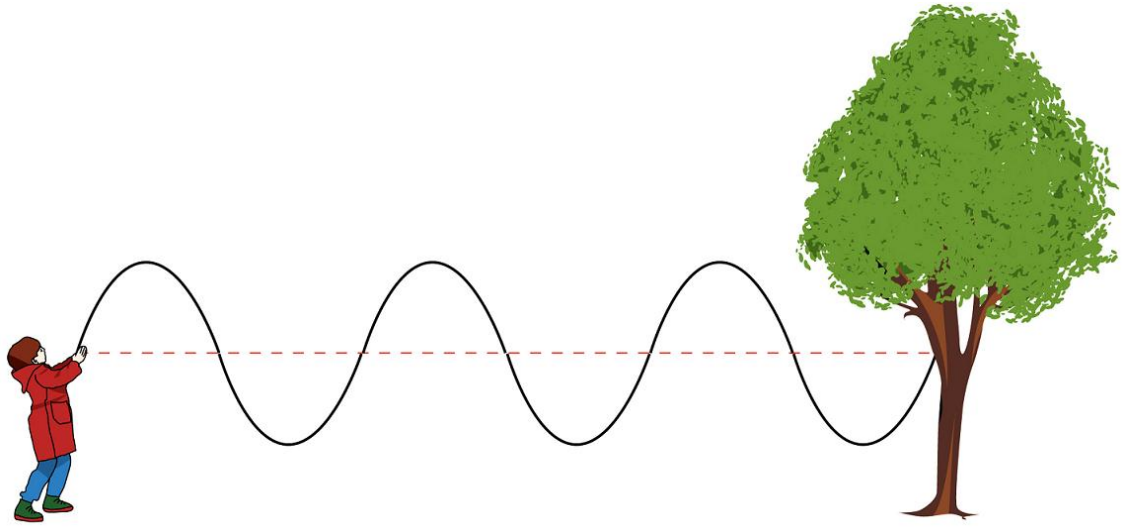
# Making Waves

## Study of Engineering Science
## (Physics & Chemistry)
## & Measurement Mathematics

(Grades 3, 4 & 5)

# LEARNING LOG



https://dr282zn36sxxg.cloudfront.net/datastreams/f-d%3A1605886967f0129c705e8f7721b4a977011fc857d0f0de93c739799b%2BIMAGE%2BIMAGE.1

**Name:** _____

# Junior Making Waves Learning Log

Copyright: Barbara J. Smith

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This document edition will be used as a pilot resource to support innovative schools. The intent of sharing this first version with students, staff and families, is so we can gather further input for future revisions of this living curriculum.

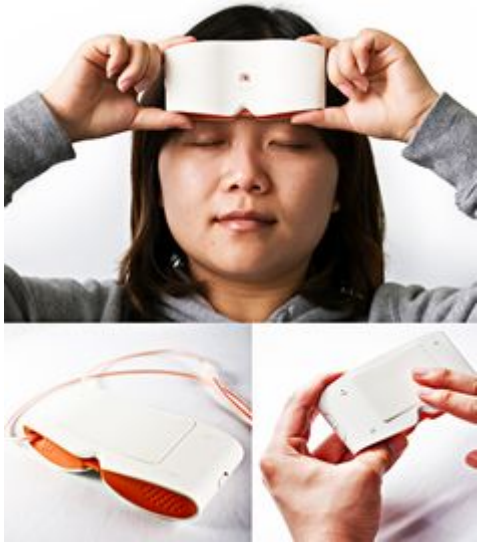
All we ask is that if you use these materials, that you give credit to the author(s) of this initial work, in your introduction.

**PURPOSE of LEARNING LOG RESOURCE:**

1. To support the Ontario Science and Mathematics Curriculum
2. To support independent and paired study during station work or during home study (holiday or at-home interest/extended homework activities)
3. To add support as an enrichment or remedial resource (students can work at their own pace)
4. To provide a learning log (evidence of learning) built in to student resources

# Table of Contents

# Making Things that Matter Challenge!



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| | |
|---|---|
| Trailblazer (Expert) | 270 - 300 points |
| Pathfinder (Apprentice) | 240-269 points |
| Rookie (Novice) | < than 240 points |

| Challenge | Maximum Points |
|---|---|
| Experiments | 30 |
| Periscope and Kaleidoscope Venn Diagram | 10 |
| Measurement Review Quiz | 60 |
| Light Quiz | 50 |
| Sound Quiz | 50 |
| KickSTARTER Reviews | 40 |
| Helping Invention | 40 |
| Learning Log Challenge (complete tasks in this booklet) | 10 |
| Classroom Work | 10 |
| TOTAL | 300 |

## Surface Check

What method do scientists use to discover things?

What are waves?

What is a light spectrum?

What makes sound?

Bonus ☺
What does a Foley Room do?

## 1. Safe Eyes and Ears


https://eyesandearsdesign.files.wordpress.com/2013/03/ee1.jpg

- What are invisible and visible things that can hurt our eyes and ears?

| How to help eyes or ears | From… |
|---|---|
| | UV Rays of sunlight |
| | Construction sites |
| | Sports |
| | Music devices |
| | Music concerts |
| | Cell phones |
| | Wi-Fi |
| | Computer screens |

- Sunglasses with UV-coating are good for our eyes.
- Why do they cost more to manufacture?
- Find out if it costs more to manufacture lenses with UV coating.

**Extension:** Email sunglass stores and ask if there are differences in retail pricing of sunglasses that have UV coating and those that do not

- https://www.quora.com/How-much-more-does-it-cost-to-coat-sunglasses-with-UV-protection

**STEP OUTSIDE:**

- Take your clipboard and a sheet of paper and do a safety audit of things that might cause harm to our eyes and ears outside.
- Share your audit findings around the campfire.
- Draw and label a safe 'roller blader' at night.

- Draw and label a safe cyclist at night.

- Draw and label a safe squash player.

- Talk with a partner and makes a list of risks when using headphones to talk on phones or listen to music.

- Share your list with another pair of students.
- Finish this sentence – Headphones are safe to use when…

_____

_____

- When do you think you should you protect your ears with earplugs?

_____

**Tool Shop Safety:**

- In Science class we like to make things with tools.
- With a partner, create a skit about how we can safely make things in a tool shop.
- Be sure to speak about how to protect our eyes and ears!


http://slideplayer.com/slide/3716895/13/images/3/Shop+Hazards+-+General+Hazards+to+the+eyes.jpg

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |


- Sign the following STEM Safety Contract:

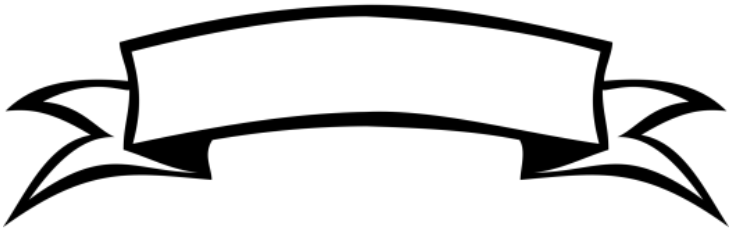
## STEM Safety Contract

1. Follow the teacher's instructions carefully. Ask questions if you do not understand what to do.
2. Do not taste, eat, drink, or inhale anything used in STEM activities unless the teacher tells you to do so.
3. Keep your hands away from your face, eyes, and mouth during STEM activities. Wash your hands after STEM activities.
4. Always wear goggles when chemicals, glass, or heat are being used and when there is a risk of eye injury from flying objects.
5. Tell the teacher if you see something/someone being unsafe.
6. Notify the teacher immediately if you have an accident or an injury.

I have reviewed these safety rules with my teacher.

_____ _____
Student's Signature Date

_____ _____
Teacher's Signature Date



# Light Waves

## 2. Lighting and Lumens

- Think about a person who returns home from work after dark.
- What are the advantages and disadvantages of street lights.

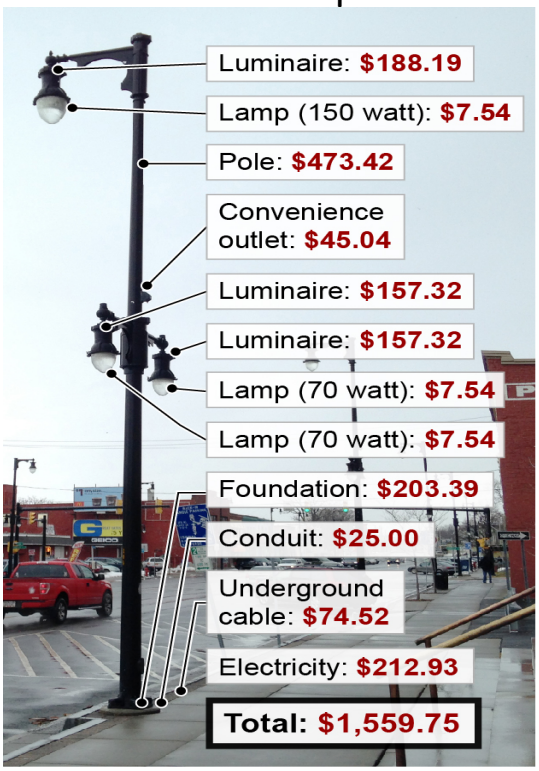
| Advantages | Disadvantages |
|---|---|
| | |

- If you are stuck use the clues below to help fill in the chart:

**Clues:** Streetlights:

- increase visibility.
- make areas safer for people to be out at night.
- use electrical energy.
- add to light pollution that makes it difficult to see the night sky.
- can harm birds when their vision is blurred (can fly into buildings)
- are expensive to put in place and maintain.
- Help us drive safely at night

- Look at the cost of the different parts of a Syracuse streetlight:




http://media.syracuse.com/graphics_impact/images/2015/04/10/street_lamp_cost2-01.jpg

## STEP OUTSIDE:

- Let's see how many lights are on the roads near our school.
- How do our street lights compare to the one in Syracuse?
- Talk about whether you think there should be more, less or the same number of lights in our rural area.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

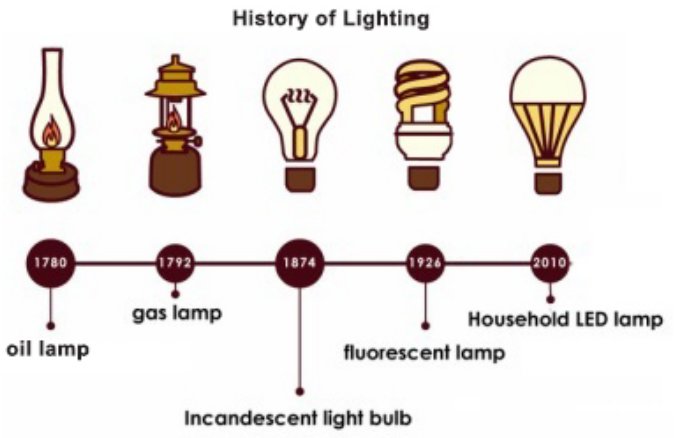
**Extension:** Where is Syracuse?
(Check out an atlas and guess which Syracuse this picture came from)

**LED Lighting**

- stands for 'Light Emitting Diodes'.
- tiny bulbs that do not have a filament that will burn out
- bulbs do not get hot like regular bulbs do
- bulbs have different shapes
- part of atoms (not seen by the visible eye) move around.
- last longer than regular bulbs by thousands of hours.
- bulbs are more expensive
- do not attract bugs
- can buy LEDs based on color and temperature (warmer yellow light or cooler white light)
- can have flat screen TV's, as tiny bulbs are not as large
- better lighting to see temperatures and clocks for cooking, and in laundry rooms for seeing many options for washing and drying.
- Lighting manufacturers have tried to make LED bulbs look like regular bulbs by having a screw-in connector.

Halogen bulb (incandescent bulb) – measured at 327 degrees
Cree LED - measured at 107 degrees
Philips Par38 CFL – measured at 167 degrees.

http://www.samudraled.com/images/efficancy/efficacy_1.png

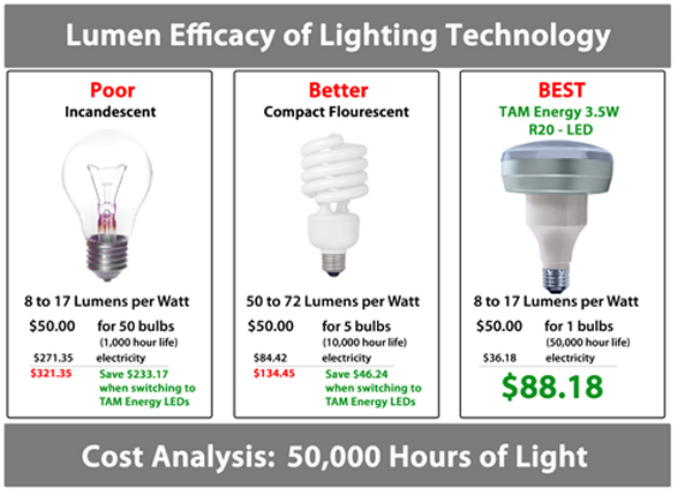



## TECH CHECK:

- http://americanhistory.si.edu/lighting/index.htm

**Measuring Light -** LED users are moving beyond the traditional unit of watts as the measurement for light bulbs. The 60 and 75-watt light bulbs are being replaced by 'lumens'.

