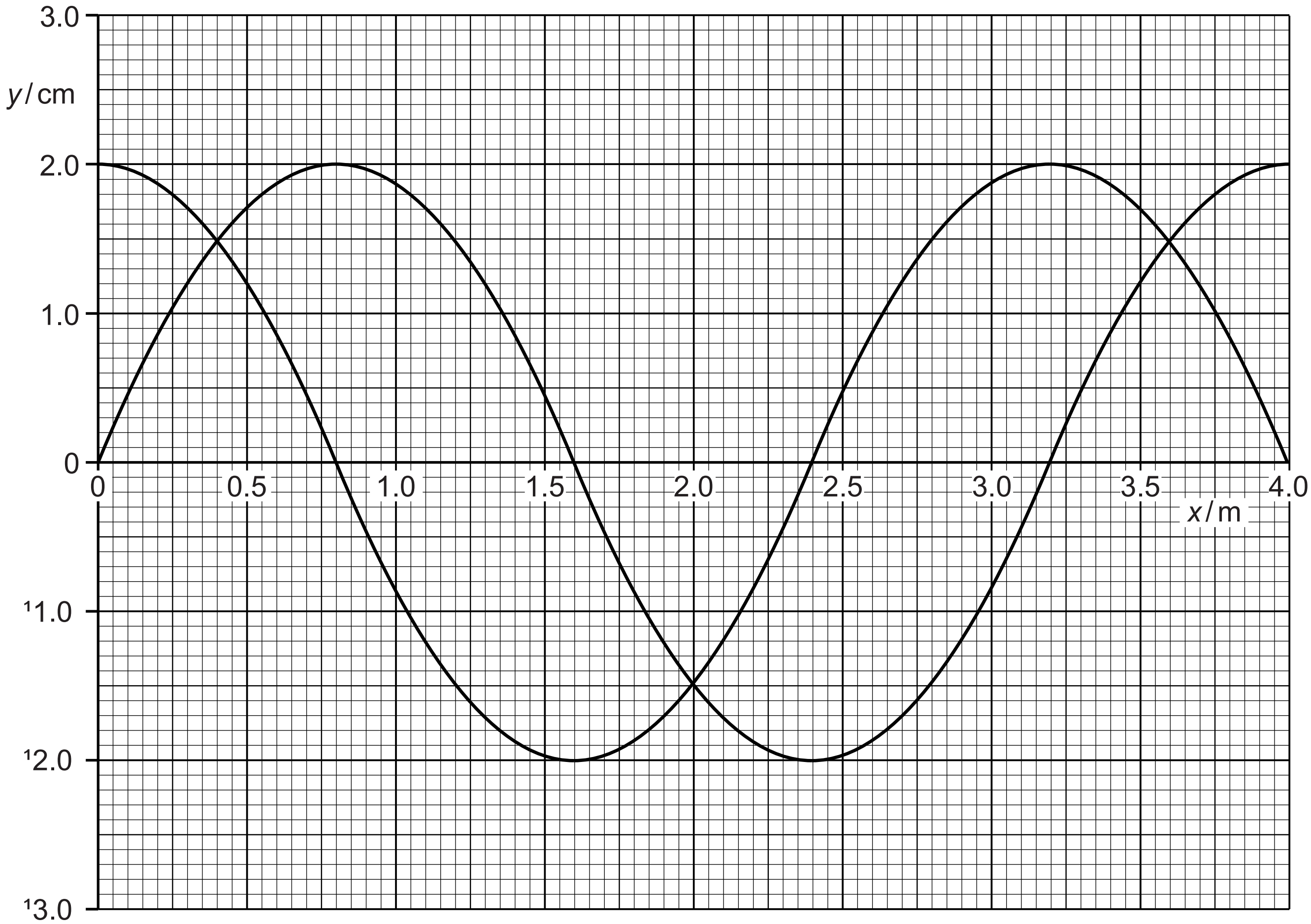

Fig. 6.1

The speed of the waves is 240 m s^{-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.

