**5** **(a)** Use the definitions of speed $v$, frequency $f$ and wavelength $\lambda$ to derive the wave equation

$$v = f\lambda.$$

[2]

**(b)** A source of sound waves of frequency 236 Hz is travelling at a constant velocity of 20 m s$^{-1}$.

A stationary observer has a microphone connected to a cathode-ray oscilloscope (CRO). The microphone detects the sound waves as the source moves directly towards the observer.

The resulting trace on the CRO is shown in Fig. 5.1.

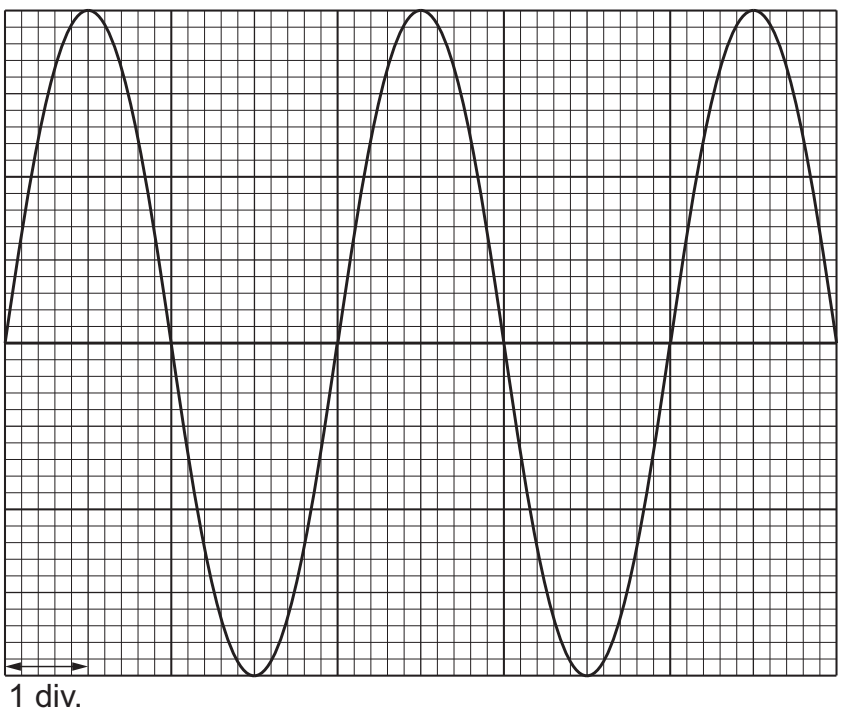


**Fig. 5.1**

The time-base on the CRO is set to 1.0 ms div$^{-1}$.

**(i)** Calculate the frequency of the sound waves detected by the microphone.

frequency = ..... Hz [2]

**(ii)** Determine the speed of the sound in air.

speed of sound = ..... m s$^{-1}$ [2]

[Total: 6]