Conversion of watts to 'lumens':
A 60-watt bulb gives off at least 800 lumens.




http://www.tamenergy.com/FILES/img/lumen-efficacy.jpg

**Extension:**

- So what are Compact Fluorescent bulbs?
- Read the following article with a classmate to find out more about CFL's

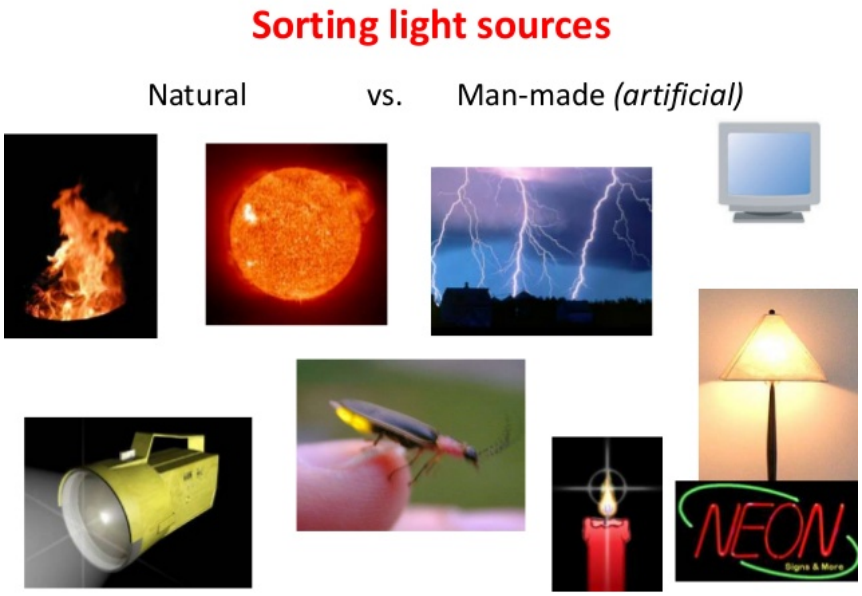
**Are Compact Fluorescent Light Bulbs Good for the Environment?**
Published November 08, 2007 (Fox News) (adapted from http://www.foxnews.com/story/2007/11/08/are-compact-fluorescent-light-bulbs-good-for-environment.html). Almost every news story about global warming recommends that consumers switch from incandescent light bulbs to more efficient compact fluorescent light bulbs (CFLs). But are CFLs really that good for the environment? Incandescent light bulbs use electricity to heat a filament that produced light. Yet 90 percent of the energy used is wasted as heat, according to General Electric's Web site. Compact fluorescent light bulbs use electricity to excite gas within a glass tube. Because CFL bulbs do not use as much heat…, less energy is spent to create an equivalent amount of light…This decreased demand for electricity reduces the need for electrical generation, which environmentalists point out reduces emissions from coal-fired plants.

In February, Australia announced a nationwide ban on incandescent bulbs, which will go into effect in 2010. The country's environment minister said the move will cut greenhouse-gas emissions by 800,000 tons by 2012 (Reuters). But this assumes that Australians will significantly reduce their current levels of electrical consumption… Manufacturers promote the savings to consumers in reduced electrical costs over the lifetime of the CFL bulb…CFL makers claim the bulbs have lifetimes of 10,000 hours each, whereas most equivalent 60-watt incandescent bulbs last 1,000 hours.

But what about any drawbacks to CFLs? CFLs don't operate well in frigid conditions, limiting their use for exterior lighting in cold areas. According to a spokeswoman from Philips Lighting, most CFLs require a minimum starting temperature of minus 20 degrees Fahrenheit; below that, it's difficult for the bulb's reaction process to begin. Other problems in cold temps include reduced light output and a pinkish glow, rather than the desirable "soft white" (actually faintly yellow) color. The bigger problem with CFLs is their mercury content. Along with the phosphor, which can be one or many of several chemical compounds, mercury helps shift the invisible UV light into the visible part of the spectrum. The National Electrical Manufacturers Association, or NEMA, suggests that CFLs of 25 watts or less — the equivalent of a 100-watt incandescent bulb — contain no more than 5 milligrams of mercury, the size of the tip of a ballpoint pen. Both CFL manufacturers and the Environmental Protection Agency recommend recycling CFL bulbs, since breaking or incinerating them releases mercury into the air. The poisonous metal can then find its way into soil, water, fish and fish-eating humans. So handle with care, lest you end up like Brandy Bridges of Prospect, Maine, who broke a CFL bulb in her daughter's room in March and was told that professional environmental cleaning would cost about $2,000.

## 3. Sources of Light

- Look at the image below to view many different examples of light sources:




https://image.slidesharecdn.com/psttilight-daynight-140304011211-phpapp01/95/pstti-light-day-night-8-638.jpg?cb=1393895573

- Complete the table and list images that are natural or man-made:

| Natural | Man-Made (artificial) |
|---|---|
| | |

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

- How Do **Fireworks** Make Light?
  There are two sources of light in fireworks:

(a) Incandescence, produced when material is heated to very high temperatures. (The 'fire' in fireworks. Reds, oranges, yellows, and whites are the most common colors in fireworks.)
(b) Atomic and/or molecular movement. Different molecules will release different colors of light after they are excited by the heat energy in fireworks. (molecules: sodium for yellow, calcium chloride for orange, strontium chloride for red, barium chloride for green, and copper chloride for blue.)

- How does using light help or hurt out environment?
- Complete the table with your ideas.

| Light Waves Helps | Light Waves Hurt |
|---|---|
| | |

- Talk about what you have included in your chart with your classmates.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentic | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

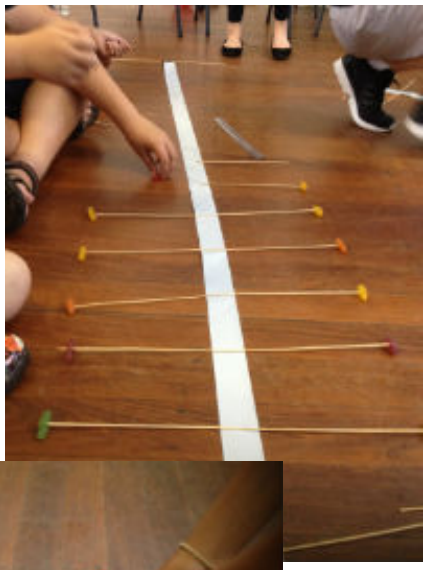
Essential Target (ET) - Record detailed observations.

# 4. The Path of Light

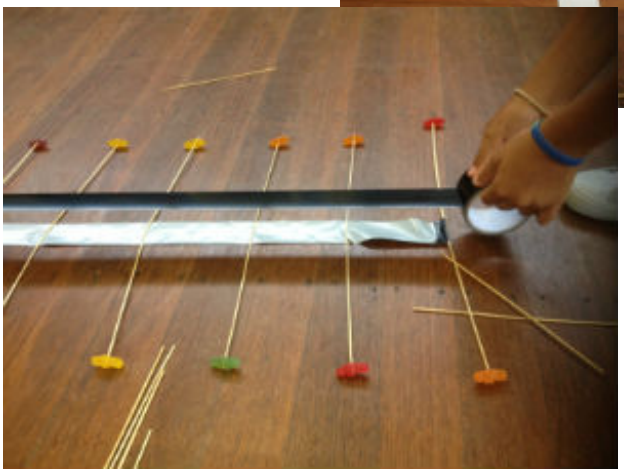
- Complete the Gaffa Wave Experiment as a class.

(Adapted from http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/make+a+wave+demonstrator.html)

**Procedure:**



(a) Lay out 3 meters of Gaffa tape on the floor.
(b) Put kebab sticks at every 20 cm mark along the tape.
(c) Place jelly candies into the end of each kebab.
(d) Cut 3 more meters of Gaffa tape to cover the first tape and secure the kebab sticks.



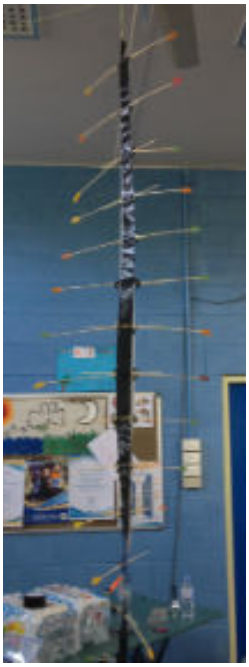
(e) Hang the wave tape from the ceiling without touching anything or the floor.
(f) Give the tape a 360-degree twist at the bottom.
(g) Then let go and watch the waves travel up and down the tape.

**Prediction:** _____

_____

**Observation:** What did you see happen? _____

**Findings** (Example of a good explanation):

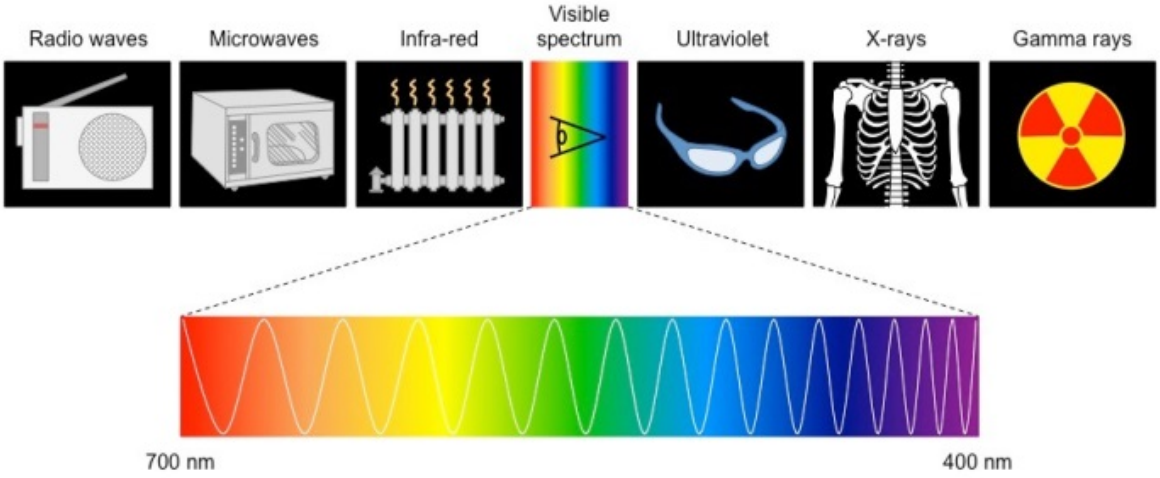


*When the tape was twisted at the bottom it seemed to be storing energy that was released when it unwound, transferring the energy into motion (kinetic) energy toward the jelly candies on the end of the stick. Once moving, the candies had momentum that kept them spiraling around the tape, transferring most of that energy back into the tape. The tape then twisted up again, which kept the transfer of energy happening until the energy eventually leaves the tape as it slows down to a stop. The chance for energy to travel through waves is what kept the transfer of energy going.*

**Recommendations:** *I think this experiment would have been better if…* _____

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

- Look at the image of the electromagnetic spectrum.





http://ib.bioninja.com.au/_Media/electromagnetic-spectrum_med.jpeg

**STEP OUTSIDE:**

- Try the same experiment except hang the tape from a tree.
- Talk about what you think will happen
- What do you think each letter stands for?

| |
|---|
| R - |
| O - |
| Y - |
| G - |
| B - |
| I - |
| V - |

- What do you think it means if the items are not in the 'visible' spectrum?

*They cannot be* _____.

