To Measure the Speed of Sound in Air

Apparatus

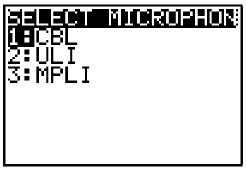
A tube around 1 m long, microphone (shown), cbl2, calculator, Physics application

Method

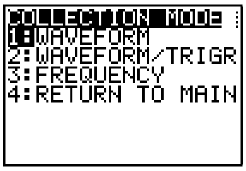
Stand the tube vertically on a hard surface. Hold the microphone close to the top of the centre of the top of the tube but not touching the tube. Set up the calculator as follows:

App Physics Enter

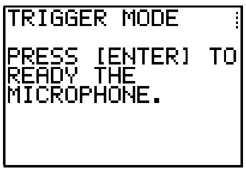
Setup probes One Microphone Enter Cbl Waveform/trigr Enter



screen 1



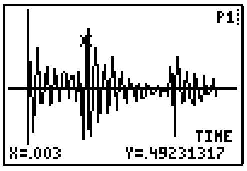
screen 2



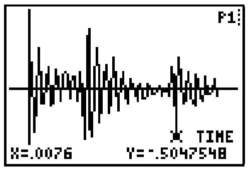
screen 3

Click fingers close to the microphone while observing the yellow LED on the cbl2. If the light flickers once when the click is made then wait for the sound graph to appear on screen. If the LED does not flicker then repeat the click. A cardboard tube of length 76.5 cm, width 8 cm and a loud clear click of fingers work well.

Results

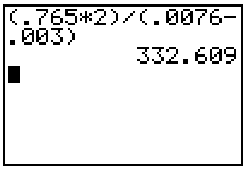


screen 4



screen 5

Screen 4 shows three peaks. The initial may have a portion missed by the sensor and so the first clearly captured peak in this case is at 0.003 s (Note X = 0.003). Sound, like a slinky spring, will reflect from both open and closed ends of the tube. When sound reflects at an open end there is an inversion of phase and so the next sound pulse, as seen in screen 5, is taken at a minimum in the amplitude plot, at X = 0.0076 s. Thus the time interval between a sound pulse and the next reflection is the difference between 0.0076 and 0.003 s. That is the time taken to travel twice the length of the tube.



screen 6

The tube in this case was 0.765 m long and so the speed of sound can be calculated as shown in screen 6.

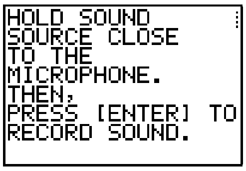
Sketch graphs (labels / units) and note summary data.

Conclusions

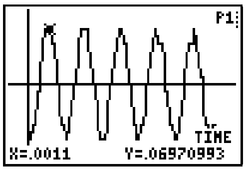
The accepted speed of sound at 0 ^{o}C is 331.5 m s^{-1}. The speed increases by 0.607 m s^{-1} for each ^{o}C rise in temperature. The temperature was 18 ^{o}C giving an expected value of 342 m s^{-1}. The value obtained, 333 m s $^{-1}$, is about 3 % less than that expected.

Options

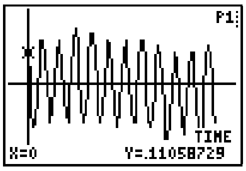
This is just a taster of some of the measurements possible in studying sound. The waveforms of sounds can be displayed by selecting Waveform rather than Waveform/trigr. This presents screen 7. Two examples of waveforms are shown in screens 8 and 9. From measurement of the time differences between crests the frequency can be measured. Different instruments give different shapes of wave and beats from two similar low frequency tuning forks can be displayed as shown in screen 10.



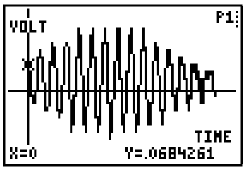
screen 7



screen 8



screen 9



screen 10

Perhaps this is one area where use of Logger pro and computer might be recommended for greater clarity in demonstration but it is important to note that even beats can be investigated by students using the cbl2 and calculators.

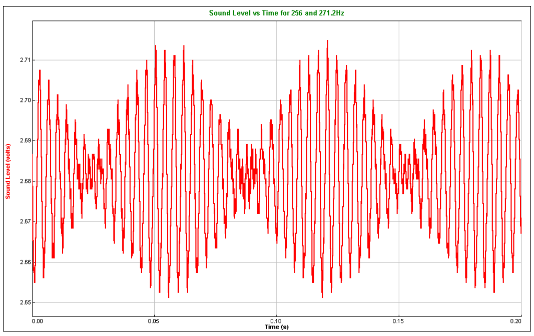


figure 1

Figure 1 shows beats from two similar tuning forks captured using the Logger pro attached to a computer.