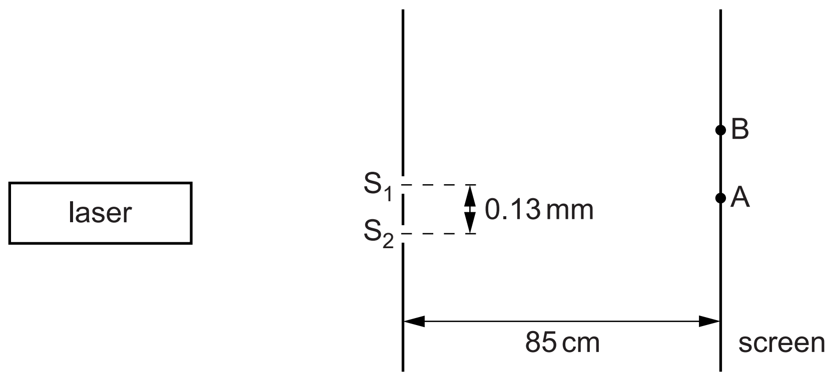

Fig. 6.2 (not to scale)

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.

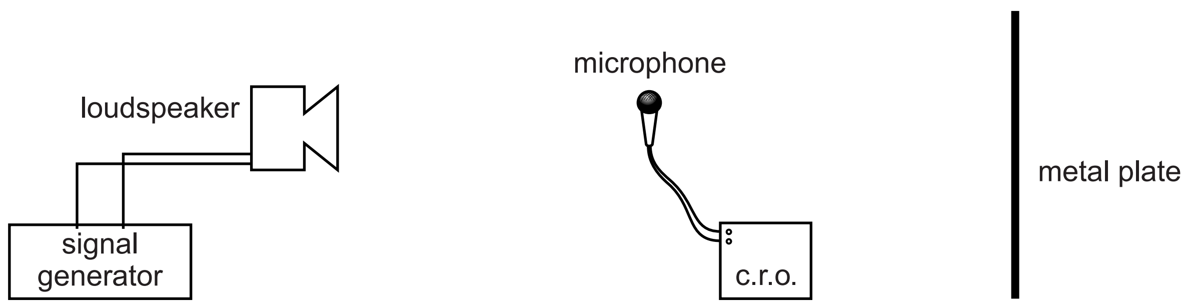

Fig. 8.1

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.

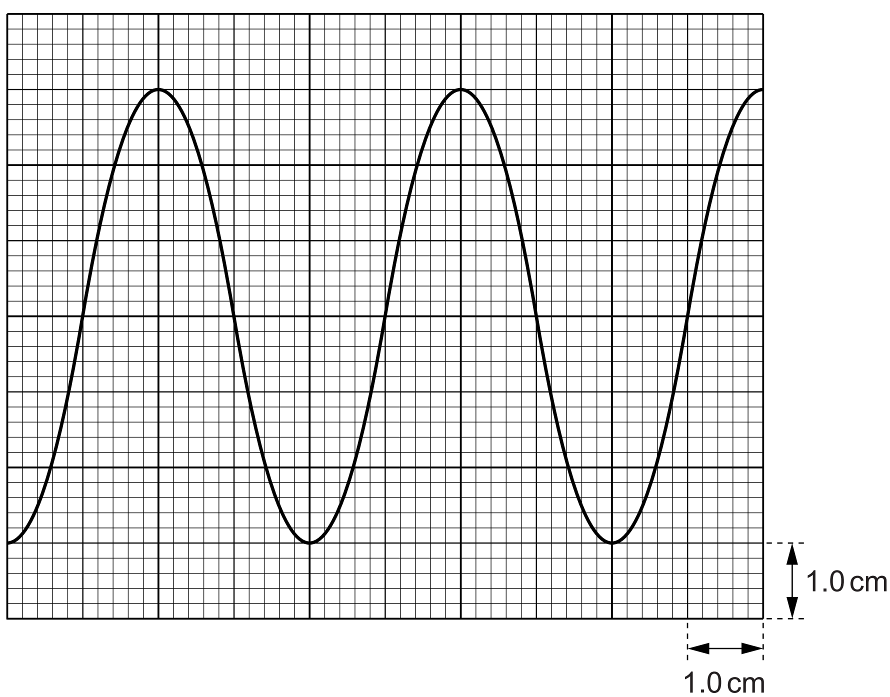

Fig. 8.2

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 = ... m s^{-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.