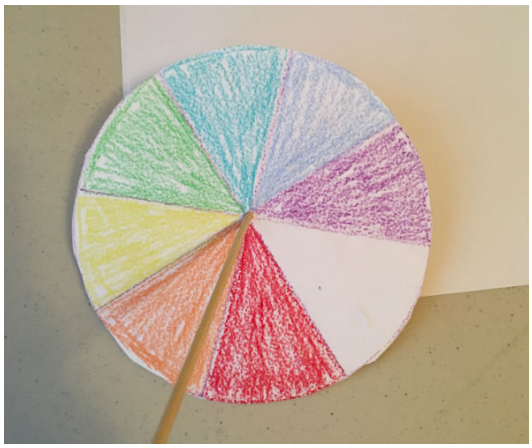
**Newton Colour Wheel Experiment**
(Adapted from
http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/newton+wheel.htm)

- After reading through the procedure, make a prediction about what you think might happen, and make a list of and gather materials you will need to complete this experiment.

**Prediction:** *I predict*_____

---

**Procedure:**



1. Cut out a round piece of paper and divide it into 8 equal segments.
2. Colour each section in the order of the colours of the rainbow; Red | Orange | Yellow | Green | Blue | Indigo | Violet.
3. You may need to look up 'Indigo'.
4. Glue the image on cardboard.
5. Put a skewer through the middle of the disc.
6. Spin the kebab stick between fingers.

**Observation:** What colour do you see? _____

**Findings:** Why do you think you see that colour?

***Clues*** **-** White light is comprised of all the colours of the visible spectrum (i.e. red, orange, yellow, *green, blue, indigo and violet...)* Spinning the disc mixed all the different wavelengths of coloured light together, creating white light. The faster you move the disc, the more white light you see. This process is called '**colour addition**'.

**Recommendation:** *I recommend* _____

_____

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

- Let's make some coloured light with:
    - 3 flashlights
    - red, blue and green cellophane
    - 3 rubber bands
    - clean white board or wall
    - dark room

(Adapted from http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/coloured+shadows.html)

- Place the red cellophane over the flashlight so that the light is coloured red. Secure the cellophane with a rubber band.
- Do the same to make a blue and green light with the other two flashlights.
- Shine all the flashlights on the same spot on the wall at the same time.
- What colour does it make? _____

- Why? _____

_____

- What is this process called? (see clue in last experiment)

_____ _____

**Colour subtraction** occurs when substances that absorb light, such as paint, are mixed together. Mixing coloured paint can lead to black paint, which happens when all visible light is absorbed.

**Black Light:**

- part of the electromagnetic spectrum
- is UV (ultraviolet) lamp that can illuminate (light up) objects and materials that contain phosphors
- used for setting in theatre, in forensic science to solve crimes, in photography and for examining and identifying money, paintings or antiques

**Phosphors:**

- special substances that glow (luminescence) when excited by radiation
- Highlighter pens have phosphors in their dye.
- When dark, reaction between phosphors and UV rays create a glow in the dark effect.

**Make Glowing Water** (adapted from http://www.sciencekids.co.nz/experiments/glowingwater.html)

- Look at this list of items and the procedure. Make a prediction about what you might discover.
    - Black light
    - Tonic water or a highlighter pen.
    - A dark room
- Break open the highlighter pen and soak it in a $\frac{1}{4}$ jar of water for a few minutes.
- Place the jar of in a dark room and turn on a black light.
- Draw and label a diagram of what you see.

**Prediction:** *I predict*_____

_____

**Observation**:

**Findings:**

*My findings were the*
*(a) same*
*(b) different*
*than my prediction.*

- Based on what you know about black light (re-read), explain what you think happened in the experiment…

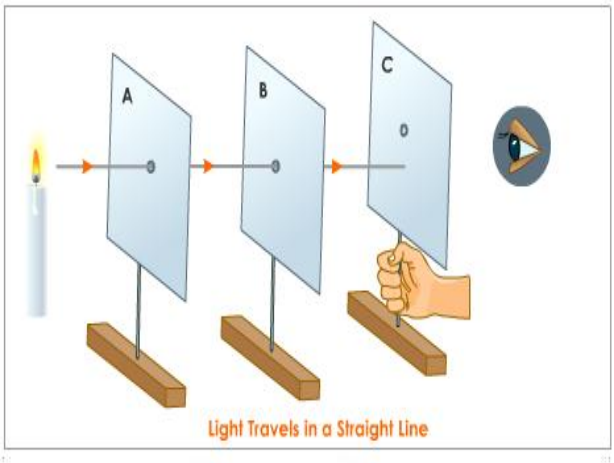
*I think* _____

_____

**Recommendation:** *I recommend* _____

_____

- With a partner, re-create what you think the experiment is about from the diagram.
- Use the 'scientific method' words on a poster to record your experiment: prediction, procedure, observation, findings, recommendation.
- Do the experiment and share your experiment with your class.




http://images.tutorvista.com/content/feed/tvcs/displaced-obstacle-rectilinear-propagation-of-light-experiment.jpeg

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

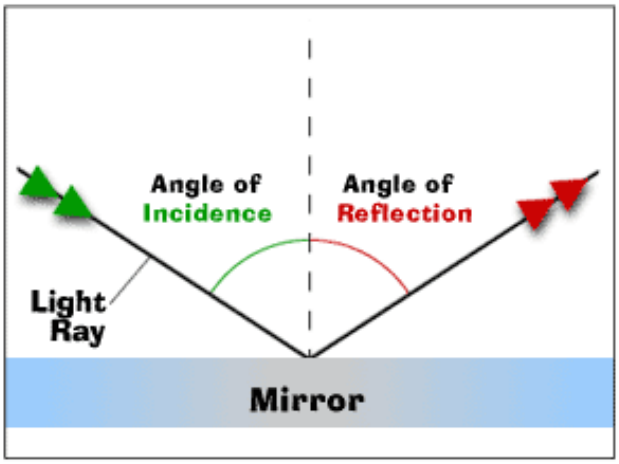
Light waves move quickly. The speed of light is 299 792 458 m / sec. – this in nearly:

_____ meters/second.

**Reflection** is what happens when light hits an object and bounces off. Light reflects off of shiny surfaces.
The light's path forms two angles:

(a) the angle of incidence and,
(b) the angle of reflection.

- When light rays make contact with a smooth surface, the light is reflected at equal angles.
- Shade in the equal angles with a light colour.



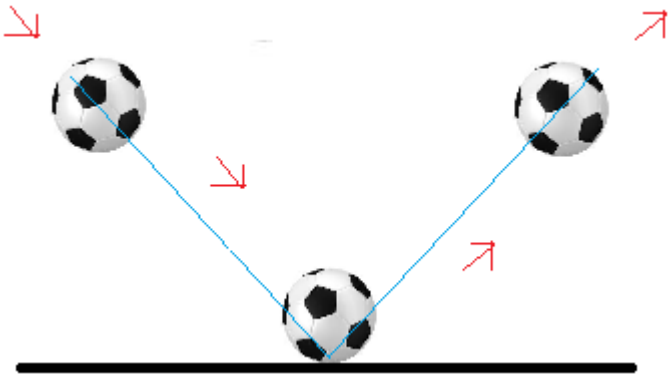

https://natashiaoeil.files.wordpress.com/2011/09/reflection_graphic.gif?w=640

- Why do you think this warning is on car mirrors?

http://blog.echovar.com/wp-content/uploads/2015/05/objects-in-mirror.jpg

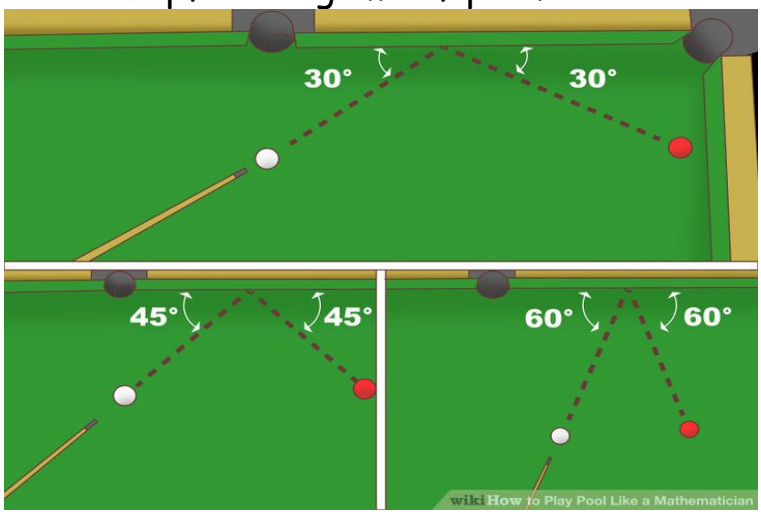
**STEP OUTSIDE:**

- Work with a partner to examine angles when bouncing a ball back and forth.
- Practice changing the force and distance you are apart.
- Try to find a way to make the angle it makes when it first hits the ground equal the angle it makes when it leaves the ground back to your partner.
- Go to the campfire circle and talk about what you discovered.
- Did it help to have a smooth surface to bounce the ball on?
- Compare this finding to how waves reflect off of mirrors.



http://www.introduction-to-physics.com/images/xbouncing-ball.png.pagespeed.ic.xSb86p8VNE.png

- Think about how knowing the angle of incidence and angle of reflection can be helpful in a game of pool.

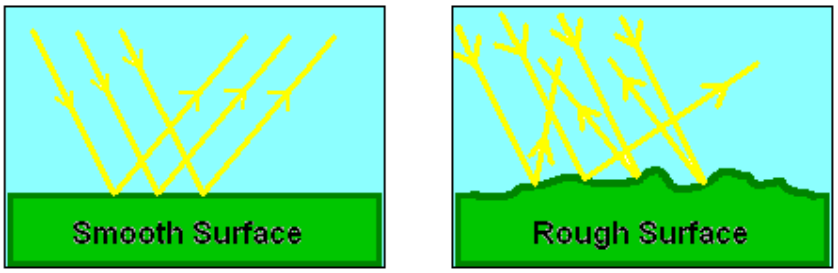



http://danielmathews.info/blog/wp-content/uploads/2016/12/Play-Pool-Like-a-Mathematician-Step-2-Version-3.jpg

## Transparent and Opaque Materials

(adapted from http://study.com/academy/lesson/transparent-and-opaque-materials-in-electromagnetic-waves.html)

Objects absorb the energy of a light wave when the wave contacts an **opaque** surface. No light waves are permitted to move through the surface of an opaque object. A surface that is **transparent** passes light through it without being dispersed, or scattered. Clear glass is transparent, and clean water is transparent.




http://www.myschoolhouse.com/courses/c/6/Images/surfaces.gif

## Path of Light Though Water Experiment

(adapted from http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/lovely+light+beam.html)

Light can also bend (refraction) when passing from one medium to another.

- Read about the path of light in this experiment with water.

**Prediction:** *I predict the light will travel in a straight path through the water.*

**Procedure:**

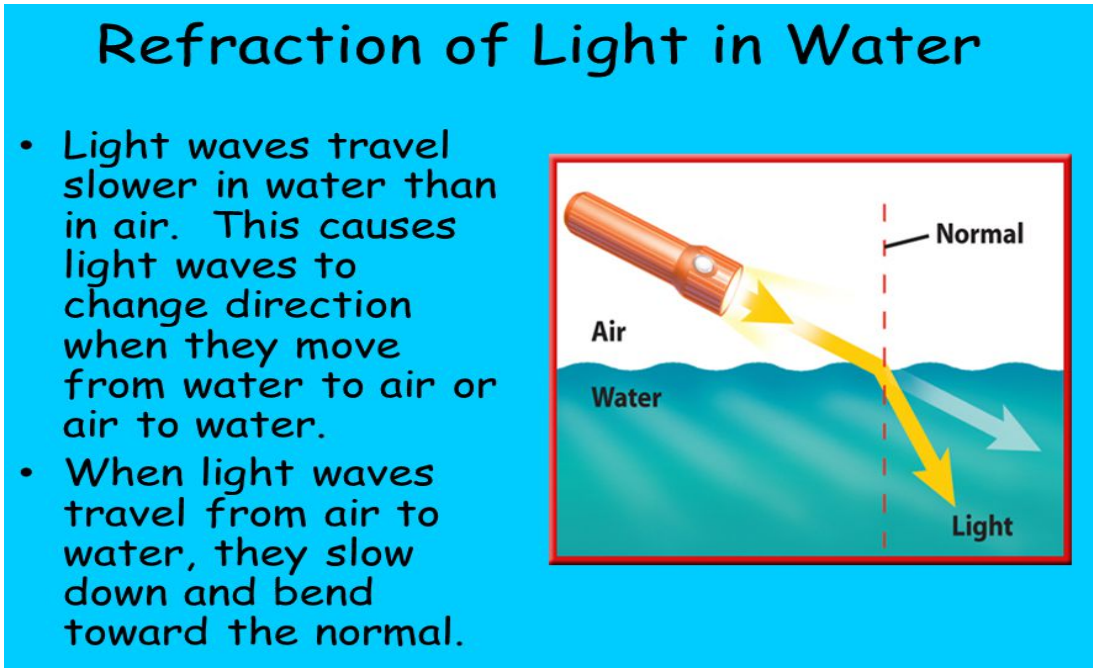
1. Wrap the sides of a bottle in foil.
2. Fill the bottle with water and turn off the lights.
3. Turn the bottle upside down and pour the water out.
4. Shine the flashlight through the bottom of the bottle.

