Higher Pitched

An experiment on the Doppler Effect for the new Higher Physics qualification.

Teachers have made it clear that the new content in the forthcoming course should be supported by practical work. Here we look at an experiment on the Doppler effect that could be used in the Cosmology part of the Our Dynamic Universe unit.

For a full guide to the experiment, showing how to use the Audacity software to analyse sounds, please go to our website [1].

You will need: a computer running Audacity [2], a computer microphone and a Doppler Ball or similar [3]

Place the Doppler ball beside the microphone and switch the ball on. Record a few seconds of the sound made by the ball using Audacity. You should see something that looks like Figure 1 appear.

Select part of your recording and follow the instructions in the downloadable guide to analyse the frequency of the sound (Figure 2).

Another way to find the frequency of the sound is to zoom in on a recording like the one shown in Figure 1. Keep zooming until individual waves can be seen, then use the time scale to find the time for, say, ten waves. From this, the frequency can be found.

Now place the microphone on the floor. Swing the Doppler ball to-and-fro, so that it passes close to the microphone at its lowest point. Doppler Balls are usually whirled around the head, but we found that using one like a pendulum gave better results for this experiment. Record a few seconds of sound. Your recording should look like the one shown in Figure 3. Each time the pendulum approaches and passes the microphone, we see that the sound gets louder, then quieter. We need to show that the frequency changes too. Select one of the sound segments and zoom in on it until it looks like the image in Figure 4.

Select an area before the peak, as shown in Figure 5.

Find the frequency of the sound using the method illustrated in Figure 2. This frequency should be greater than the frequency of the sound from the stationary ball. Repeat for the sound after the peak. The frequency here should be smaller than the frequency of the ball when it was at rest. The method of finding the time for ten waves to get the new frequency was less satisfactory in the situation where the frequency had been Doppler-shifted.

Figure 6 below shows the formula for the frequency shift.

$$f = \frac{v}{(v \pm v_s)} f_s$$

Figure 1 *- A typical recording.*

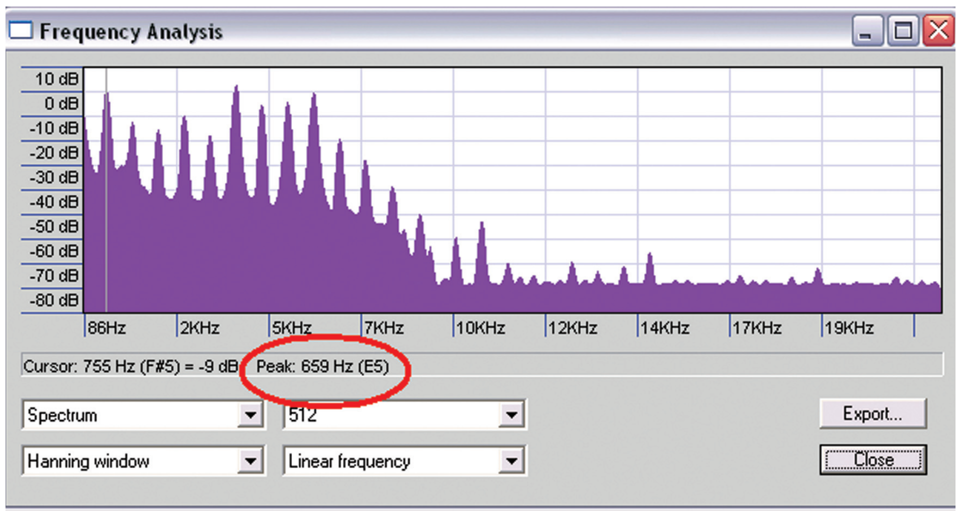

Figure 2 *- analysing the frequency of the sound.*

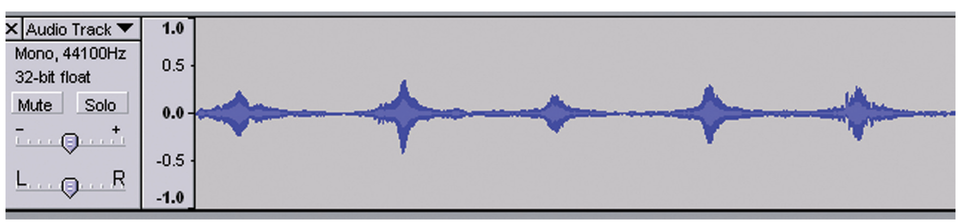

Figure 3.

Mercury in Schools

A number of issues relating to the use of mercury in schools have recently come to light and which need some clarification.

