

Resonance Quick Start Guide

What's it all about then?

This experiment is about resonance. In this experiment you will be making a wine glass vibrate at its resonant frequency.

When the glass is vibrating at its resonant frequency we will use a strobe light to see the glass flexing.

It's a great experiment which allows the students to really get to grips with the concepts of sound and resonance.

How to present this:

This is a guide suggesting how to present the experiment to the students. You do not have to follow it exactly, as long as you allow the students to explore the concepts involved. You can expand or shorten this experiment as necessary to fill the time allocated.

Remember - the emphasis here is to ensure the students interact with the equipment, try things out for themselves and above all - have 'fun'.

There is a more detailed version of this document available which provides background information on the experiment. This is available from the Operations Coordinator or from the Lab in a Lorry website: http://www.labinalorry.org.uk/volunteer_information/downloads.cfm

The kit:

- Signal generator
- Spectrum analyser software - Spectrogram
- Speaker
- Wine glasses
- Strobe light
- Retort stand and clamps
- Sound-proof box
- Slinky spring
- Ping pong ball
- Amplifier



Image of equipment

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Introduction

For the experiment there are two things the students need to be aware of. First of all they should know that sound is produced by vibrations (eg. get them to hum and feel the vibrations in their throat). Secondly, they will need to understand a bit about frequency.

Put simply - frequency is a measure of 'how often something happens'. In this case the frequency is the number of vibrations (or sound waves) every second (1 Hertz (Hz) = 1 vibration per second). If you have time, you could use a slinky spring to demonstrate different frequencies, ie 1 wave/sec or 2 waves/sec. We can also show how sound travels through the air as a longitudinal (compression) wave.

Part 1: The equipment

- 1.1 Introduce the signal generator which is connected to an amplifier and speaker.

Drop the frequency down very low and see how the speaker is very slowly moving in and out. We can't hear it because humans hear from ~25 Hz - 20,000 Hz.

Ask one of the students to change the frequency of the signal generator and listen to the noise that is produced by the speaker. When we can hear it, place the ping pong ball on the speaker to "see" the vibrations (only up to ~150 Hz)



Image of the signal generator

- 1.2 Introduce the spectrum analyser.

The spectrum analyser is a computer programme that analyses and displays the frequency of sounds received by the microphone. The display shows the frequency in Hertz.

Hum a note into the microphone and observe it on the screen. Ask the students to do the same, some may need a little encouragement.

Part 2: Singing wine glasses

- 2.1 Every object has a natural frequency that it likes to vibrate at – its resonant frequency. Introduce this by showing how to make a wine glass 'sing' by dipping your finger in some water and then rubbing it around the rim of the glass. Get all of the students to have a go. When the glass is singing it is actually vibrating at its natural (or resonant) frequency.

Ask the students about the singing glasses - do they all sound the same?

- 2.2 Use the spectrum analyser to find out what frequencies the glasses have. It may help to use the 'capture' button on the spectrum analyser which freezes the screen and lets you see the most prominent frequency.

To highlight that each glass has its own natural (or resonant) frequency (or "a note it likes to sing"), you can 'capture' the resonant frequency of a glass and then get another student to make that glass sing. The major peak will occur at the same frequency (it may be a different volume, so the peak may be taller or shorter).

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Part 3: Make a wine glass vibrate without touching it

- 3.1 Ask a student to take a wine glass and find its resonant frequency (running a finger around the glass and using the software). Place the wine glass in the sound box. (Sometimes it's quicker to have one already measured and set up).

Ask the students how we could make the wine glass vibrate without touching it and how could we tell if it was vibrating? Place a ping pong ball in the bowl of the glass, close the sound box and ask one of the students to tune the signal generator to the resonant frequency of the wine glass.

- 3.2 Once the resonant frequency is found the glass will vibrate and the ping pong ball will start to bounce around. You can emphasise at this point that the speaker is moving the air molecules at the same frequency which the glass likes to vibrate at - and in turn is making the glass vibrate and flex.

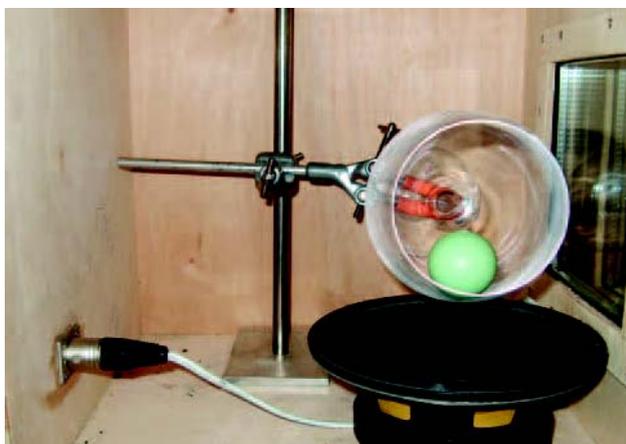


Image of a wine glass and speaker in the sound box'

Part 4: Using the stroboscope

- 4.1 To see this vibration in slow motion use the strobe light.

Please check whether anyone is sensitive to strobe lighting before using the strobe.

To explain how a strobe works, turn on the fan and ask a student to adjust the frequency of the strobe until the fan looks like it is motionless. Ask why this happens. Simply put, every time the light flashes on, we see a 'snapshot' of the fan. If the fan is always in the same place when the light is on, it will look stationary.

- 4.2 Take the ping pong ball out of the glass and make sure that the signal generator is set to the resonant frequency of the glass in the sound box. Place the stroboscope to the window in the side of the sound box and adjust the frequency of the strobe. Once the correct frequency on the strobe is achieved the glass will appear to vibrate in slow motion.
- 4.3 Ask the students how we can make the wine glass break. What is it that will make it shatter? Try increasing the amplitude and see if you can get the wine glass to break. There is a video of a breaking glass on the DVD if the glass doesn't break.