**Observation:** *The light shines through the water and creates a beam of light that pours from the mouth of the bottle.*

**Findings:** *The light is bouncing within the stream of water producing a beam of light. When it passed through the water it slightly changed direction, so it did not travel in a straight path as I predicted.*

**Recommendation:** *I recommend*_____

_____




http://slideplayer.com/slide/4884649/16/images/44/Refraction+of+Light+in+Water.jpg

Anything through which light can pass is called a 'medium' – this includes air, glass, water and a vacuum. When light passes from one medium to another it changes direction – we say that it is 'refracted'.

**Telescopes**

A refractor **telescope** bends light inward, making objects appear closer to you than they really are. Light waves inside these telescopes help astronomers see stars and planets up close!

**Microscopes and Magnifying Glasses**

Like a telescope, a microscope refracts light waves to magnify the size of things.

**STEP OUTSIDE: Make a Rainbow**

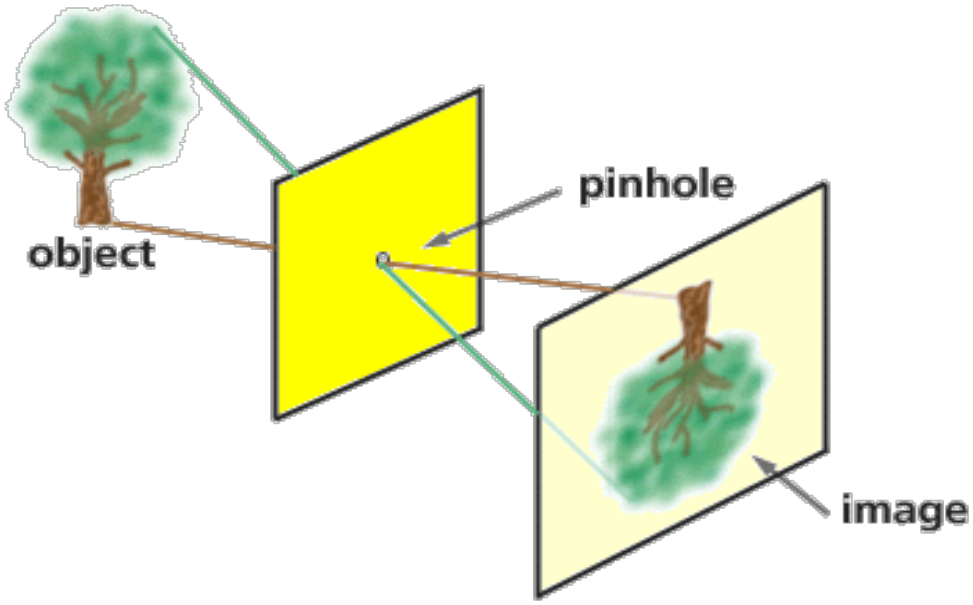
- Use sunlight and water to make a rainbow.

1. Take a glass of water and paper outside on a sunny day.
2. Hold the glass of water above the paper and watch as sunlight passes through the glass of water, refracts (bends) and forms a rainbow of colors on your sheet of paper.
3. Try holding the glass of water at different heights and angles to see if it changes what you see.

We can see a rainbow as an arc of color in the sky.

You may also see a rainbow in a water fountain or within a waterfall. Rainbows form in the sky when sunlight refracts (bends) as it passes through raindrops. It acts in the same way when it passes through your glass of water. The sunlight refracts, separating it into the colors red, orange, yellow, green, blue, indigo and violet. When white light from the sun falls on these droplets, it splits into seven colours and a rainbow is formed. Rainbows **disperse** light usually in these seven colours, just after the rain when the sun is shining. After it rains, many water droplets are suspended in the atmosphere. These droplets of water are what bends the light wave.

**The Pinhole Camera**




http://www.cyberphysics.co.uk/graphics/diagrams/Light/pinhole.gif

Depending how large the opening, light waves can bend and spread out.

**TECH CHECK:**

- https://www.youtube.com/watch?v=szcTN1IfyCE
- https://www.youtube.com/watch?v=pvYZbGQCe9Q
- https://digital-photography-school.com/photography-101-light-and-the-pinhole-camera/

- Read the following ways movies and films use light:

## Green Screens in Films and Movies

(Adapted from https://www.livescience.com/55814-how-do-green-screens-work.html)

In movies and on television, actors walk — and sometimes fly — through…fantastic landscapes that simply don't exist in the real world. They ride on dragons' backs, grow crops on distant planets... Sometimes the story takes place in a familiar city, but in the distant past — or the far-off future. Sometimes, characters stage epic battles that seem to pulverize (destroy) landmarks or places that audiences know well or where they live…All of this high-tech fakery happens with the help of backdrops of brightly colored fabric or paint, and a process called "chroma key," also referred to as "green screen", due to the backdrops' color, which is typically a vivid green. Chroma keying allows media technicians to easily separate green screens and panels from the people standing in front of them and replace those backgrounds with pretty much anything — from animated weather maps to the skyline of famous cities…

Harry Potter (Daniel Radcliffe) and his broomstick take flight with a little chroma key "magic." *Credit: Warner Bros.*

…The color is typically bright green or bright blue, because these differ so greatly from human skin tones and aren't usually found in clothing. For the effect to work, there must be no visible shadows…Chroma keying isn't just for backgrounds; it works with objects, too…Software and apps such as Photoshop, After Effects and iMovie make it possible for even amateur photographers or video editors to easily tweak and manipulate their own green-screen images…with results that the original creator never intended …It is commonly used for weather forecast broadcasts…where someone is seen standing in front of a large map during live television newscasts… Chroma keying is also common in as visual effects in videogames.

## TECH CHECK:

- http://www.sciencekids.co.nz/experiments/makearainbow.html
- http://www.funscience.in/study-zone/Physics/RefractionOfLight/DispersionOfLight.php)
- http://explore.org/live-cams/player/northern-lights-cam
- https://www.youtube.com/watch?v=q19fw24pvn8
- https://www.youtube.com/watch?v=HzIBmuLHMSE
- http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/rainbows+in+a+feather.html
- https://www.kickstarter.com/projects/lomography/the-lomography-daguerreotype-achromat-29-64-art-le?ref=NewsApr0716&utm_campaign=Apr+07&utm_medium=email&utm_source=newsletter

## Extension:

- Read 'Seeing in Stereo' to find out more about how our eyes work.

**Seeing in Stereo**

1 Have you ever asked yourself why you have two eyes instead of one, three, or even hundreds as some insects have? Have you wondered why your eyes are set close together on the front of your face rather than on the sides of your head, as on animals like rabbits, antelopes, and horses?

2 Your eyes are like two small cameras. A camera captures an image of an object and records this image in miniature on a small piece of film. Similarly, when you look at something, each eye takes in what it sees and sends this image to the back of the eyeball. From each eye, an optic nerve then sends the image to the brain. Because your eyes are set close together, they view the world from about the same height but from slightly different angles. While your right eye sees an object a little to the right, your left eye sees the same object slightly to the left. Working as a team, the eyes send the images to the part of your brain called the *cerebral cortex*, which assembles them into a single, centered image.

3 Seeing with two eyes working together is called *stereoscopic vision*. This allows you to view the world in three dimensions, or 3-D. These dimensions are height, width, and depth. Perceiving depth allows you to judge the distance between you and the objects you see. It also helps you to adjust to the changing angle at which you see something as you move closer to or farther away from it. As you walk along a sidewalk, for example, seeing in stereo helps you to know how close you are to the street, how far you need to walk to arrive at a certain building, and how close you are to stepping on a rock or a piece of glass. As your body moves, your eyes give you a continual flow of information about where things are in relation to where you are.

4 If images are coming from only one eye, however, only two of these dimensions—height and width—can be perceived. A world seen with one eye is thus two-dimensional, as in a photograph. Depth perception is lacking, making it more difficult to move around safely.

5 Now consider why your two eyes are located on the front of your face. Think of other animals with this same arrangement. Some examples are lions, wolves, and owls. What do these creatures have in common? They are all animals that hunt. These animals have eyes facing directly in front of them. This provides a field of vision that is about 180 degrees wide, like a half-circle. This kind of sight is called *binocular vision*.

6 On the other hand, animals that are hunted have eyes on the sides of the head. This provides nearly a 360-degree field of vision. Because these animals need to be on the alert in order to stay alive, they need to see things coming from the sides and from behind. However, without stereoscopic vision, these animals have a more difficult time determining how far away a threat is.

7 With vision that is both stereoscopic and binocular, humans share with predators the ability to see clearly from side to side and to accurately determine how far away objects are. If you think it would be great to have another type of vision, perhaps with hundreds of tiny eyes like many insects do, think again! Each tiny insect eye sees only a tiny part of what the creature is viewing. Besides, what if you needed glasses? Be glad for the eyesight that you have.

Which claim from the article is *least* supported by factual evidence?

**A** Your eyes are like two small cameras.

**B** This allows you to view the world in three dimensions, or 3-D.

**C** On the other hand, animals that are hunted have eyes on the sides of the head.

**D** If you think it would be great to have another type of vision . . . think again!

According to this passage, an eye is like a camera because both

**A** have an optic nerve.

**B** are able to perceive color.

**C** record images in miniature.

**D** work only while remaining still.

Stereoscopic vision is a result of having

**A** hundreds of eyes, all seeing parts of an image.

**B** two eyes close to one another that work together.

**C** a three-hundred-sixty-degree field of vision.

**D** one eye on either side of the head, each seeing a different image.

Owls, hawks, and eagles have eyes facing frontward because they are

**A** prey.
**B** birds.
**C** hunters.
**D** large.

| **How well did you record detailed observations?** | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

## 5. Light and Heat

- Check off which light waves give off light and heat:

| Light waves from… | Give off light – no heat | Give off light and heat |
|---|---|---|
| sun | | |
| firefly | | |
| glow stick | | |
| candle | | |
| incandescent light bulb | | |
| LED | | |
| fluorescent bulb | | |

**STEP OUTSIDE: Making a Heat Wave**

(adopted from http://www.sciencekids.co.nz/experiments/lightcolorheat.html)

- Wrap a glass with white paper using an elastic band or tape to hold it in place.
- Wrap another glass with black paper.
- Fill each glass with the same amount of water.
- Measure the temperature of the water in each glass.
- Place the glasses outside in the sun for 2 hours.
- Record the water temperature in each glass after being in the sun.

| | Before Sun | After Sun |
|---|---|---|
| White Paper Wrapped Glass | | |
| Black Paper Wrapped Glass | | |

- Read the explanation of possible findings:

Dark surfaces such as the black paper absorb more light and heat than the lighter ones such as the white paper. After measuring the temperatures of the water, the glass with the black paper around it should be hotter than the other. Lighter surfaces reflect more light, that's why people wear lighter coulored clothes in the summer, it keeps them cooler.

- Repeat as much of this explanation as you can to your teacher without looking at it again.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

# 6. Periscope Design

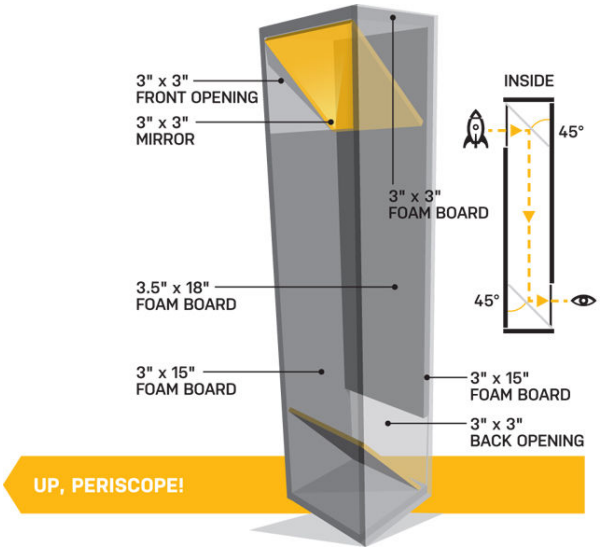
If you work on a submarine, a periscope is a handy way to view what's happening above the surface of the water!

https://go.spinweb.net/hubfs/periscope-water.jpg

The inside of a periscope looks like the letter 'Z'. At the top of the devise is a mirror that is on a 45-degree angle. Light reflects from something viewed on the surface and then bounces off the upper mirror to another 45-degree slanted mirror on the bottom, so people below can see what is above them or coming close to the underground ship.

http://www.popularmechanics.com/technology/a8725/early-adopter-how-to-build-a-periscope-15075808/

- Create an experiment where you will make, test, and revise your own periscope.
- How might you use what you know about light and mirrors your device?
- Which properties of light will be most useful to you in your device?
- What challenges might you encounter, and how can you overcome them?




in

# Periscope Design Experiment

**Prediction & Hypothesis:**

**Procedure:**

**Observations:**

**Findings:**

**Recommendations:**

| **How well did you generate a hypothesis?** | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

ET - Make predictions.

