# Sound

**Hearing - A Thing of the Past**

**Primary Module**
**Years 4-7**

**Science Strand: Energy and Change**

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# Abstract

What is sound? Why do sounds differ? Why are sounds loud, soft, pleasant, unpleasant, musical or noisy? Your visit to the GDC could answer some of your questions.

Sound waves are also called acoustic waves and are also longitudinal waves – waves with particles that move (oscillate) along the same line as the waves travel**,** Sound waves can travel through solids, liquids and gases and have a wide range of frequencies.

Students at the GDC will be able to investigate producing different sounds, gain an understanding of the way sound is transmitted and look at the frequency of sound.

# Background Information

These sheets are for teachers to use prior to their visits to the GDC. They can be used as information sheets for the students to access or as general background information.

Sound is a form of energy produced by a vibration. Energy is the ability to do work and to vibrate means to move back and forth.

Many sounds give us pleasure. Almost everyone enjoys music and singing. Music is everywhere - songs of birds, hum of insects, rustle of leaves murmur of a creek.



When sound waves move through the air, the air molecules move quickly or vibrate. If there are no air molecules, no sound is made, because there is nothing to vibrate. When you shout the vocal cords in your throat vibrate. These vibrations pass through your mouth into the air, making the air itself vibrate. Your ear picks up the vibrations and you can hear them as sound.

Air is not the only medium to conduct sound. Other gases will do the same. Liquids and gases are even better conductors of sound. Whales communicate under water over huge distances.

The most common way communicate is through talking. Without sound the world would lose some of its beauty, it would be a more dangerous place and communication would be difficult and cumbersome.

Get students to imagine all the ways we communicate without talking – body language, sign language, emails, text messages, letters, etc

The loudness of sounds is measured in **decibels**. When an aeroplane lands they reach a very high number of decibels and the ground controller will wear earmuffs to stop his ears being damaged. The number of sound waves that pass by in a second gives us the **frequency** of a sound. Frequency is measured in **hertz,** which is the number of waves passing every minute. High notes have a high frequency, they make a lot of vibrations and have a high number of hertz. Low notes have a low frequency. Another word for frequency is pitch. A high pitch is a high frequency, many waves per second or many cycles per second.

We cannot hear sounds of very high or very low frequency but some animals can.

A pregnant woman can see her unborn baby through high frequency sound waves They are reflected off the skin and other surfaces of the baby and form an image on the monitor. This is called an ultra sound machine.

People guessed that sound was vibrations in the air as long ago as the days of ancient Greece, 2 500 years ago. Aristotle, the famous Greek philosopher, knew that light travels faster than sound because he could see the flash of lightening before he heard the crash of thunder. Sound travels at 344 metres a second in air.

Mersenne, early in the 17th century, tried to establish the speed of sound firstly by shouting at a wall a known distance away and working out how long the echo took to come back and by getting someone to fire a gun a set distance away and work out how long after he saw the flash that he heard the bang. He believed that light and sound travelled through the air like waves. He deduced that neither light nor sound can pass through a vacuum where there is no air to transmit them. He was wrong about light, but he was right about sound.

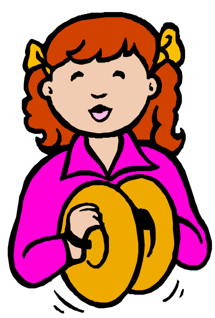
An experiment by Robert Boyle in the 1600's using a loudly ticking watch in a glass globe proved that sound needed air to transmit. As he slowly pumped air out of the globe the ticking grew fainter and as he filled it up with air again the ticking grew louder.

In 1740 Brianconi showed that sound travels faster through warm air. Through solids and liquids sound moves much faster. High pitched and low pitched sounds travel at the same speed.

The Doppler Effect, named after Austrian physicist Christian Doppler, is the effect you hear from a speeding police car or ambulance as it approaches you the pitch is higher, it suddenly drops to a lower pitch as it passes you and speeds away. . There is no change in pitch produced by the siren it is just the sound waves get squashed up as they go into the air.

Lots of objects like pianos, buckets and drums have their own special frequencies at which they naturally vibrate. The particular sound of, say a wine glass compared with a rubbish bin – easy to distinguish- is because of the particular set of frequencies that they vibrate at. A loud speaker is forced to vibrate by electric currents, so it can make any sound and therefore reproduce sounds faithfully. Big things usually vibrate more slowly.