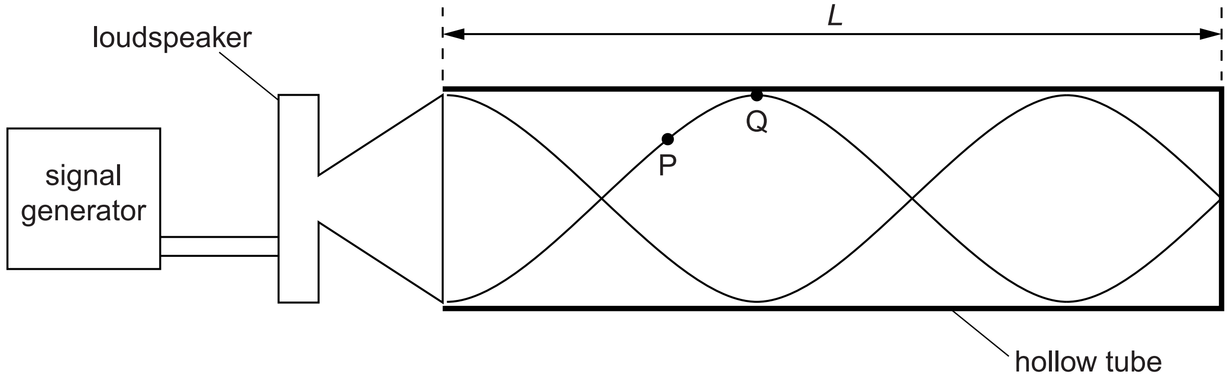

Fig. 6.1

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.

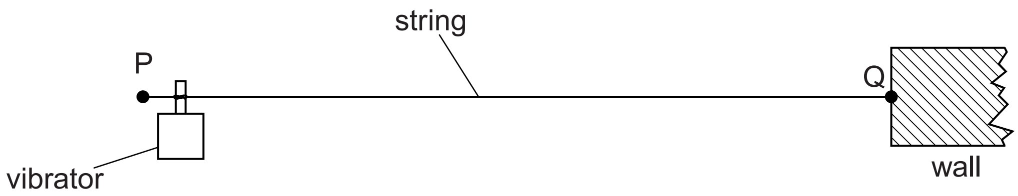

Fig. 5.1

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 m s^{-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.

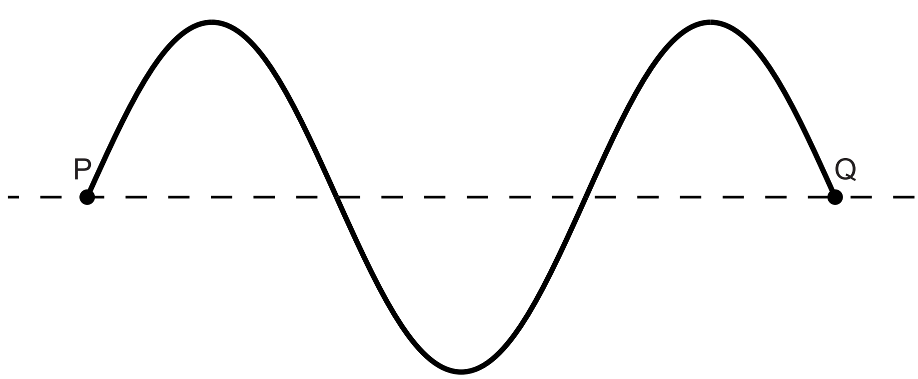

Fig. 5.2 (not to scale)

(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 ms). Explain your answer.

.... [3]