ET - Draw conclusions.

## 7. Kaleidoscope Design

Light travels in a straight line until it bumps into an object that changes the direction of the path of light. Shiny surfaces, such as mirrors, send or reflect light back to you. Inside a kaleidoscope, the shiny tube helps to act like a mirror by reflecting back and forth to the viewer the images made by materials inside or on a moving piece at the opposite end of the tube. When the kaleidoscope is turned, all the pieces move, giving the viewer many different images to see.

- Create an experiment where you will make, test, and revise your own kaleidoscope.
- How might you use what you know about light and mirrors in your device?
- Which properties of light will be most useful to you in your device?
- What challenges might you encounter, and how can you overcome them?

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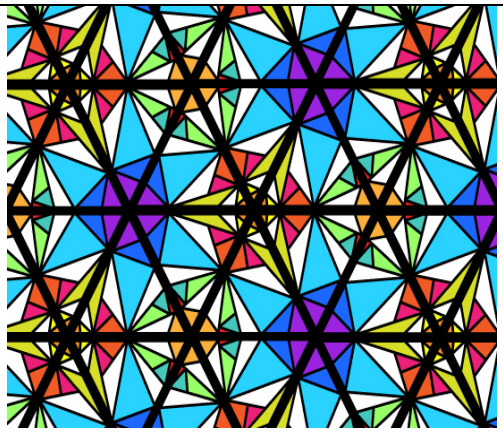


https://www.bricartsmedia.org/sites/default/files/paragraphs/cico/kaleidescope_background%20pattern.jpg

## TECH CHECK:

- http://www.wikihow.com/Make-a-Kaleidoscope
- http://buggyandbuddy.com/science-for-kids-how-to-make-a-kaleidoscope/

# Kaleidoscope Design Experiment

**Prediction & Hypothesis:**

**Procedure:**

**Observations:**

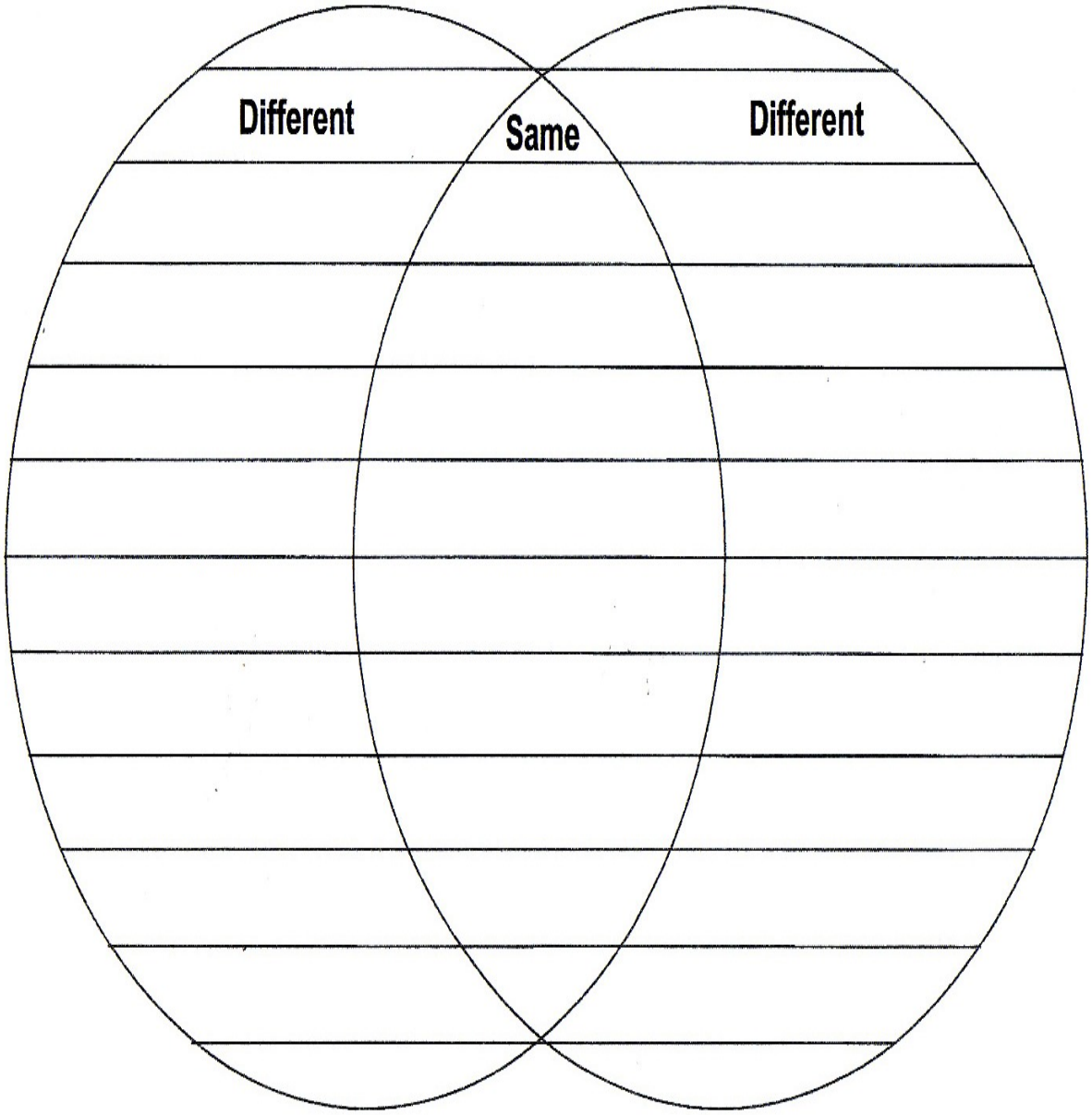
**Findings:**

**Recommendations:**

| **How well did you make predictions?** | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

| **How well did you draw conclusions?** | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

- Using a Venn diagram, compare as many similarities and differences as you can think of in your periscope and the kaleidoscope designing experience.




https://adventureclubinteractive.files.wordpress.com/2013/02/venn-diagram.jpg

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

# 8. Light Careers

Jobs – Light Crew

- The light crew analyzes the script and designs lighting to fit the needs of the show following the Director's vision
- The Light crew will hang, focus, color, and maintain the lighting instruments needed
- The Light crew will program and run the light board

http://slideplayer.com/slide/5671257/18/images/10/Jobs+%E2%80%93+Light+Crew+The+light+crew+analyzes+the+script+and+designs+lighting+to+fit+the+needs+of+the+show+following+the+Director%E2%80%99s+vision..jpg

- Read the following job description for a Lighting Designer. Circle at least three items you find interesting about the job.

WANTED: LIGHTING DESIGNER

A theatre **lighting designer** (or LD) works with the director, choreographer, set **designer**, costume **designer**, and sound **designer** to create the **lighting**, atmosphere, and time of day for the production in response to the text, while keeping in mind issues of visibility, safety, and cost. Lighting directors or lighting designers, work on theater productions. They create and manage all aspects of lighting for a production. Lighting directors work with the artistic and production staff to support the director's plans for the production. Lighting directors begin by designing a lighting plan for the production. They use set designs, theater plans, storyboards, photos, computer software and scripts to create lighting cues and devise a layout. Throughout the rehearsal and design process, the lighting director must edit and develop this plan. Safety concerns and special effects must be considered…The lighting director must also work within a lighting budget. They must inventory equipment and order items needed for their lighting plan. In the U.S. earn an average salary of about $55,000. A Bachelor of Fine Arts (BFA) degree program includes both technical and design components. Students study drafting, machinery, tools, electronics, management and technology related to theater lighting. They must be able to demonstrate organizational skills, aesthetic aptitude and the ability to collaborate with others to meet their design goals by the end of their program. They also study makeup, costumes and sound… Lighting directors may also need to attend construction and safety training. (adapted from https://www.aact.org/lighting-designer)

# Sound Waves

## 9. Properties of Sound

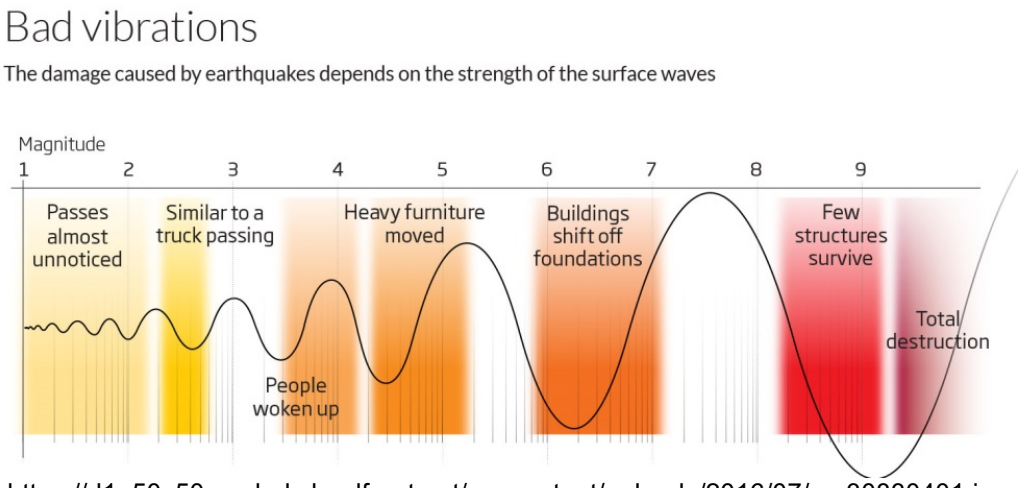
- Make your own gong with a partner!
  1. Tie two 30cm strings to the corners of a coat hanger.
  2. Dangle the coat hanger upside down by holding the 2 strings.
  3. Wrap your fingers around each string and put these fingers in each ear.
  4. Knock the hanger against a hard surface.

- Talk about what happened.
- Were you surprised?
- Think about how light travels through waves, and talk about how your 'gong making' helped you feel that sound travels through waves as well.

Sound is produced by vibrations. When the coat hanger hit the hard surface, it vibrated. These vibrations travel faster to your ear through the vibrating strings because they are solid. According to http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/coathanger+gong.html, vibrations travel faster through solids than liquids or gases. This is why we can detect earthquakes hundreds of kilometers from their source.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

- Take a look at this graph called: 'Bad Vibrations' to see how the size of the wave and distance between vibrations can be more or less damaging:




https://d1o50x50snmhul.cloudfront.net/wp-content/uploads/2016/07/mg30830401.jpg

**Voice Vibrations**

Waves travel in different ways throughout our body every day. Heart beats are waves of blood being pumped throughout our body. We can feel these waves when we take our pulse or health professionals take our blood pressure. When we speak, our vocal chords (muscles) vibrate to make different sounds. Our words can have a high pitch (faster vibrations) or a lower pitch (slower vibrations). The speed of vibrations is known as 'frequency'. How often, or 'frequent' do the waves vibrate? The pitch (fast or slow frequency waves) can change sound.

**STEP OUTSIDE:**

- Fill bottles with different amounts of water.
- Arrange each bottle in order, from the most to the least full of water.
- Blow across the top of each bottle.
- Compare the different sounds you make.
- Talk about why you think the sounds are different.