Their natural frequencies are lower. That is why a double bass is so much bigger than a violin. All sounds are created by something vibrating, and the sounds made by a musical instrument are no exception. The vibrations of musical instruments are designed to be very pure and precise. In instruments like the piano the frequencies are tuned to the notes of the musical scale. It is the purity and regularity of vibrations that distinguish music from noise



# PRE VISIT ACTIVITIES

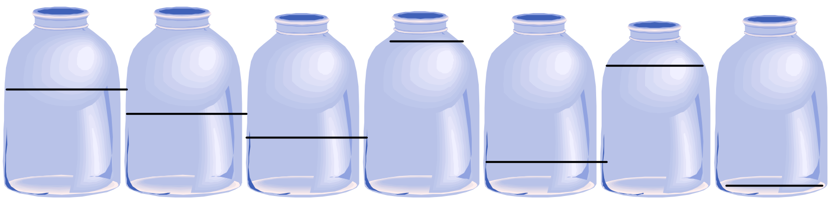
These sheets are for teacher use prior to their visit to the GDC. They can be used for students to access information or as general background information

## 1. Singing Bottles

Arrange several bottles of the same size in a row. Leave the first one empty and put a small amount of water in the next one. Add increasing amounts of water to the bottles until you get to the end of the row. (See diagram below). The last bottle will be nearly full. Lightly tap the bottles with a spoon or blow across the tops. Discuss with students what they hear.

As the student taps the bottle or blows across the top the air inside the bottle vibrates. As there is a different amount of air in each bottle, so each bottle will make a different sound.

Alternatively, have students investigate how to produce different sounds from the bottles – see worksheet.



## 2. How far away is it?

During a storm you will often see lightening before you hear thunder. When lightening flashes it releases a great amount of heat. This warms the air, which expands with a small explosion that we call thunder. We see the flash of lightening almost immediately but the sound waves from the thunder take longer to reach our ears. When you see lightening, count the number of seconds before you hear the thunder. Divide the number of seconds by three and this will give you the amount of kilometres away the storm is.

### 3. Seeing is believing

You will not be able to see sound waves in the air but you see the effects of the waves.

The following demonstration will show that sound is a vibration.

1. Take an ice cream container and cover it with a piece of plastic to make a drum. Wrap tape around the container or use an elastic band to keep the plastic taut.

2. Sprinkle some coloured sugar or hundreds and thousands on top of the plastic.

3. Hold a metal cake tin or baking dish above the drum and bang with a wooden baton or spoon.
   The sugar or hundreds and thousands should dance up and down.
   When the tin is banged the metal continues to vibrate for a few seconds. This makes the air vibrate too. When the vibrations hit the plastic they set off the vibrations and the sugar/hundreds and thousands dance up and down.

### 4. Make a ripple tank

You will need: a flat tray or baking dish; a long thin strip of plastic or metal; an eye dropper; water, coloured ink or food colouring.

Method:

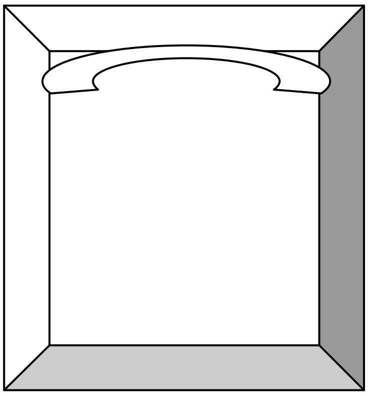
1. Fill the tray with water mixed with ink or food colouring.

2. Bend the strip of plastic or metal to fit across the tray as shown in diagram.

3. Drop water from the eye dropper as evenly as possible into the centre of the curved plastic.

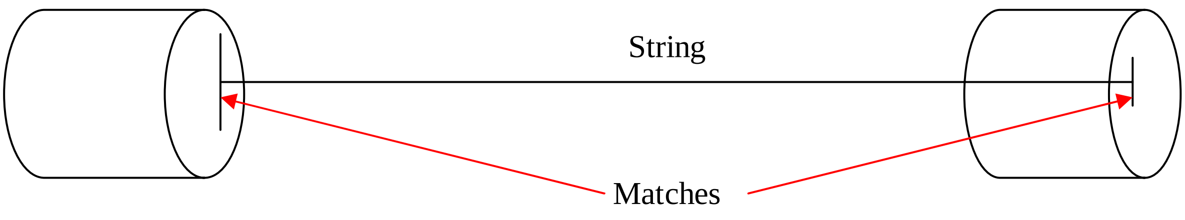
4. Watch the ripples.

