4 **(a)** For a progressive wave, state what is meant by the frequency.

.....

..... [1]

(b) A loudspeaker, microphone and cathode-ray oscilloscope (CRO) are arranged as shown in Fig. 4.1.

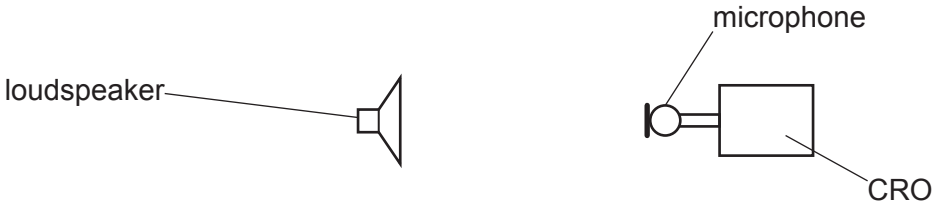

Fig. 4.1

The loudspeaker is emitting a sound wave which is detected by the microphone and displayed on the screen of the CRO as shown in Fig. 4.2.

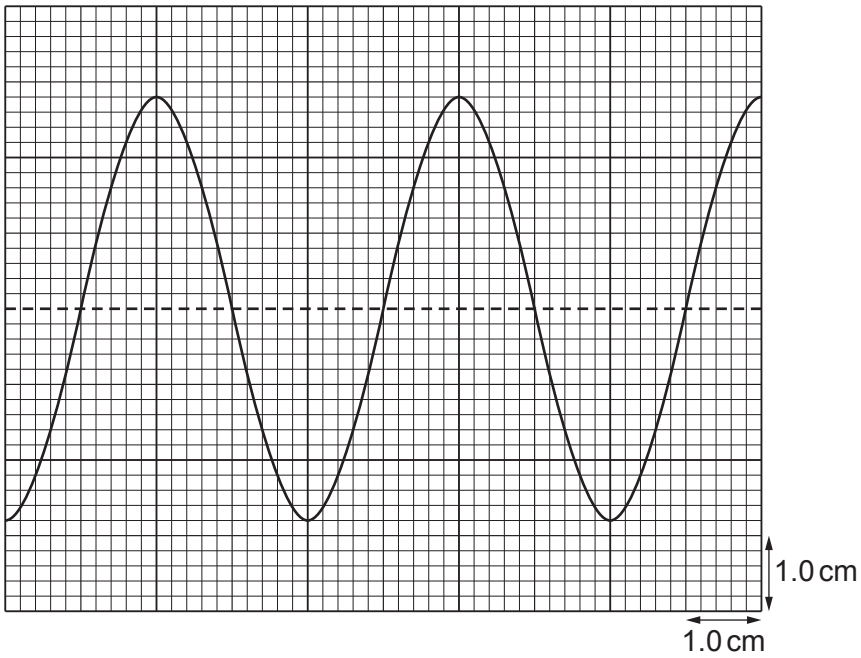

Fig. 4.2

The time-base on the CRO is set to 0.50 ms cm^{-1} and the *y*-gain is set to 0.20 V cm^{-1}.

Calculate:

(i) the frequency of the sound wave

frequency = ... Hz [2]

(ii) the amplitude of the signal received by the CRO.

amplitude = ... V [1]

(c) The intensity of the sound wave in **(b)** is reduced to a quarter of its original intensity without a change in frequency. Assume that the amplitude of the signal received by the CRO is proportional to the amplitude of the sound wave.

On Fig. 4.2, sketch the trace that is now seen on the screen of the CRO. [3]

(d) A metal sheet is now placed in front of the loudspeaker in **(b)**, as shown in Fig. 4.3.

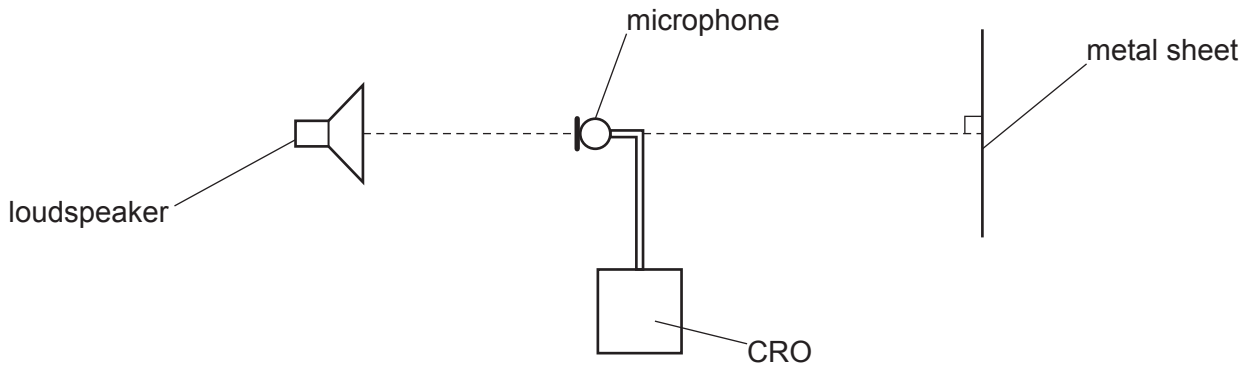

Fig. 4.3

A stationary wave is formed between the loudspeaker and the metal sheet.

(i) State the principle of superposition.

.....

.....

..... [2]

(ii) The initial position of the microphone is such that the trace on the CRO has an amplitude minimum. It is now moved a distance of 1.05 m away from the loudspeaker along the line joining the loudspeaker and metal sheet.

As the microphone moves, it passes through three positions where the trace has an amplitude maximum before ending at a position where the trace has an amplitude minimum.

Determine the wavelength of the sound wave.

wavelength = ... m [2]

(iii) Use your answers in **(b)(i)** and **(d)(ii)** to determine the speed of the sound in the air.

speed = ... $m\,s^{-1}$ [2]

[Total: 13]