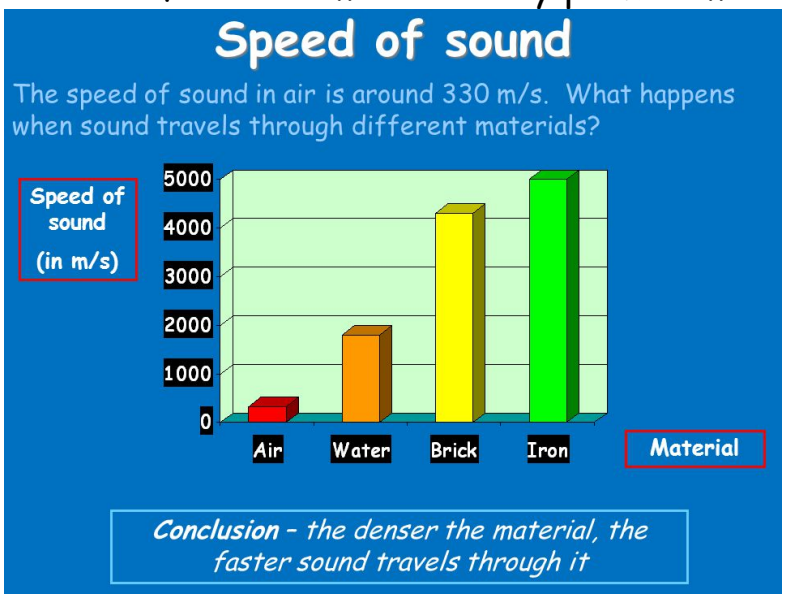
**Clue:** Changing the amount of air and water in each bottle helps you change how high or low the sound is. When adding air forces, the air inside the bottles  vibrates. The more space for air inside each bottle, the more room for molecules to move around slowly (at a lower pitch). With less room the air molecules have less space and therefore move faster, as the waves bump into each other more often, producing a higher pitch.

- Make an outside 'water' xylophone with notes made from carefully measured amounts of water for each key.


https://static.studyladder.co.nz/cdn/course/78/8e727618facd.jpg

- Weigh each bottle and keep track of the mL of water used for each note.
- Create a chart to record data here:

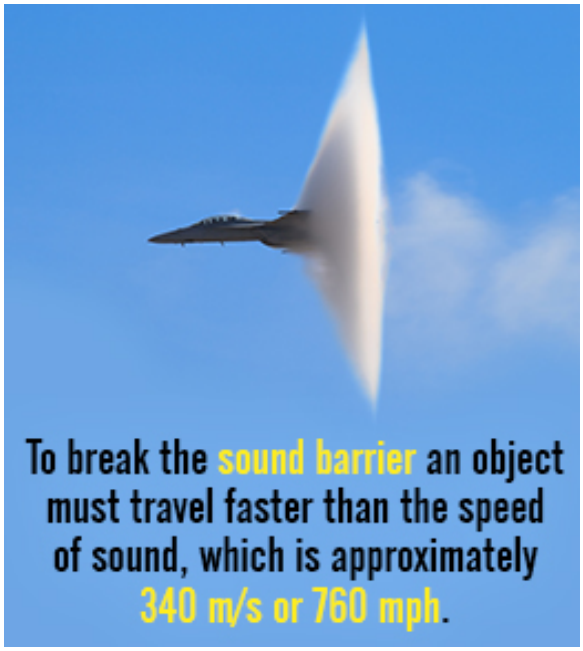
The speed of sound is faster in more densely packed material.




http://images.slideplayer.com/18/5673305/slides/slide_2.jpg

Chuck Yeager set the first record for breaking the sound barrier on October 14, 1947. He flew the Bell X-1 at Mach 1 at an altitude of 13,700 m.

http://www.buzzle.com/img/articleImages/611472-52830-14.jpg




| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

**Reflection and Absorption of Sound**

Sound can be absorbed and reflected.

## Reflection of Sound

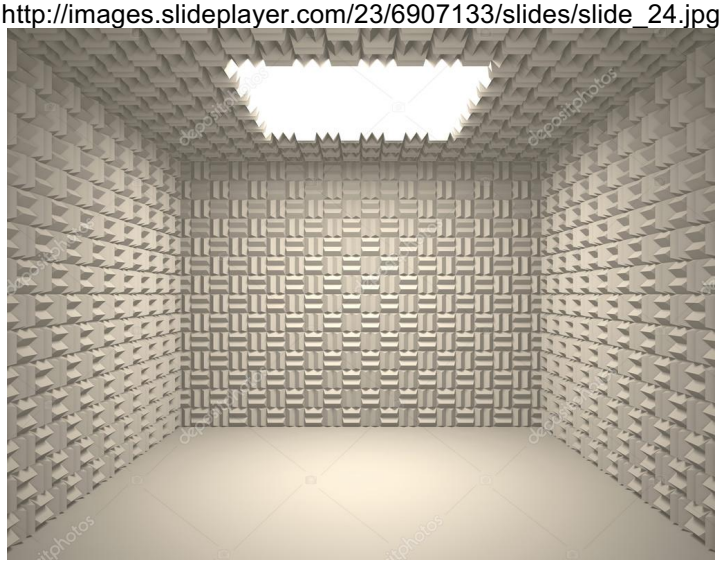
Sound reflects strongly from rigid surfaces.

Softer surfaces absorb sound.

Quiet after a fresh snowfall because the soft, irregular surface of the snow absorbs sound instead of reflecting it.

13-Sep-15 Physics 1 (Garcia) SJSU

http://images.slideplayer.com/23/6907133/slides/slide_24.jpg



https://static8.depositphotos.com/1213337/802/i/950/depositphotos_8020783-Acoustic-room.jpg

- Talk about why do you think this is called an 'acoustic' room?
- Design your own sound proof room on poster paper.
- Use the following words when you share your design with your classmates (wave, vibration, pitch, reflect, absorb)

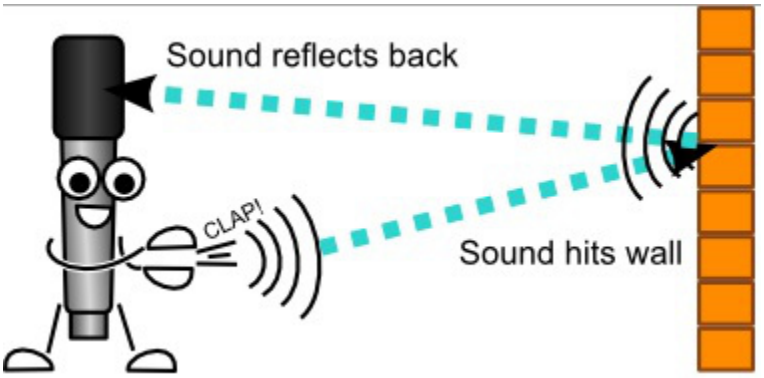
**TECH CHECK:**

- http://www.primaryscience.ie/media/pdfs/col/Sound_Insulation_Younger.pdf

**Sound Waves Move**

Whales send and receive messages because sound travels faster through water than air. Water molecules are packed more tightly than gas molecules in air. This causes vibrations to travel faster through liquids. More energy is lost when sound travels through air.

Sound waves reflect off of surfaces. These are called **echoes.**



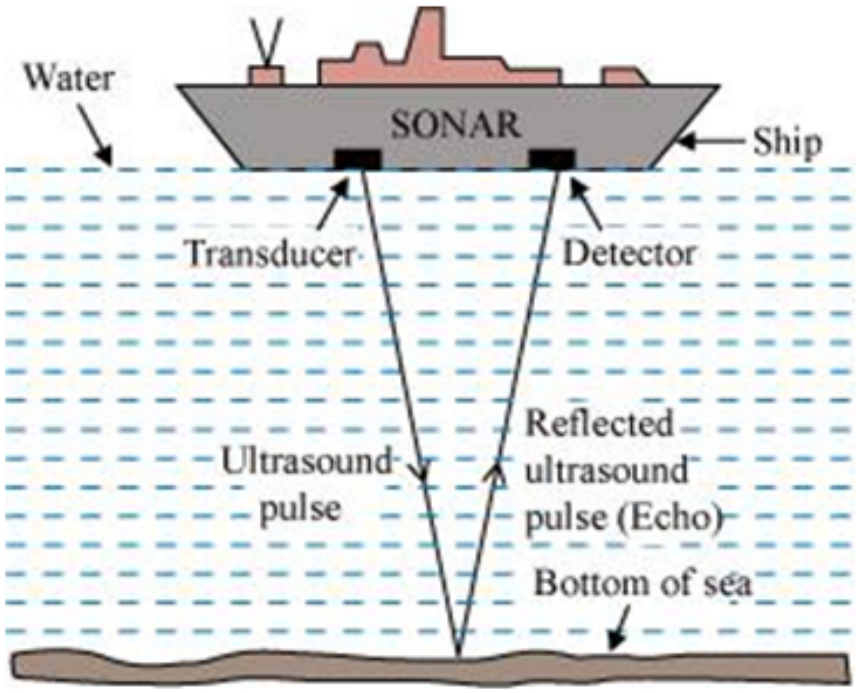

https://abucketfullofscience.files.wordpress.com/2016/03/echo.jpg?w=660

ECHO

- An echo happens when sound bounces off a surface
- You can get an idea of the speed of sound if you live near a cliff, mountain, or large building that makes a good echo. The delay between the original noise (a clap for example) and its echo is the time it has taken the sound to travel there and back.

https://image.slidesharecdn.com/lightandsounddailypowerpoint-120118082700-phpapp01/95/light-and-sound-daily-power-point-51-728.jpg?cb=1326876433

Map makers and treasure seekers use sonar waves to navigate the landscape under water.




http://2.bp.blogspot.com/-fLAju7EqObU/U89qLxtRQHI/AAAAAAAADJE/uKrUgZRcK-M/s1600/sonar.png

- Talk about whether you think it fair to use 'fish finder' technology to locate fish below the surface of water?

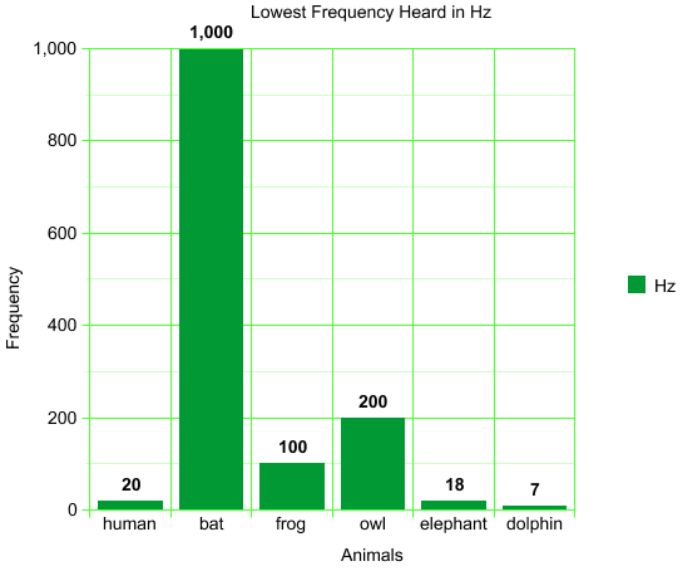
**Animal Ears**

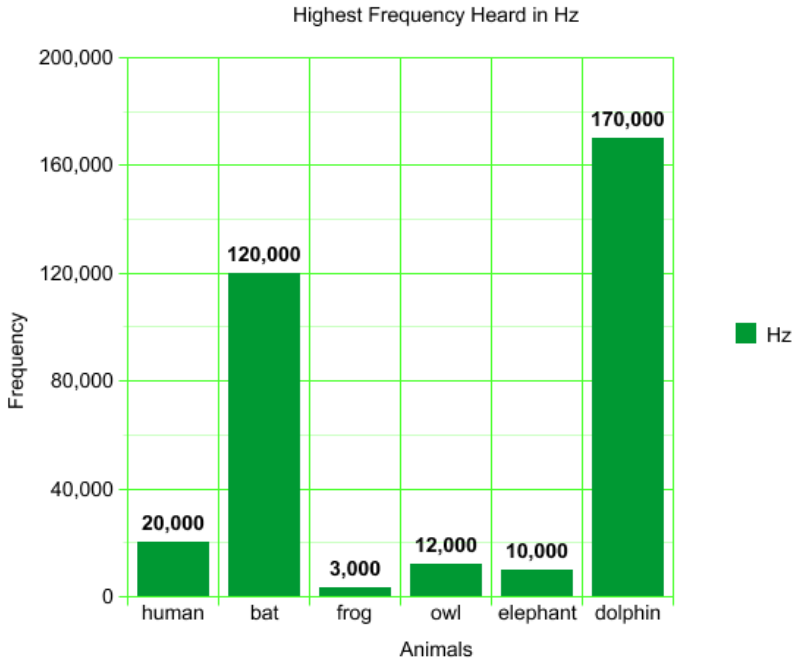
While we can hear bird calls, dog barks, and bees buzzing, we only hear some noises many animals make. Many animals can generate and hear sounds that are too high-pitched or too low-pitched for humans to hear.

