

- 4 (a) By reference to the direction of propagation of energy, explain what is meant by a *longitudinal* wave.

.....
..... [1]

- (b) A car horn emits a sound wave of frequency 800 Hz. A microphone and a cathode-ray oscilloscope (c.r.o.) are used to analyse the sound wave. The waveform displayed on the c.r.o. screen is shown in Fig. 4.1.

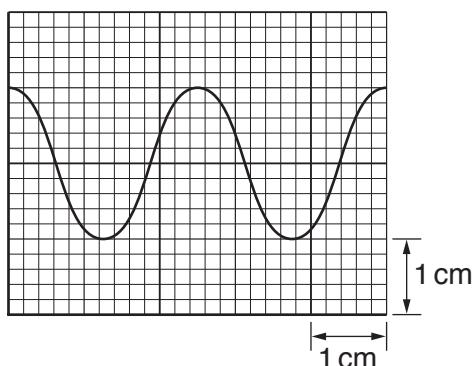


Fig. 4.1

Determine the time-base setting, in scm^{-1} , of the c.r.o.

$$\text{time-base setting} = \dots \text{ scm}^{-1} [3]$$

- (c) The intensity I of the sound at a distance r from the car horn in (b) is given by the expression

$$I = \frac{k}{r^2}$$

where k is a constant.

Fig. 4.2 shows the car in (b) on a road.

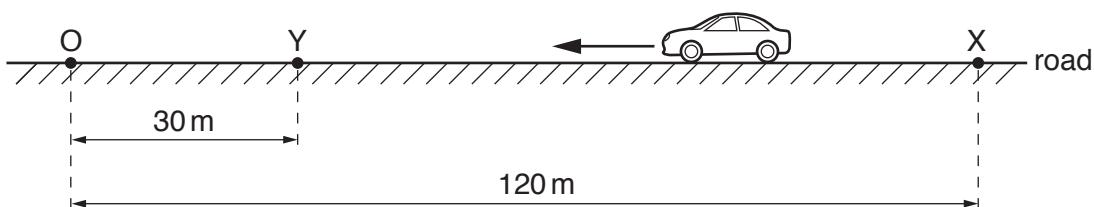


Fig. 4.2

An observer stands at point O. Initially the car is parked at point X which is 120 m away from point O. The car then moves directly towards the observer and stops at point Y, a distance of 30 m away from O.

The car horn continuously emits sound when the car is moving between points X and Y.

- (i) The sound wave at point O has amplitude A_X when the car is at X and has amplitude A_Y when the car is at Y.

Calculate the ratio $\frac{A_Y}{A_X}$.

$$\text{ratio} = \dots \quad [3]$$

- (ii) When the car is parked at X, the frequency of the sound from the horn that is detected by the observer is 800 Hz. As the car moves from X to Y, the maximum change in the detected frequency is 16 Hz. The speed of the sound in air is 330 ms^{-1} .

Determine, to two significant figures,

1. the minimum wavelength of the sound detected by the observer,

$$\text{wavelength} = \dots \text{ m} \quad [2]$$

2. the maximum speed of the car.

$$\text{speed} = \dots \text{ ms}^{-1} \quad [2]$$

[Total: 11]