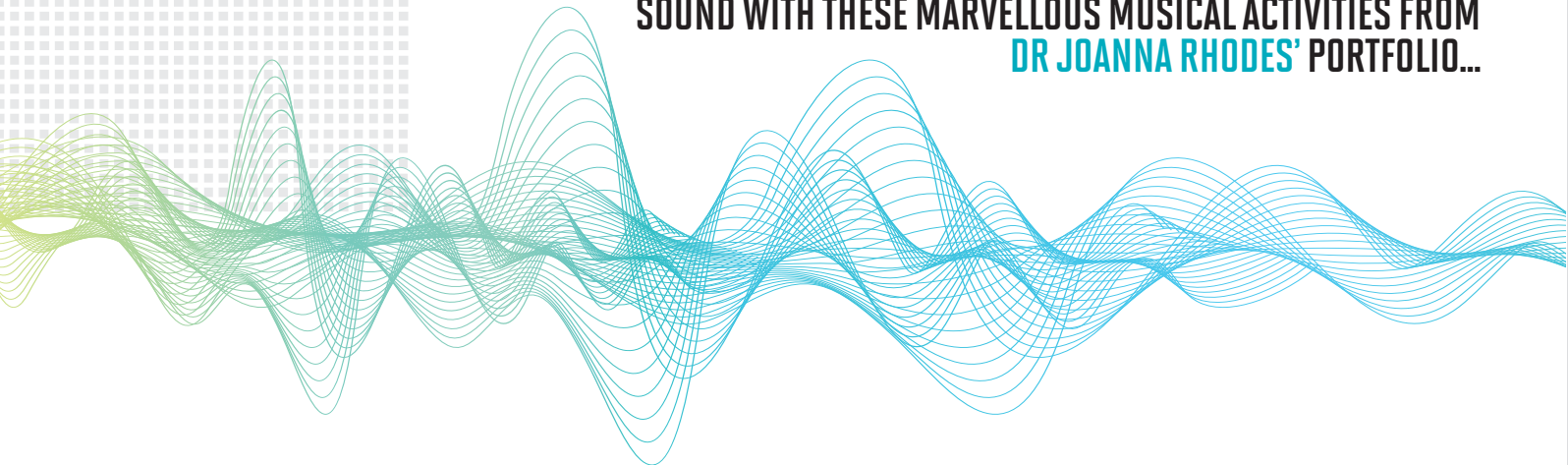


**TODAY  
YOU  
WILL...**

- > CREATE AND PLAY YOUR OWN MUSICAL INSTRUMENT
- > DEVELOP YOUR UNDERSTANDING OF THE PHYSICS OF SOUND

# RIDING THE WAVES

**MAKE SURE YOUR LEARNERS NEVER FORGET THE PHYSICS OF SOUND WITH THESE MARVELLOUS MUSICAL ACTIVITIES FROM DR JOANNA RHODES' PORTFOLIO...**



The conductor puts down his baton and the orchestra rises and takes a bow. But there is a bit of a twist in this assembly. The students are not from the music department and they have not been playing normal instruments. These are learners from a physics lesson and each one has used the physics of music to create and play his or her own musical instrument. Like characters from the hit musical *Stomp*, the students have performed an exhilarating piece of music demonstrating all the different ways we can create those unusual longitudinal waves that we call sound!

In this noisy and amusing lesson students investigate the physics of music by creating and playing their own musical instruments. You could even create an 'orchestra' to perform in assembly. The most confident students can follow up their performance with detailed descriptions of how their instruments worked including calculations of the frequencies of sound produced. Others might decorate their instruments and talk about the historical importance of music and its continued value to cultures around the world, thus developing strong cross-curricular links with music and performing arts as well as mathematics, IT and art.



## STARTER ACTIVITY

Sound waves in air (and any fluid medium) are longitudinal waves because particles of the medium through which the sound is transported vibrate parallel to the direction that the sound wave moves. This is most visually demonstrated by a slinky spring stretched out horizontally on a table. Students pull in and release the first coils of the slinky setting up vibrational motion in directions parallel to the direction that the

energy is transported [Additional Resource 1]. Students need to relate this demonstration to the production of noise and a superb and messy way to do this is to use a non-Newtonian liquid on a speaker cone. This complicated sounding experiment simply involves a corn flour paste on a vibrating bass speaker cone attached to a music player [AR2]. Students should notice that the motion of the corn flour is parallel to the vibrations of the speaker [AR3].

## HOME LEARNING

In this homework activity direct students to websites on experimental musical instruments [AR8]. They can choose an invention such as the Bowfridgeophone, Patch's chromelodion or hydraulophone [AR9] and use their physics understanding to explain how the instrument works; where the standing wave is set up and how pitch and volume is changed as the musician plays the instrument. Maybe ask students to design and draw their own experimental musical instrument that could be made from found or recycled instruments explaining how the sound will be made and controlled.

## MAIN ACTIVITIES

### 1. Let's make some noise!

Invite students to bring in real musical instruments and maybe borrow some examples from your music faculty. It is good to include examples from each set of instruments including strings, woodwind, brass and percussion. Use a microphone to change the sound wave into an alternating current and display the resulting wave on a cathode ray oscilloscope (CRO). Illustrations of what you will see can be found at [GCSEscience.com](http://GCSEscience.com) [AR4]. Ask the musicians to change the pitch (how high or low the sound is) and the volume (how loud the sound is). Students should be encouraged to observe the effect this has on the wave and to illustrate the difference in wavelength of a wave at high and low pitch and the difference in amplitude of a wave that is quiet and one that is loud. The University of Colorado has produced a superb simulation that lets you see sound waves. Adjust the frequency or volume and you can see and hear how the wave changes. Move the listener around and hear what she hears students can use to investigate the properties of sound [AR5].