According to: http://www.dangerousdecibels.org/virtualexhibit/6measuringsound.html, "frequency is **measured** in the number of **sound** vibrations in one second. A healthy ear can hear **sounds** of very low frequency, 20 **Hertz** (or 20 cycles per second), to a very high frequency of 20,000 **Hertz**. The lowest A key on the piano is 27 **Hertz**."

- Look at the two graphs to find out what animals have the highest and lowest pitches, as measured in Hz (Hertz).

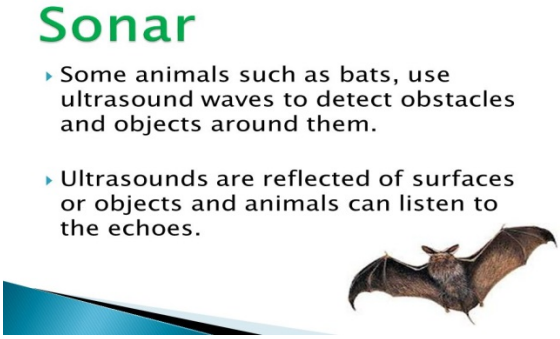
## Hearing Frequency Charts




http://engagingstudents.blackgold.ca/index.php/division-i/sci-d1/science-3/topic-d-hearing-and-sound/animal-hearing-project/

Most mammals can gather and funnel sound through their pinnae or exterior ears. Many animals use sound to communicate with each other. They may use sound to warn of danger, look for food, or find a mate. Spiders can hear prey, such as insects when they beat their wings. Whales and bats find prey using high-pitched sounds, and then listen to the echoes to see if the waves bounce back quickly, indicating prey is nearby. Some animals have built in sonar that use the reflection and absorption of sound waves to move around.

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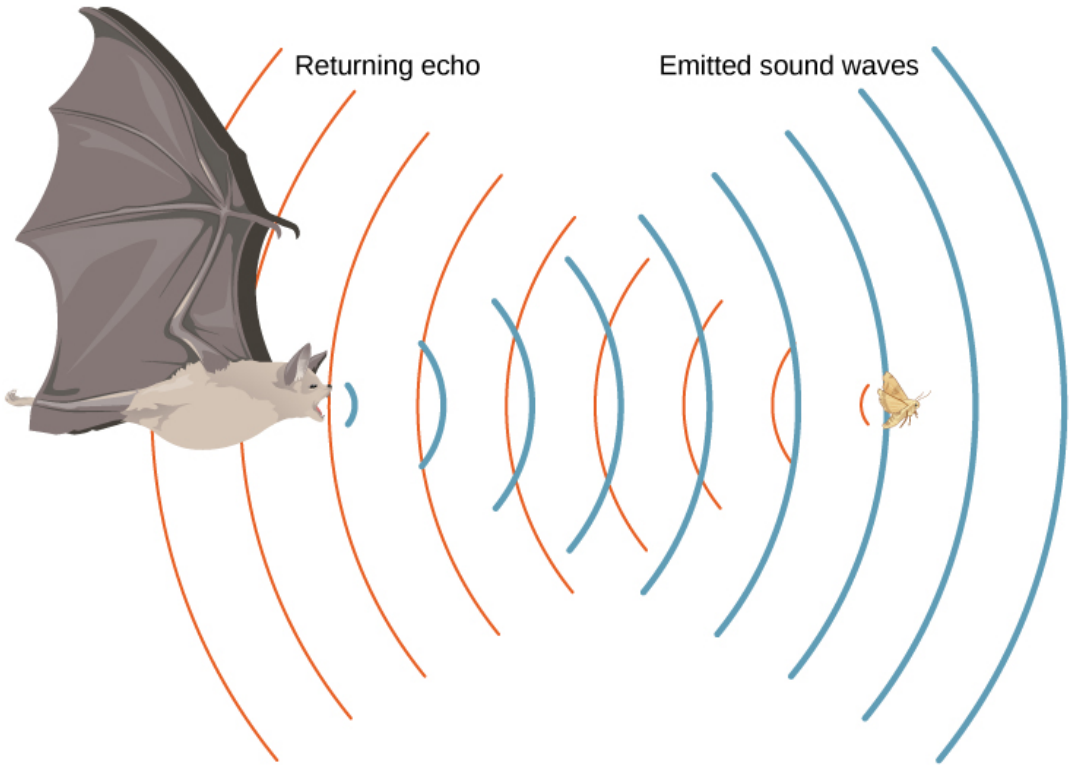



http://cnx.org/resources/62100cf41000f4088df4660048cc281b314fc2d3/CNX_UPhysics_17_02_Bat.jpg

**Extension:** Read through the following challenge to see if you would use your knowledge of waves to solve this problem:

You and a friend, both experienced campers, are out for a wilderness weekend in one of your favorite deserted areas when, around sunset, you see a large, densely concentrated, directional swarm of bats sweeping low across the landscape. Intrigued by the sighting, you hike back along their flight path until you come upon the entrance to a cave from which they emanate — a cave that, as far as you know, is unknown. And the lack of any signs of human activity around the entrance seems to confirm that. Not wanting to pass up this once-in-a-lifetime opportunity for some genuine adventure, you convince your friend to at least go in a little way to explore the cave. Gearing up with packs and flashlights, you tie a guide rope to a bush near the entrance and slip through the narrow opening to have a look inside. The cave quickly widens, and once you get past the odor of the bats, you're both astonished by the undisturbed beauty of the structure. You venture deeper into this pristine geo-world until the rope runs out, but neither of you is keen to stop now. So you agree to make directional markers along the way in order to explore farther – marks cut into the cave floor or walls, piles of stones, bits of fabric; whatever they are, assume that they stick.

**The Challenge -** Taking many turns through tunnels and chambers…you finally realize that you have not been trail-marking for some time. The flashlights make everything seem bright, but when they're off it is pitch black. A little backtracking doesn't find your last markers, and you realize you're most definitely lost. You hear the chittering of a few remaining bats and the dripping of water, but other than that and your breathing, the cave is deathly silent. So, aside from resisting the urge to panic, what do you do now?

**What You Have -** Two sturdy, aluminum-frame overnight backpacks, two canteens of water, some protein bars and other durable foods, two flashlights with extra batteries, a Swiss Army knife or Leatherman tool, a strong, flexible 3-foot wire saw with split-ring finger-handles on both ends, some waterproof matches, a compass, a cellphone (no, you don't get a signal down here), and a GPS locator (also no signal). Besides your hiking boots, you each have waterproof nylon rain gear and a nice warm jacket…

**Analysis and Commentary**…Bats always fly to and from their caves at the same general times each day, leaving en masse near sunset, and returning at dawn. And they always use the same convenient opening to the cave for their comings and goings. You and your friend followed the bats as they returned home at dawn and entered the bat cave through the flight-entrance in the morning when the bats were home for the day. Once underground in a bat cave, even if you become lost you can always find the surface opening by just following the bats as they navigate toward the surface, since they fly as a group and always use the same exit to hunt for food at night.

So lighting a fire to follow escaping smoke and airflow patterns would not be a good choice, since not only might the smoke pool and contaminate the breathable air, but with many possible entrances, following an air flow pattern could get you in even deeper trouble. Using your GPS or compass would not help much either since you didn't think of using them until you discovered you were lost. And taking a GPS reading or getting a compass heading from a point where you are totally lost is of little value.
Several of you also suggested splitting up with your friend to explore in different directions. And, while you could perhaps cover more territory in search of the exit that way, we didn't think that was really advisable. Two heads are better than one. Two people can work to keep each other calm and focused, and if you both go off exploring in different directions, at least one of you will be headed the wrong way. And should one of you stumble into worse trouble, your problems could be considerably compounded.
By conserving your flashlight batteries for when you will need them to first locate, and then to follow the bats as they leave the cave is, to our thinking, the most promising and reliable course of action. And, with hardly any luck, you and your friend should, within 24 hours, or 36 at the most, be able to find your way back to the surface. (adapted from http://makezine.com/2017/05/31/the-makeshift-challenge-to-the-bat-cave/)

## 10. Sound Technologies

Sound can be modified on a radio, television or microphone by turning up the volume. Technology that supports making sound louder or 'amplifying' it – is something that an aging population, in addition, to the hearing impaired, need.

- Create an underwater telephone (if you have access to a swimming pool) or imagine what you think might happen

(adapted from http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/underwater+telephone.html)

1. Fit 2 funnels into the ends of a rubber tubing.
2. Stretch a balloon over the end of one funnel.
3. Make sure it is tight across the funnel
4. Place the funnel with the balloon into the water.
5. Place the other funnel over your ear.
6. Your partner will go underwater and talk through the other funnel under water.

Prediction: *I predict….*_____

_____

Sound is produced by vibrations.
The stretched balloon picks up vibrations that travel through the water. As the balloon starts to vibrate it amplifies the sound so you can hear it.

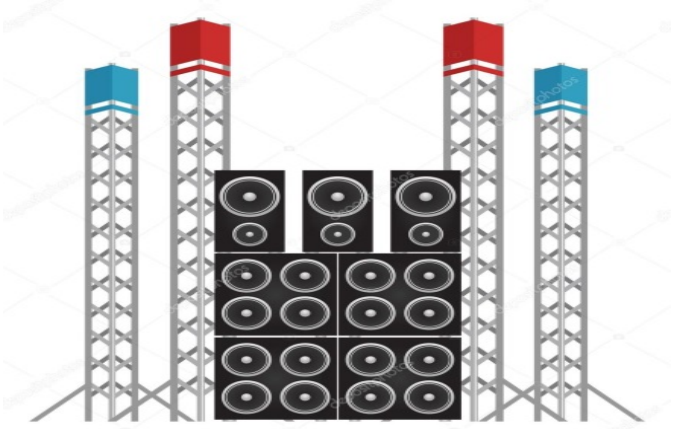
Where the Hertz measures how fast (the frequency) of sound vibrations, the **decibel** measures amplitude - the loudness of sound, by tracking the amplitude of the wave. Small differences in amplitude (short sound waves) make quiet sounds, while large differences (tall sound waves) make loud sounds.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

## TECH CHECK:

- http://www.sciencekids.co.nz/videos/humanbody/ear.html
- http://sciencing.com/make-model-ear-children-5833451.html
- http://www.fizzicseducation.com.au/Free+experiments/light+and+sound/slinky+shake.html
- http://www.sciencekids.co.nz/experiments/balloonspeakers.html

A speaker amplifies sound (makes it louder). At a concert with 20,000 people, you need speakers to hear the performer. Microphones connected to speakers allow for more members of an audience to hear music, even if they are not close enough to see the actual performers.



https://st2.depositphotos.com/1026665/8208/v/950/depositphotos_82080930-stock-illustration-festival-and-concert-speakers-plus.jpg

A loudspeaker uses electricity and magnets to pump sound into the air. Vibrations are attracted to and repelled from the magnet. A metal coil with electricity is wrapped around the magnet to capture the vibrations and amplify the sound.

- Have you been at a concert or factory and had to cover your ears?
- Have you walked past a work site and heard a jackhammer sound?

Loud noises for a brief period of time will usually not be harmful, but for people who work in noisy environments, it can be a problem. Work places need to be aware of and measure the amount of noise, as well as issue ear protection equipment to reduce the impact of the noise.

Making precise measurements of noise used to be quite a tricky business, but now there are automated, electronic sound-level meters that do the job for you. Let's take a closer look!

**Extension:**

- Read the following details about sound meters (adapted from http://www.explainthatstuff.com/soundlevelmeters.html)

*What makes one sound louder than another?*
Meters that measure sound levels work by calculating the pressure of the sound waves traveling through the air from a source of noise. That's why you'll sometimes see them referred to as sound pressure level (SPL) meters. Devices like this give a measurement of sound intensity in units called decibels, a scale first devised by telephone pioneer Alexander Graham Bell (decibel~Bell).

The Landing Signal Enlisted (LSE) is the brave person who has to guide helicopters and jet airplanes safely in to land on aircraft carriers. Notice that they always wear heavy duty earmuffs to protect their hearing against jet engine noise that can exceed 150dB at such close quarters… Sound level meters…have a pointy stick at the top, which is the microphone that samples and measures the sound. The stick keeps the microphone away from the body of the instrument, cutting out reflections, and giving a more accurate measurement. …longer-term analysis is a fairer and more accurate way of sensing whether sound is a nuisance or a health issue than simply relying on one or two instantaneous measurements.

