7 (a) In the experimental arrangement shown in Fig. 7.1, radio waves emitted from the transmitting aerial are detected at the receiving aerial.

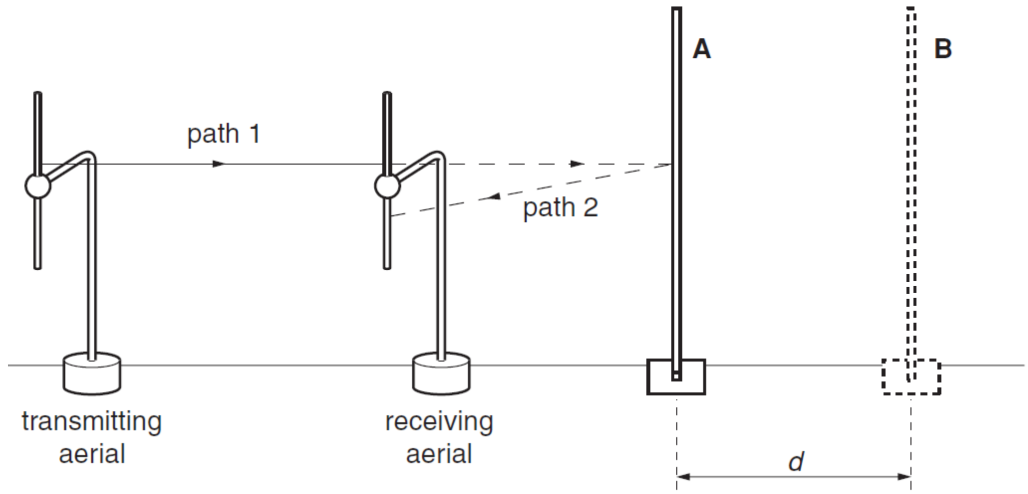

Fig. 7.1

Waves travel from the receiver along two paths: directly from the transmitter (path 1) and by reflection from the metal sheet (path 2). The waves arriving at the receiver are combined to give a resultant signal. As the metal sheet is moved away from the receiver, the resultant signal rises and falls.

(i) With the plate in position A, the output signal from the receiver is a maximum. Explain, in terms of superposition of the waves how a maximum signal can occur at the receiver.

....

....

....

.... [2]

(ii) The metal plate is moved away from the receiver to position B, causing the output signal to decrease to a minimum.
Use the idea of superposition of wave to explain why the signal has decreased to a minimum.

....

....

.... [2]

(iii) Explain why the minimum signal is not necessarily zero.

....

....

....

.... [2]

(iv) Given that the frequency of the waves is 1.0 GHz, calculate the approximate distance *d* between the positions A and B of the metal plate shown in Fig. 7.1.

distance *d* = ... m [3]

(b) A vertical tube of length 0.60 m is open at both ends, as shown in Fig. 7.2.

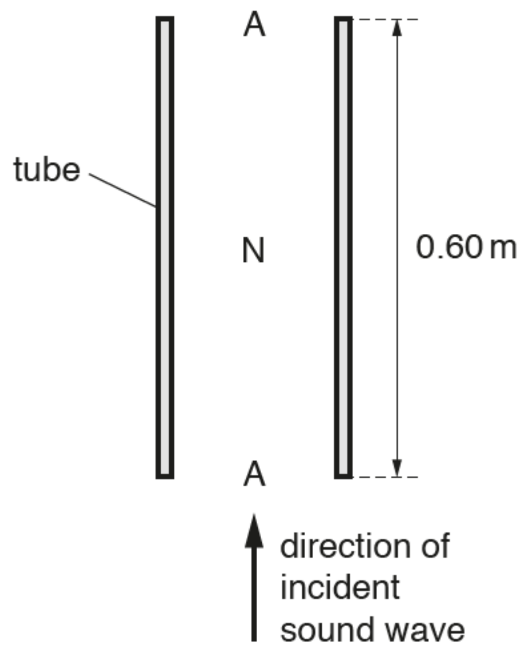

Fig. 7.2

Fig. 7.2

An incident sound wave of a single frequency travels up the tube. A stationary wave is then formed in the air column in the tube with antinodes A at both ends and a node N at the midpoint.

(i) Explain how the stationary wave is formed from the incident sound wave.

....

....

....

.... [2]

(ii) On Fig 7.3, sketch a graph of the variation of the amplitude of the stationary wave with height *h* above the bottom of the tube.

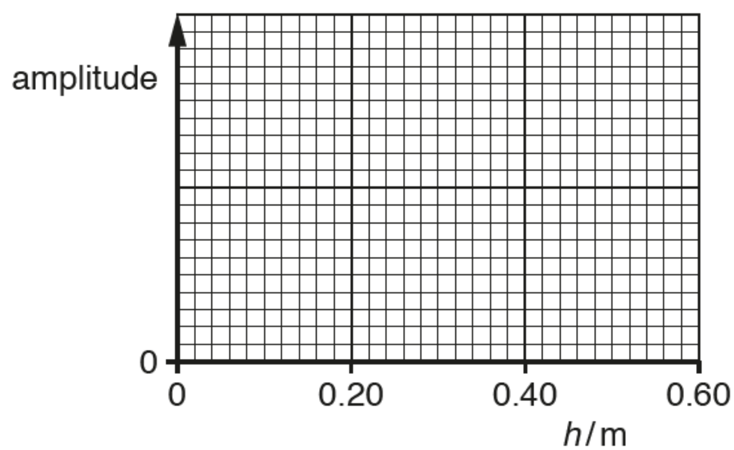

Fig. 7.3

[2]

(iii) For the stationary wave, state :

1. the direction of the oscillations of an air molecule at a height of 0.15 m above the bottom of the tube ;

.... [1]

2. the phase difference between the oscillations of a molecule at a height of 0.10 m and a molecule at a height of 0.40 m above the bottom of the tube.

phase difference = ... rad [1]

(iv) Describe the movement of air particles on either side of the node and hence, state what happens to the pressure at a node during one cycle of oscillations.

....

....

....

....

.... [3]

(v) The speed of sound c for longitudinal wave in air is given by

$$c = \sqrt{\frac{K}{\rho}}$$

where ρ is the density of air and K is a constant.

A student measures the fundamental frequency f to be 275 Hz. The density of air in the pipe is 1.3 kg m^{-3}. Determine the value of K in air.

K = ... kg m^{-1} s^{-2} [2]