   Sound waves radiate from their source in circles. A curved surface of the right shape will deflect the waves in a straight line so that they reach everywhere along the line at the same time. Sometimes stages are built like this so that this effect is created. You saw this effect in the water.



**5. Make your own telephone**

Get two paper cups and make a hole in the bottom of each cup. Pass a piece of string through both holes and tie a matchstick to each end of the string to the bottom of the cup. Find a partner and pull the string so it is taut. Now speak softly into the cup. Your voice will pass along the string to your partner's ear.



# SINGING BOTTLES

There are many objects that produce sounds. Using the sheets below plan and carry out your investigation.

1. The Problem: What factors affect the sound that can be produced by the glass jars?

2. Background Knowledge: What do you already know about the sounds produced by glass jars that might be useful?

3. Can you predict what might happen if you experimented with the sounds made by glass jars?

4. Method: What method will you use to test your predictions? Sketch the method below and list the equipment and apparatus you will need.

5. How did you make it fair test?

6. Results:

7. Explain your results:

8. Conclusion

Seeing is Believing

1. What are you trying to find out?
*That sound is caused by a vibration*

2. What do you think will happen?

3. What did you observe?

4. Why did it happen?

Make a Ripple Tank

1. What will I investigate?

2. What do I think will happen?

3. Why do I think this will happen?

4. What am I going to do?

5. What happened?

6. Why did it happen?

7. How could I improve this investigation?

**These sheets are for teachers to use for assessment purposes**

**Overarching Learning Outcomes**

**Curriculum Framework:**
The following Student Outcome Statements will enable teachers to have a clear picture about the achievements required of students to demonstrate an outcome.
Students typically in Years 4-7 will be performing at Levels 2-4. The following examples demonstrate outcomes for Level 3.

**Investigating Scientifically:**

**Planning:** Plans for investigations, showing some awareness for the need of fair testing; makes simple predictions based on personal experience.

**Conducting:** Uses simple equipment in a consistent manner; records data in simple tables, diagrams and graphs.

**Processing Data:** Displays numerical data as tables or bar graphs, identifies patterns in data and summarises the data.

**Evaluating:** Identifies difficulties experienced in conducting the evaluation.

**Energy and Change:**
Understands some patterns of energy use and some types of energy transfer.

**Progress Maps:**
The following grid will enable teachers to have a clear picture about the achievements required of students to demonstrate an outcome in the Science Learning Area. Typically students in Years 4-7 will perform at Levels 2-4.

**Investigating Scientifically:**
Students investigate to answer questions about the natural and technological world, using reflection and analysis to prepare a plan; to collect and interpret data; to communicate conclusions; to evaluate their plan, procedure and findings.

| | **Level 2**<br>**When given a focus question & a familiar situation, contributes elementary ideas about variables & procedures, collects & makes limited records of data & can say whether what happened was expected.** | **Level 3**<br>**Shows some awareness of the need for fair testing & makes simple predictions, collects & organises numerical data & descriptive information using simple tables, diagrams & graphs; identifies main features, patterns & difficulties in the investigation** | **Level 4**<br>**Plans & conducts different types of investigations, taking account of the main variables; collects data using repeat trials or replicates, explains patterns in data & information prepared in different formats ; makes general suggestions for improving the investigation** |
|---|---|---|---|
| **Planning:** Plan investigations to test ideas about sound | Identifies when given a focus question some of the variables to be considered | Plans for investigations on sound, shows awareness of fair testing, makes simple predictions based on personal experience. | Identifies variables to be changed, the variables to be measured and at least one variable to be controlled |
| **Conducting:** collect and record a variety of information relevant to their investigation on sound | Observes, classifies, describes and makes simple non-standard measurements and limited records of data | Uses simple equipment in a consistent manner, records data in simple tables, diagrams or observations | Uses equipment appropriately; recognises the need for safety equipment and precautions; takes care with data collection to ensure accuracy |
| **Processing data:** translate and analyse information to find patterns and draw conclusions to extend their findings | Makes comparisons between objects and events observed | Displays numerical data as tables, bar graphs and identifies patterns in data, summarises data | Calculates averages from repeated trials; plots data as line graphs where appropriate; makes conclusions which summarise and explain patterns in data. |
| **Evaluating data:** reflect on an investigation, evaluate the process, generate ideas | Comments on what happened; determines if what happened was expected | Identifies difficulties experienced in conducting the experiment | Makes suggestions for improving the investigation |