### 2. Sound studio

In this activity students investigate ways of making their own musical instruments. All objects have a natural frequency or set of frequencies at which they vibrate when struck, plucked, strummed or somehow disturbed. The actual frequency is dependent upon the properties of the material the object is made of (this affects the speed of the wave) and the length of the material (this effects the wavelength of the wave). It is the goal of your student musicians to find instruments that possess the ability to vibrate with sets of frequencies that are musically sounding (i.e. mathematically related by simple whole number ratios) and to vary the lengths and properties to create the desired sounds.

Good examples include straw

oboes made by cutting the end of a straw into a triangular tip and blowing hard into it. Shortening the straw incrementally increases the pitch by shortening the wavelength. Challenge students to produce an octave of straw oboes for your orchestra. Other ideas include creating a trumpet with a hosepipe and funnel or cutting Velcro into different lengths and pulling it apart. Stretching and plucking rubber bands of different lengths are other examples that can be modified to produce and interesting instrument using ice cream, margarine tubs, milk cartons and cereal packets. Blowing over milk bottle tops with different volumes of water creates a superb flute effect but requires a bit of practice; an alternative is to strike the milk bottles with a spoon to give a glockenspiel-like effect. Other examples of musical instruments are available on Phil Tulga's website [AR6] and students can be as large and creative as they like – why not make cardboard rock guitars or ping stretched elastic against a wooden board? Encourage learners to apply their understanding of sound by using the CRO and microphone to tune their instruments to a musical scale and to record the wavelength and frequency of

## SUMMARY

Play students a clip of Landfill Harmonic – a group of Paraguayan students who have created an orchestra from trash dumped at the landfill site where they live [AR10]. Inspire your students to create and perform a short piece of music using the instruments they have created and perhaps even perform in a school assembly. Ensure that physics is the star of the show by asking students to describe and explain how their instrument works to create sounds of different pitch and volume.

each note using a useful table found here [AR7]. iPad apps such as ProTunerLite and Guitartuna and Cleartune Chromatic are free or very low cost tuning meters that use the iPad or iPhone microphone to display the frequency of the note played. Another amazing iPad app is Sound Uncovered from Exploratorium; this app features incredible auditory illusions and other acoustic phenomena. It allows students to hear with their eyes, see with their ears, make and modify recordings, and test their own hearing.

## INFORMATION CORNER

### ABOUT OUR EXPERT



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### STRETCH THEM FURTHER

Explore interesting properties of sound waves, such as resonance, with your more able students. Help them to set up experiments such as inducing vibrations in one of two mounted tuning forks of the same natural frequency [AR11] and differing sized bobs which vibrate backwards and forwards at different natural frequencies [AR12]. The operatic classic, shattering a wine glass, is demonstrated beautifully on high-speed film in a video by Salford University [AR13].

### ADDITIONAL RESOURCES

- [AR1] LONGITUDINAL SOUND WAVES  
[TINYURL.COM/TSMM1](http://TINYURL.COM/TSMM1)
- [AR2] RECIPE FOR DANCING CORN FLOUR  
[TINYURL.COM/TSMM2](http://TINYURL.COM/TSMM2)
- [AR3] CORN FLOUR 'DANCING' TO DUBSTEP  
[TINYURL.COM/TSMM3A](http://TINYURL.COM/TSMM3A) AND CORN FLOUR VIBRATIONS  
[TINYURL.COM/TSMM4](http://TINYURL.COM/TSMM4)
- [AR4] CRO DIAGRAMS OF SOUND WAVES  
[TINYURL.COM/TSMM5](http://TINYURL.COM/TSMM5)
- [AR5] PHET INTERACTIVE SIMULATION OF SOUND WAVES  
[TINYURL.COM/TSMM55](http://TINYURL.COM/TSMM55)
- [AR6] INVENTING HOMEMADE INSTRUMENTS WITH MATH AND MEASUREMENT  
[TINYURL.COM/TSMM6](http://TINYURL.COM/TSMM6)
- [AR7] TABLE OF MUSICAL NOTE FREQUENCIES AND WAVELENGTHS  
[TINYURL.COM/TSMM7](http://TINYURL.COM/TSMM7)
- [AR8] HYDRAULOPHONE DEMONSTRATION  
[TINYURL.COM/TSMM8](http://TINYURL.COM/TSMM8)
- [AR9] EXPERIMENTAL MUSICAL INSTRUMENTS  
[TINYURL.COM/TSMM9](http://TINYURL.COM/TSMM9)
- [AR10] LANDFILL HARMONIC  
[TINYURL.COM/TSMM10](http://TINYURL.COM/TSMM10)
- [AR11] RESONATING TUNING FORKS  
[TINYURL.COM/TSMM11A](http://TINYURL.COM/TSMM11A)
- [AR12] IDEERS FROM BRISTOL UNIVERSITY  
[TINYURL.COM/TSMM12](http://TINYURL.COM/TSMM12)
- [AR13] WINE GLASS SHATTERING, SALFORD UNVIERSTY  
[TINYURL.COM/TSMM13](http://TINYURL.COM/TSMM13)

