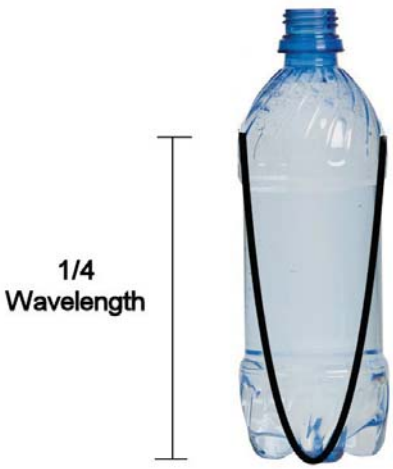
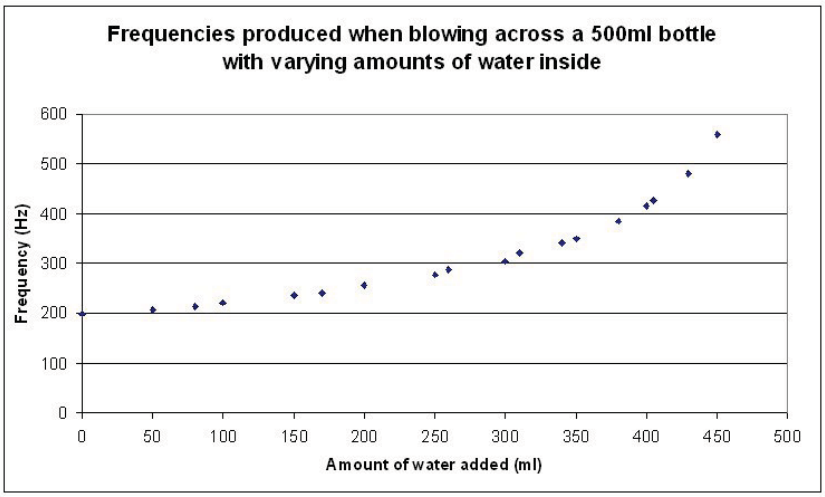
Resonance - Teacher Resource

Musical Bottles

After visting Lab in a Lorry the students should know that sound is produced by vibrations and the number of vibrations per second is called the frequency. In this follow-up activity the students can investigate the frequency of a note produced by blowing over a bottle.

Activity 1	Setup Guide and Information
Investigating Frequency Equipment: 500ml Bottle Measuring Cylinder Computer with Spectrogram Software. Water	First of all get the students to blow over the neck of the bottle. Does it make a sound? If not try changing the angle until a note can be heard. At this point the air inside the bottle is resonating to produce the sound. Using the Spectrogram software it is possible to measure the frequency of the note produced. An empty 500ml Coke bottle should produce a note with a frequency around 200Hz. Students can investigate the relationship between the amount of water added to a bottle and the frequency of the note produced. A general rule is that the more water in the bottle, the higher the note. Explanation: sound is produced by vibrations. In this case the air inside the bottle is caused to vibrate which produces a sound. When more water is added the amount of air available to vibrate decreases, this has the effect of shortening the wavelength and therefore increasing the frequency (wave speed = frequency X wave length ($v=f\lambda$)) If the students have not yet covered the wave equation a simpler explanation is that "with less air inside the bottle it is easier for it to vibrate so it can vibrate faster - i.e. at a higher frequency" This activity can be run as a scientific investigation, giving the students the chance to make a prediction, measure and record results, plot a graph etc. The investigation is suitable for all age ranges from S1 up to S6. Advanced students would of course be expected to process and analyse their results, but the investigation part is identical. If time permits the students can enter their results into an Excel spreadsheet and use this to graph the results. For older students, or indeed gifted and talented you might like to use the "Graph" software (download link available on the Lab in a Lorry website). This can be used to calculate a curve of best fit. The results show a standard power relationship with the frequency being inversely proportional to the volume of air in the bottle. A graph of frequency against 1 / (volume of air) should yield a straight line - sample data included, see the spreadsheet "Bottle frequencies"





From Activity 1 it should be clear that we can produce a range of notes by using the same type of bottle and varying the amount of water inside it. In the next activity the students use what they have learnt to enable them to play a song by blowing over the bottles.

Activity 2	Setup Guide and Instructions
Making Music Equipment: 500ml Plastic Bottles Measuring Cylinders Water	Below we have recorded the amount of water necessary to produce a standard octave, starting from middle C (256 Hz on the scientific scale). We have also included the score for a couple of well known songs which require less than 8 notes. Split the class into groups based on the number of notes in the song, 6 notes = 6 groups. Assign each group a note and using the table below, get them to fill their bottles with the corresponding amount of water.You can then stand at the front and conduct whilst the students perform the song.

Producing notes using a standard 500ml Coke bottle

Note	Frequency (Hz) (scientific)	Amount of Water (ml)
C (middle)	256	200
D	288	260
E	320	310
F	341	340
G	384	380
A	426	405
B	480	430

Twinkle Twinkle Little Star

C C G G A A G F F E E D D C

G G F F E E D G G F F E E D

C C G G A A G F F E E D D C

Jingle Bells

E E E E E E E G C D E

F F F F F E E E E G G F D C

Curriculum Links

Forces, Electricity and Waves

First	Second	Fourth
By collaborating in experiments on different ways of producing sound from vibrations, I can demonstrate how to change the pitch of the sound. **SCN 1-11a**	Through research on how animals communicate, I can explain how sound vibrations are carried by waves through air, water and other media. **SCN 2-11a**	By recording and analysing sound signals, I can describe how they can be manipulated and used in sound engineering. **SCN 4-11a**

Experiences and Outcomes

- develop curiosity and understanding of the physical world
- demonstrate a secure knowledge and understanding of sound and vibration
- develop skills for learning, life and work
- develop skills in the accurate use of scientific language, formulae and equations
- apply safety measures and take necessary actions to control risk and hazards
- recognise the impact the sciences make on our lives, the environment and on society
- recognise the role of creativity and inventiveness in the development of the sciences