**Energy and Change:**
Students understand the scientific concept of energy and explain that energy is vital to our existence and to the quality of our lives.

| | **Level 2** Understands ways that energy is transferred and that people use different types of energy for different purposes | **Level 3** Understands patterns of energy use and some types of energy transfer | **Level 4** Understands that energy interacts differently with different substances and this can affect the use and transfer of energy |
|---|---|---|---|
| **Students understand the scientific concepts of energy, give examples of energy sources and describe patterns of energy use around the home and in the community** | Students can: describe how another person uses energy in their daily life and list common types of energy | Students can: describe a pattern of energy use at home or school; classify objects as sources or receivers of energy | Students can: compare different sources of energy in terms of their ease of use, cost and effects on living things and the environment |
| **Students understand that energy can be converted from one form into another, and that change involves the transfer of energy** | Students can describe a way that energy is transferred and understand that energy moves from one thing to another | Students can: relate the transfer of energy to the carrier and the intended use of that energy | Students can: compare different ways of enabling or impeding the transfer of energy and how different forms of energy transform in different materials |

**Activities on Site**

**Task:** To gain an understanding of the way sound is transmitted and to look at the frequency of sound.

**Materials:** Work sheet, long spring, long pipe, timer, digital camera, metal clicker, wooden blocks, tape measure.

**Concepts:** The longitudinal nature of sound waves, pitch, tone, frequency and resonance, the nature of echoes.

**Procedure:**

**Introduction:** Students work with the Know/Wonder/Learned worksheet. Students can write down what they already know about sound and what they would like to know. At the end of the session they will return to Learned section and complete it.

**Task One**

1. Students predict what will happen if you jiggle the long wire.
2. Students read the introduction on their work sheet.
3. Discuss periodic motion (motion which repeats itself at regular intervals), a cycle (the movement between a point during a motion and the same point where the motion repeats), a period (the time taken to complete one cycle of a motion), frequency (the number of cycles of a particular motion in one second), wavelength (the distance between two successive points at the same position).
4. Explain to students they will make waves and measure the frequency and wavelength they have created.
5. Discuss frequency
6. Students can experiment jiggling the long wire at regular or irregular intervals. Waves can be counted as they pass the student.
7. Repeat the jiggling at time intervals selected by the student.
8. Write observations and the frequency on worksheet.

**Task Two**

1. Students predict how long it will take sound to travel down the pipe.
2. Students guess the length of the pipe.
3. Suggestion for the investigation follows below:
   - Select two students to stand at each end of the long pipe.

- At a given signal a student at one end of the pipe gives a loud shout - another student presses the stop watch. When the student at the other end of the pipe hears the shout he raises his hand. Students record time on worksheet.
- Discuss with students the speed of sound and how they could work it out from the data collected.

**Task Three**

1. Discuss with students the speed of sound. Students predict and enter their prediction of how fast sound travels on their worksheet.
2. Students assemble outside the GDC. One student keeps a steady beat with wooden blocks as the rest of the group listen for an echo off the building. Now set the beat at say 2 beats per second.
3. Students walk away from the building until the echo is heard at the same time as the next clap.
4. Students measure the distance from the building using the tape measure. This is exactly half the distance that sound travels in one second.
5. Students discuss in their group what they think an echo is and enter ideas on worksheet.

**Task Four: Echoes in the ripple tank**

In the solar ripple tank observe the water waves reflecting from the end of the tank. Have you ever seen ocean waves reflecting off a groyne or rock face?

**Task Five: Aeolian Harp**

Listen to the mysterious sounds of the universe. Do you know what is making these sounds?

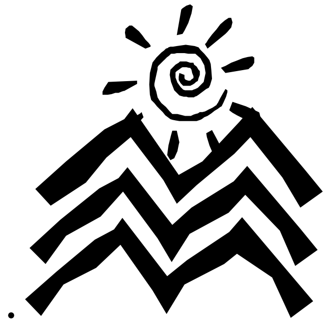
**Task Six: Spring Pendulum**

Allow the spring to oscillate freely. Can you make it go any faster? What pattern does the spring make in its movement?

