4 **(a)** State the conditions required for the formation of a stationary wave.

....

....

....

....[2]

(b) The sound from a loudspeaker is detected by a microphone that is connected to a cathode-ray oscilloscope (c.r.o.). Fig. 4.1 shows the trace on the screen of the c.r.o.

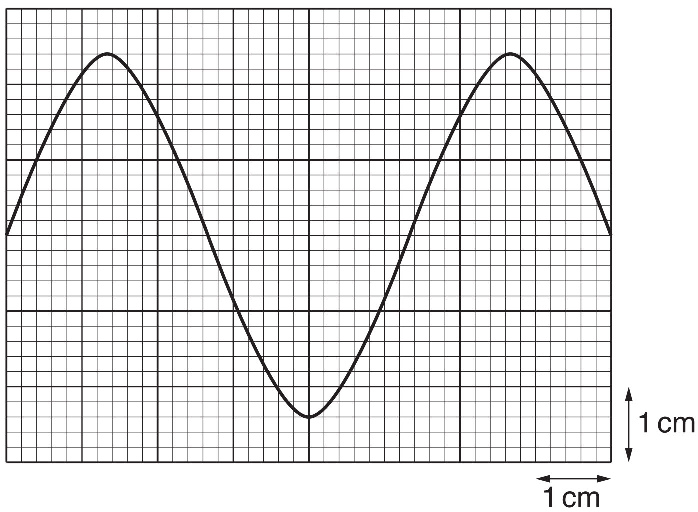

Fig. 4.1

In air, the sound wave has a speed of $330\,m\,s^{-1}$ and a wavelength of 0.18 m.

(i) Calculate the frequency of the sound wave.

frequency = ... Hz [2]

(ii) Determine the time-base setting, in $s\,cm^{-1}$, of the c.r.o.

time-base setting = ... $s\,cm^{-1}$ [2]

(iii) The intensity of the sound from the loudspeaker is now halved. The wavelength of the sound is unchanged. Assume that the amplitude of the trace is proportional to the amplitude of the sound wave.

On Fig. 4.1, sketch the new trace shown on the screen of the c.r.o. [2]

(c) The loudspeaker in **(b)** is held above a vertical tube of liquid, as shown in Fig. 4.2.

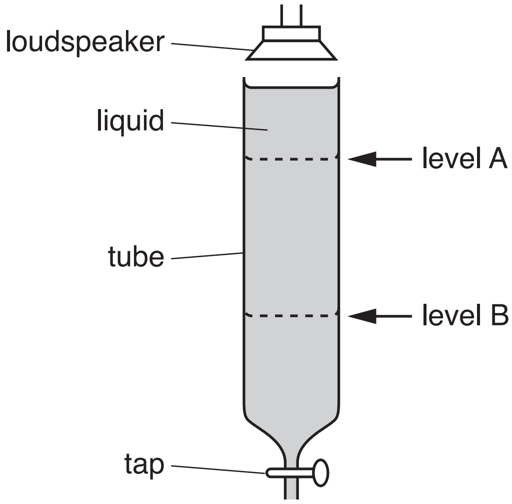

Fig. 4.2

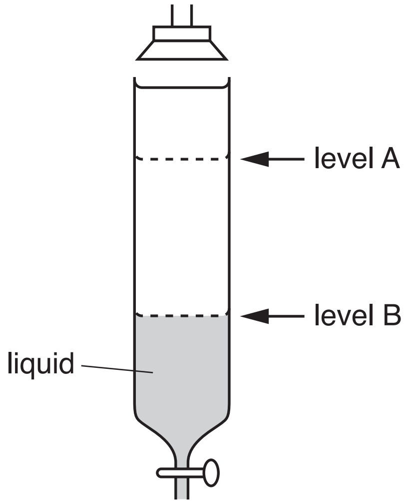

Fig. 4.3

A tap at the bottom of the tube is opened so that liquid drains out at a constant rate. The wavelength of the sound from the loudspeaker is 0.18 m. The sound that is heard first becomes much louder when the liquid surface reaches level A. The next time that the sound becomes much louder is when the liquid surface reaches level B, as shown in Fig. 4.3.

(i) Calculate the vertical distance between level A and level B.

distance = ... m [1]

(ii) **On Fig. 4.3**, label with the letter N the positions of the nodes of the stationary wave that is formed in the air column when the liquid surface is at level B. [1]

(iii) The mass of liquid leaving the tube per unit time is $6.7\,\mathrm{g\,s^{-1}}$. The tube has an internal cross-sectional area of $13\,\mathrm{cm^2}$. The density of the liquid is $0.79\,\mathrm{g\,cm^{-3}}$.

Calculate the time taken for the liquid to move from level A to level B.

time = ... s [2]

[Total: 12]