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

....

....

.... [2]

(b) A stationary wave (in solid line) is produced by the superposition of two progressive waves, P and Q. Fig. 9.1 shows the positions of the stationary wave and one of the two progressive waves, P, at a particular instant in time.

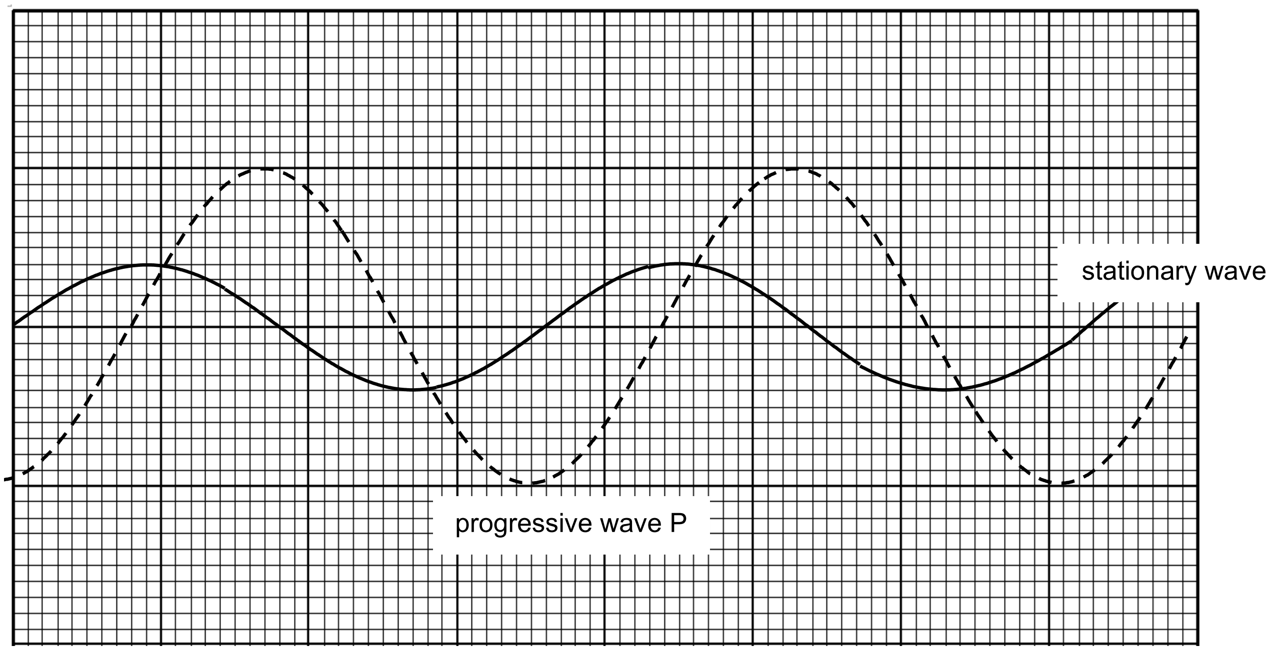

Fig. 9.1

Sketch on Fig. 9.1 progressive wave Q that superposes with progressive wave P to produce the stationary wave shown. You should include at least one complete wavelength in your sketch. [2]

(c) Fig. 9.2 shows an experiment with sound waves.

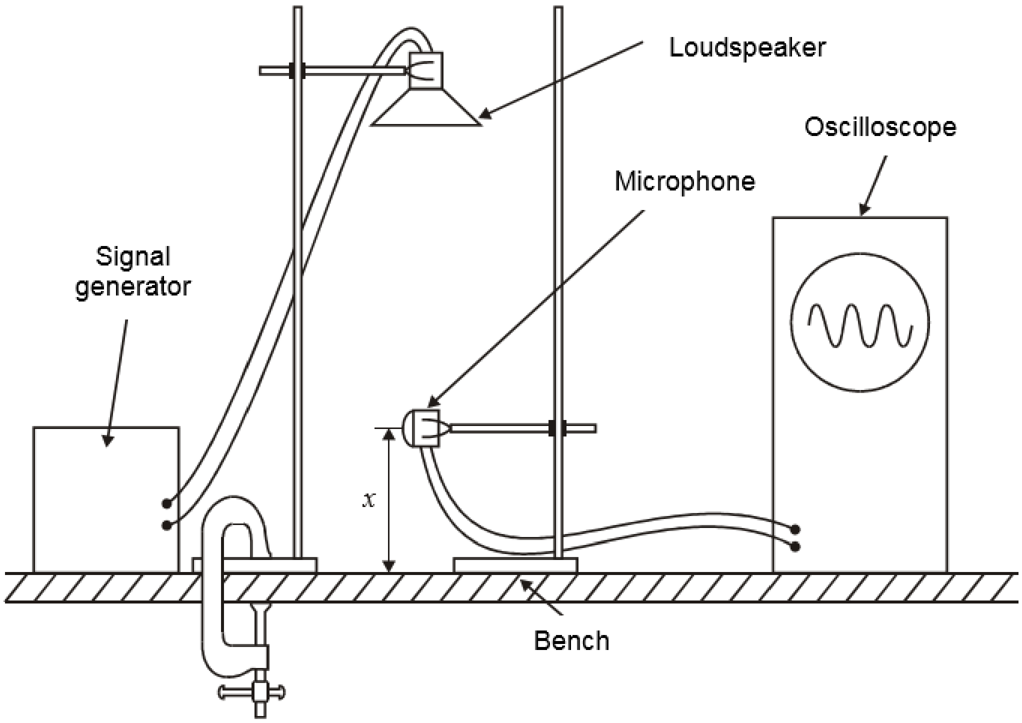

Fig. 9.2

The loudspeaker connected to a signal generator is mounted, pointing towards the bench. The sound is detected by a microphone connected to an oscilloscope. The height of the trace on the oscilloscope is proportional to the amplitude of the sound waves at the microphone.