**Task Seven: Parametric Pendulum**

This pendulum is driven by the turning of a handle. Time the turning of the handle with the swing of the pendulum. The natural oscillation of the pendulum can be matched by your turning of the handle and as a result the swing of the pendulum will increase. You can also decrease the swing of the pendulum by turning the handle at the correct time.

Sound waves are not like waves in the sea. Waves in the sea go up and down, with crests and troughs moving across the surface. Such waves are called transverse waves.



Sound waves are called longitudinal waves. They move by alternatively squeezing and stretching like a spring.

Important words for discussing waves

Motion which repeats itself is called Periodic Motion. Some periodic motion can be described as waves. A wave repeats its motion in distance as well as time. The wave length is the length of one wave.

- A cycle is the smallest complete unit of motion that repeats.
- Period is the time it takes to complete one cycle.
- Frequency is the number of cycles that happen in a given period of time.

1. Write down what you already know about sound in a sentence.

2. Write questions about what you would like to find out about sound in the Wonder column and fill in note form what you already know in the Know column.

| Know | Wonder | Learned |
| --- | --- | --- |
| | | |
| | | |
| | | |
| | | |
| | | |

Task One – The Long Wire

1. What are you going to investigate?

2. **Predict** what will happen to the long wire if you jiggle it?

3. How will you make your investigation with the long wire a fair test a fair test?

4. Which variables are you going to:
   a) Change?

   b) Measure

   c) Keep the same?

5. What equipment will you need?

6. What happened? Describe your observations and record your results. Draw a diagram of the wave that you produced as it passed down the wire.

7. Could you use the grid below to collate your results?

| Attempt | Time (sec) | Frequency |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

Could your results be represented as a graph?

8. What do your results tell you?

9. Are there any patterns or trends in your results?

10. Explain your results?

## TASK TWO – THE LONG PIPE

1. What is your task?

2. Prediction:

3. Estimate the length of the pipe?

4. What will you do? What equipment do you need?

5. What will you measure?

6. Describe the method you will use to carry out the activity.

7. Draw up a suitable table for showing your results.

8. Explanation of results:

9. Conclusion:

**<u>Task Three – Wooden Blocks</u>**

1. From the previous activity you know speed travels at:

2. The distance from the building to our group was:

3. I think an echo is:

4. Return now to your Know, Wonder and Learned sheet and fill in the Learned section.

**Task Four : Echoes in the ripple tank**

Lay on the floor in the theatre & look up at the solar ripple tank. Observe the water waves reflecting from the end of the tank.

1. What do these waves remind you of?

2. How long does it take for one wave to travel from one end of the tank to the other?

3. Watch as the speed increases. What happens to the waves?

4. Can you draw the wave pattern?

**Task Five: Aeolian Harp**

1. Listen to the sounds from the harp. What do you think creating this sound?

2. What can you do to make different sounds?

**Task Six: Spring Pendulum**

Allow the spring to oscillate freely.

1. Can you make it go any faster?

2. What pattern does the spring make in its movement? Draw the pattern below.

3. Can you make a different pattern with the pendulum bob?

**Task Seven: Parametric Pendulum**

This pendulum is driven by the turning of a handle.

1. Time the turning of the handle with the swing of the pendulum. The natural oscillation of the pendulum can be matched by your turning of the handle and as a result the swing of the pendulum will increase. Can you explain how you increased the pendulum's swing (amplitude)?

2. You can also decrease the swing of the pendulum by turning the handle at the correct time. Can you explain how you decreased the pendulum's amplitude?

Reflection :

1. How accurate were your predictions?

2. Why do you think the title of this activity is 'Hearing - a Thing of the Past?'

3. Some sounds are said to be 'supersonic' or 'ultrasonic'.
   When you get back to school find out what the words above mean.

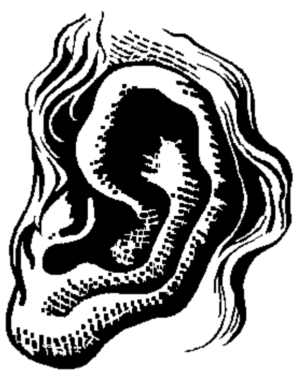
4. What do you think the word part ‘sonic’ might mean?