In September's School Science Review (SSR) [1] it was stated that mercury in schools is banned.

The ASE Safeguards Committee, on which SSERC is represented, has written to the SSR to assure them that it is not. Through SSERC SafetyNet [2], we advise that wherever possible you try to find an alternative but if there is none then you may continue using mercury as recommended in the Uses & Control Measures [3].

There was an incident in a Scottish school recently where a mercury thermometer fell off the wall where it was mounted and the bulb broke, spilling the mercury. Although the amount was very small it still had the potential to form concentrations of toxic vapour in the atmosphere which would be many times more than is safe. Matters were complicated by the fact that, having broken on a carpet, it was not cleaned up properly. Problems were further compounded when a school cleaner then used a vacuum cleaner. Not only did this risk spreading the mercury more widely, it meant that the vacuum cleaner had to be disposed of as well as the carpet.

We would therefore remind everyone that any mercury spillage, no matter how small, should be cleared up carefully as advised on the SSERC website [4].Furthermore, we would suggest that it is not a good idea to have mercury-containing devices mounted on walls in classrooms (or elsewhere in schools) and that any should be replaced with devices not containing mercury.

Perhaps a reason for the premature announcement in the SSR is the consultation that is taking place by ECHA (European Chemicals Agency) on behalf of European Commission regarding the banning of mercury in measuring devices within the EU. The consultation closes on 24th December but it seems almost certain that such a ban will indeed come in to force in 2014. You can view a summary of the proposals [5] or if anyone has time on their hands and wishes to read through the full proposals on the ECHA website [6].

The main impact for most schools will be on mercury usage in thermometers and barometers. There may be a delay in implementation of the regulations for these devices but, even if not, there are no plans to force establishments to dispose of mercury containing devices they already possess. It will merely be impossible to buy new ones.

References

[1] School Science Review, *Faraday's rotating wire – the homopolar motor: time to update?* by Geoff Auty, September 2010, Vol.92, No. 338, p116.
[2] http://tinyurl.com/HazChem-mercury
[3] http://tinyurl.com/HazChem-UCM-mercury
[4] http://tinyurl.com/HazChem-spillage-mercury
[5] http://echa.europa.eu/doc/restrictions/info_note_hg_in_measuring_devices_en.pdf
[6] http://echa.europa.eu/doc/restrictions/annex_xv_restriction_report_mercury_en.pdf

---

Figure 6 – Doppler Effect formula

Where:

f is the observed frequency
v is the speed of sound
v_s is the speed of the sound source
f_s is the frequency of sound emitted by the Doppler Ball.

This can be used to estimate the speed of the ball as it approached the microphone. Other methods can be used to verify this speed, for example conservation of energy.

Note that a Doppler Ball gives out a fairly pure tone. We have yet to try this experiment with a buzzer unit but suspect that the tone produced might be too messy to use.

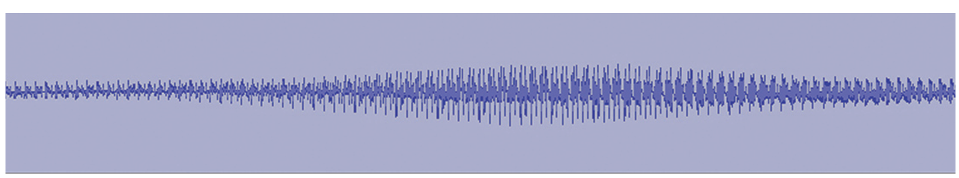

Figure 4.

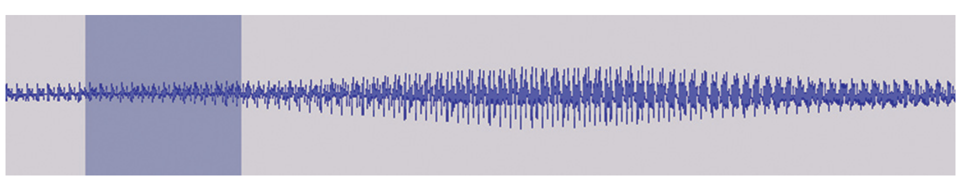

Figure 5.

References

[1] http://tinyurl.com/Higher-Pitched
[2] http://www.sserc.org.uk/members/SafetyNet/bulls/218/Audacity_intro.htm
[3] Lascells Doppler Ball, available from Timstar, product code SO76360, Instruments Direct, product code PH103240 - http://www.inds.co.uk/physics/doppler_ball.htm