When the vertical distance *x* between the microphone and the bench is varied, the amplitude of the sound waves is found to vary as shown in Fig. 9.3.

amplitude / arbitrary units

16

12

8

4

0

0 4 8 12 16 20

x / cm

Fig 9.3

(i) Explain the formation of alternating maxima and minima.

....

....

....

....

.... [3]

(ii) Explain why the intensity of the minima increases with *x*.

....

....

....

.... [2]

(iii) The speed of sound is 340 m s^{-1}. Use Fig. 9.3 to calculate the frequency of the waves emitted by the loudspeaker.

frequency = ………………… Hz [3]

(d) Light of wavelength 650 nm is incident normally on a double slit such that the waves emerge from X and Y in phase, and reach a screen 1.5 m away, as shown in Fig. 9.4.

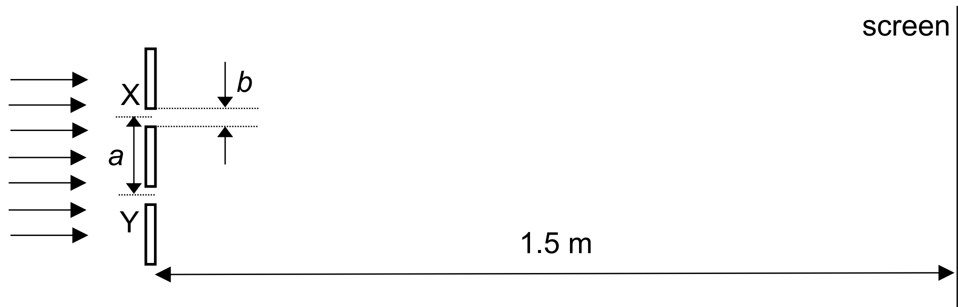

Fig. 9.4

The variation of intensity with distance along the screen is shown in Fig. 9.5.

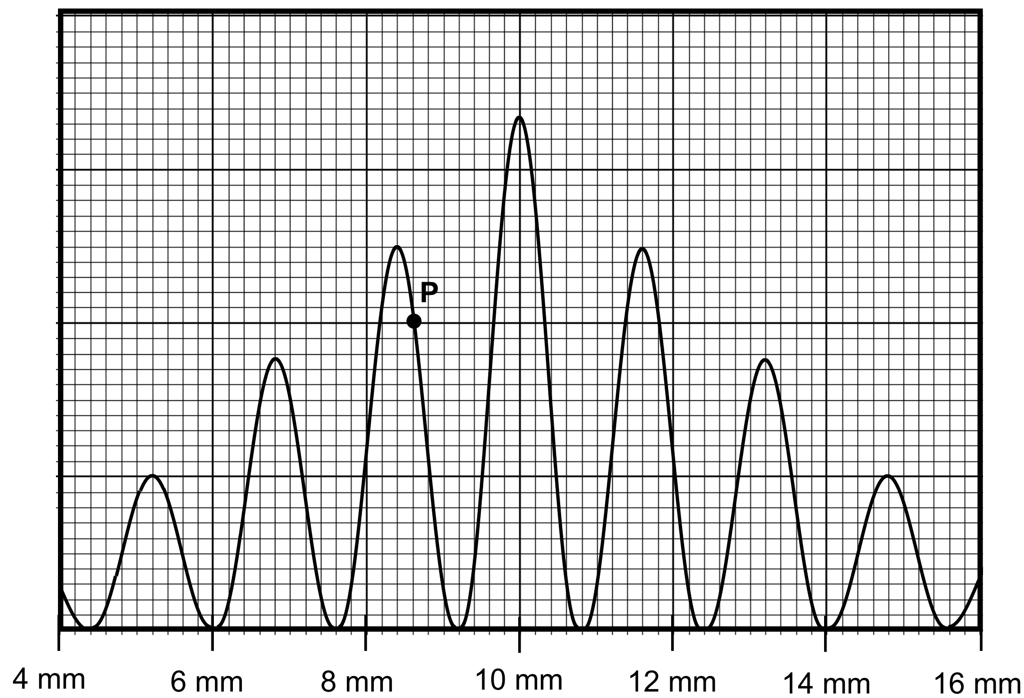

Fig. 9.5

(i) Explain how it can be deduced from Fig. 9.5 that the waves from the two slits are coherent.

.... [1]

(ii) Determine the phase angle between the waves from the slits when the waves meet to produce the intensity at point **P** on the pattern of Fig. 9.5.

phase angle = …………………. rad [2]

(iii) Calculate the separation a, between the slits.

a = …………………… mm [2]

(iv) Given that the 6^{th} order bright fringe is the first missing order due to the diffraction envelope, calculate the width b, of each slit.

b = ……………………. mm [3]

END OF PAPER