Post Visit Activities

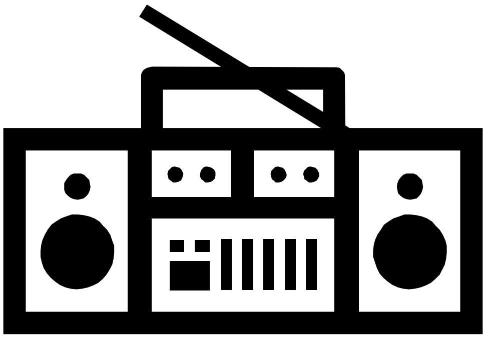
Following the visit to the GDC the following activities will consolidate understandings about sound.

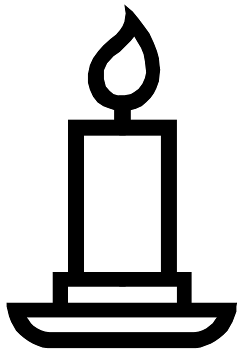
1. **Sonic Words:** Students to use Internet, dictionaries to find other 'sonic' words. Discuss supersonic, ultrasonic. Are there any other 'sonic' words?

2. **Shapes of ears**: The shape of ears are important. Discuss the shape of ears with the class. Experiment with sound by listening to short sounds - teacher clapping with students having one ear closed with their hand. Could students detect the direction the clapping came from? Look at animals' ears, where they are on the head, whether they lie down or stand up. Have students cover their eyes while you hide a ticking clock in the room. Get them to cover one ear and select a few students at a time to locate the clock.

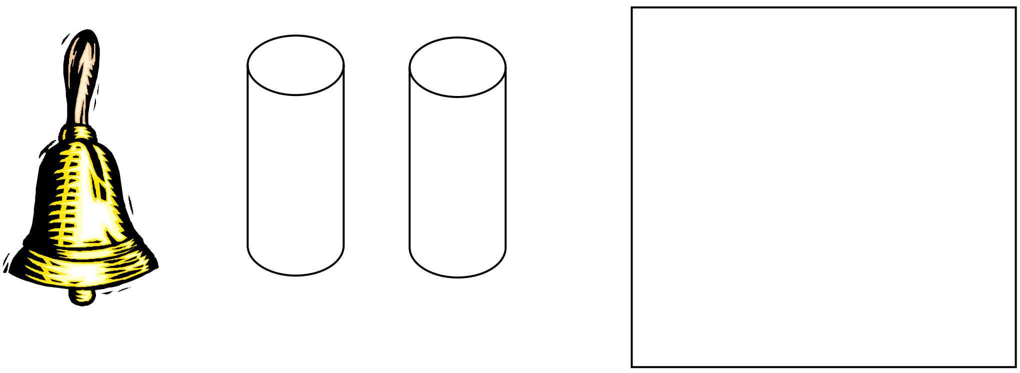




4. **Sound makes candles flicker:** For this activity you will need different styles of music on cassette or CD player, a candle, matches and a cassette or CD player with speakers. To seethe vibrations made by the speakers, light the candle and place the flame in front of the speaker. Watch the flame flicker as the sound is produced. Students observe while different styles of music, different volumes are used. Do the different styles of music affect the flickering of the candle?





5. **Bouncing Sound:** for this activity you will need: two large cardboard cylinders, a small bell, a board about 45cm square. One students holds the board upright on a desk and place the cylinders at 45° angles to the board as in the diagram. Leave a gap of about 5 cm between the board and the end of the cylinders. Ring the bell softly at the outer end of one of the cylinders and ask a student to listen at the other end. The sound of the bell travels along the tube, is reflected from the board into the other tube.



6. **Detecting Sound Vibrations:** For this activity you will need: a tin can, a piece of rubber from a broken balloon, a piece of mirror, a torch.

   Cut both ends out of the can. Cover one of the open ends with the balloon rubber. Glue a piece of mirror to the outside of the balloon about an inch from the centre. Place the can in a stationary position and direct a light beam at the mirror so that the reflection falls on the screen or wall. By shouting or singing into the open end of the can the light reflection on the screen will vibrate in accordance with the sound vibrations. This works even better if the light beam is a beam of sunlight reflected outside by another mirror.

7. **Garden Hose Sound Pipe:** Stretch a length of garden hose across a room or from one room to another. Speak or whistle into one end. Another student listens with the hose up to their ear. Does the loudness depend on the bends in the pipe? How softly can you speak and still be heard?