- Complete the chart to compare the cost of at least 3 different sound meters.

| | **Sound meter 1** | **Sound meter 2** | **Sound meter 3** |
|---|---|---|---|
| Price $ | | | |
| What makes sound meter different than other sound meters? | | | |

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

- How are each of these items different from one another?

| **Sound Wave making devices** | **How they are different…** |
|---|---|
| cell phone | |
| car radio | |
| microphone | |
| hearing aid | |
| hands-free music/phone | |

**Sound Audit**

- What kinds of things make sound in your home?

**STEP OUTSIDE:**

- What kinds of things make sound outside our school?

- Talk about the difference in the two sound audits.
- If you used a sound meter, would it be more precise? Yes No ?
- Put a check beside the people who probably would not want to be in a noisy environment and talk about what their point of view would be different.

| | |
|---|---|
| appliance salesperson | |
| landscaper | |
| cottage owner | |
| yoga instructor | |
| vet | |
| rock band musician | |
| special effects technician | |
| hearing impaired person | |

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

## TECH CHECK:

- https://www.youtube.com/watch?v=b9Z-zEXEb6o (bullroarer) waves
- http://www.beltonehearingtest.com/
- http://www.primaryscience.ie/media/pdfs/col/Sound_Insulation_Younger.pdf

Advances in technology have allowed us to develop hearing aids for people who might never have been able to hear well without them. Such progress has led to music inventions, like music devices that can be played at high volume levels that can lead to hearing impairment.

- Read about hearing loss from two articles and then respond to the questions that follow:

**Article 2: Now Hear This** (John Mitchum)
What do former president Bill Clinton and rock musician Pete Townshend have in common? Both men have hearing damage from exposure to loud music, and both now wear hearing aids as a consequence. As a teenager, Clinton played saxophone in a band. Townshend, who has the more severe hearing loss, was a guitarist for a band called the Who. He is one of the first rock musicians to call the public's attention to the problem of hearing loss from exposure to loud music. Temporary hearing loss can happen after only 15 minutes of listening to loud music. One early warning sign is when your ears begin to feel warm while you listen to music at a rock concert or through headphones. "What happens is the hair cells [in the inner ear] are damaged, but they're not dead," says physician and ear specialist Dr. Sam Levine. According to Dr. Levine, if you avoid further exposure to loud noise, it's possible to recondition the cells somewhat. However, he adds, "Eventually, over a long period of time, hair cells are permanently damaged." And this is no small problem. When tiny hair cells in the cochlea (CO-klee-uh), a coiled tube in the inner ear, are damaged or destroyed, an abnormal sound is sometimes produced in a person's head. This sensation of a ringing in the ears is called tinnitus (tin-IH-tuss). Tinnitus can also consist of hissing, clicking, or buzzing sounds that can be heard only by the person affected with the condition.

What sound level is dangerous? According to Dr. Levine, regular exposure to noise in excess of 85 decibels is considered dangerous. A decibel is the unit of measurement for sound. Most people don't carry around the scientific equipment that measures decibels, though. The chart on this page offers a comparison of decibel levels to certain sounds. Here's another gauge you can use. If you're at a rock concert and the music is so loud that you have to shout to make yourself heard, you're at risk for hearing loss. That's when wearing protective devices such as earplugs becomes critical.

The facts are pretty frightening. But are rock bands turning down the volume? Most aren't. "Rock music is supposed to be loud," says drummer Andrew Sather. "I wouldn't have it any other way. And neither would the real fans of rock." Continued exposure to loud music and the failure to wear earplugs can lead to deafness, according to Dr. Levine. He states, "There's no cure for tinnitus or hearing loss. Your ears are trying to tell you something. That ringing is the scream of your hair cells dying. Each time that happens, more and more damage is done."

| Levels of Common Noises | Approximate Decibel (dB) |
|---|---|
| Normal conversation | 50–65 dB |
| City traffic | 70–75 dB |
| Food blender | 88 dB |
| Portable CD player on volume 5 out of 10 | 100 dB |
| Jet plane flying above a person standing outside | 103 dB |
| Rock band during a concert | 110–140 dB |

**Article 2: I Learned the Hard Rock Way (by David Todman)**

1 I always thought that hearing loss was something that affects other people—and not only other people, but much older other people.

2 I was a guitarist in a rock band for nearly nine years, and before that I attended every rock concert that came to town. If someone had suggested that I wear earplugs while playing or listening to music, I would have laughed. What was the point of listening to music if you couldn't enjoy it at full volume?

3 When I first began playing in a band, I noticed that my ears would ring after a concert and in normal conversations people's voices would sound muffled. But my hearing would return to normal in a day or two, so I didn't think there was any problem. I now know that people can lose their hearing gradually. My doctor explained that repeated exposure, week after week, causes permanent damage. I didn't realize that I had a problem until it was too late.

4 High-pitched sounds were the first ones I had trouble hearing. Different words—for example, hill, fill, and sill— sounded the same to me.

5 Sometimes my ears produce a low, dull sound, something between the hum of an organ and the purr of a car motor. At other times the sound is a ringing or a faint, high squealing. Still other times the sound is like the whooshing inside a seashell. The sounds can get so bad sometimes that I can't function. I become completely immobilized, often for hours at a time.

6 I'm now so concerned about the dangers of listening to loud music that I speak about the subject to students in middle schools and high schools. I tell students about a study in which researchers found that about 17 percent of middle school and high school students have some degree of hearing damage or loss and that the most significant hearing loss was detected in students who attend rock concerts frequently. It wasn't until my hearing loss was diagnosed by my doctor that I learned how delicate people's ears are. So please take my advice: protect your ears.

Don't go to loud rock concerts, or if you do go, use earplugs. It might not seem cool to wear earplugs, but let me tell you, hearing loss is definitely not cool. And, by the way, stuffing cotton in your ears won't do much good. That will reduce sound by only seven decibels.

8 Earplugs are not for wimps. Three of the four members of the band Metallica wear earplugs. If you play in a band, you'll still be able to hear yourself and the other instruments when you wear hearing protection devices…you may hear more clearly once distracting noise is curtailed or even completely blocked out. Musicians' earplugs are comfortable and easy to insert; they filter sound better than disposable plugs.

9 Music once meant everything to me. It was the center of my life and is still important. But preserving my hearing means more. After all, what good is great music if you can't hear it?

- Use the 'Now Hear This' article to answer questions below:

The tone at the beginning of the article is —

A. factual
B. humorous
C. urgent
D. hostile

- Which of these sentences is a warning from the author to the reader?

A. Most people don't carry around the scientific equipment that measures decibels, though.
B. When tiny hair cells in the cochlea (COklee-uh), a coiled tube in the inner ear, are damaged or destroyed, an abnormal sound is sometimes produced in a person's head.
C. If you're at a rock concert and the music is so loud that you have to shout to make yourself heard, you're at risk for hearing loss.
D. As a teenager, Clinton played saxophone in a band.

- The reader can tell that drummer Andrew Sather believes wearing earplugs is —

A. unreasonable
B. unsafe
C. harmless
D. impolite

- What is the purpose of the chart included at the end of the article?

A. To show readers that the only sounds that are dangerous come from music at rock concerts
B. To warn readers against exposing themselves to the sounds on the list
C. To give readers examples of the noise levels of some familiar sounds
D. To inform readers that normal daily activities will cause hearing loss

- In paragraph 3, the word recondition means to —

A. not be seen
B. fill with sound
C. become larger in size
D. make good again

- Use the 'I Learned the Hard Rock Way' article to answer questions. Which word best describes Todman?

A. Humorous
B. Formal
C. Encouraging
D. Patient

- When Todman speaks to students, he wants them to —

A. understand their risks of developing hearing loss
B. be involved in playing in rock bands
C. know that he still hopes to perform with a rock band one day
D. believe that wearing earplugs is the only option they have to prevent hearing loss

- Paragraph 5 is mainly about —

A. the sounds that are the most annoying for someone who has hearing loss
B. the effect of hearing so many different sounds at high decibel levels
C. the fact that a person with hearing loss can hear high and low sounds
D. the kinds of sounds that someone with hearing damage can experience

- What was one indication that Todman might have a problem with his hearing?

A. Certain words began to sound alike to him.
B. He began wearing earplugs, which blocked out some sounds.
C. Music at full volume became unbearable to listen to.
D. He was able to hear only sounds that were at a high pitch.

- Which of these best describes how Todman feels about his youthful experiences as a musician?

A. He believes that playing in a rock band helped him become a better public speaker.

B. He regrets having spent so many years playing in a rock band instead of developing other skills.

C. He wishes that he had known the long-term effects of listening to and playing loud rock music.

D. He is disappointed that he became involved in playing rock music rather than some other type of music.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

## 11. Noise Pollution

Technology can help us do things faster and sometimes easier. While a gasoline-powered lawn mower or leaf blowers saves time, these things can lead to noise pollution.

https://userscontent2.emaze.com/images/c0314ce2-2fb9-41d2-8690-3d9655dac08f/450e5a32a0fb0002892846eeaae22a85.png

The issue of wind turbines has been a problem for some local people, and birds, if these large devices wind up in migratory paths.

http://storage.theenterprisebulletin.com/v1/dynamic_resize/sws_path/suns-prod-images/1297437524895_ORIGINAL.jpg?quality=80&size=650x&stmp=1447294031035

- Read this summary of an article about Carla and Mike Stachura's concern about wind farms.

**Ontario family says wind turbines have made life a 'nightmare'**
(By Brian Hill, Global News, May 31, 2017 8:05 am,
adapted from http://globalnews.ca/news/3490234/ontario-wind-turbines-family-complaints/)

Carla Stachura and her husband Mike thought they'd found the perfect spot to retire. A house in rural Ontario where they run a wildlife sanctuary with lamas and a variety of birds, and planned to spend their retirement years enjoying the peace and quiet of country life. But that dream was shattered when wind turbines began popping up near their Goderich, Ont. home. Since then, their dream has become a nightmare. The couple says they've been unable to sleep and exposed to prolonged periods of annoying noise. Adding to their frustration, they say the provincial government won't lift a finger to help them, other than order more tests.

"We've been having issues since they turned the turbines on," said Carla. "It was alarming. There was a high pitched tonal wooing...And that was in addition to crashing and the thumping and the whomping." The couple purchased the property in 2003. They say it was paradise until the K2 Wind Farm, operated by Pattern Energy, started operations in the spring of 2015. "I immediately called K2," Carla said. Over the past two years, officials from the ministry have measured violations of the province's noise limits at the couple's home on two occasions, first in August 2015 and again in March 2017. Despite these violations, the couple says the government has done nothing other than order more tests... ...documents show that in 54 per cent of all cases – more than 1,700 individual complaints – the ministry did not investigate residents' concerns..."The lack of response from the ministry shows just how unprepared they were for the potential effects of putting these giant machines so close to people and their communities," said Jane Wilson, president of Wind Concerns Ontario.

But Glenn Murray, Ontario's Minister of the Environment and Climate change, says this couldn't be further from the truth. He says the government works quickly and thoroughly to address concerns. He also says he has great empathy for anyone suffering due to wind turbine noise.

According to Charbonneau, the ministry promised a thorough noise review would be conducted within two years of the turbine starting up. This is supported by a 2012 letter from the director of the ministry's environmental approvals branch, Doris Dumais...

The complaint files also show that as late as November 2015, a lack of monitoring resources and incomplete noise reports prevented environmental officers from the ministry's Guelph district office from responding to complaints. The complaint file notes that nighttime monitoring resources were no longer available after February 2015. This is important because many complaints occur during evening and nighttime hours, when residents are trying to sleep and background noise is minimal.

Back in Goderich, the Stachura's are finally seeing some action from the Minister...According to the families in the area, the company has agreed to begin testing. However, the families say this provides little comfort given the long history of the problems they've faced. "We want to be able to resume our lives," said Carla. "This is an agricultural area. Never did we think that this would be turned into an industrial site."

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https://qph.ec.quoracdn.net/main-qimg-dd62f0ec4838794889f3614a19712298-c

- Now talk about these more modern wind turbines that look like trees:

https://cdn.psfk.com/wp-content/uploads/2016/08/claudio-coluccis-design-psfk.com_.jpg

- Create 3 questions about these tiny wind turbines?

1. _____

2. _____

3. _____

**Challenge**: Find out where these micro turbines are being used?

http://assets.inhabitat.com/files/eight-turbines.jpg

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

## TECH CHECK:

- Ontario residents fight wind turbines planned near Collingwood airport
- Ontario signals offshore wind moratorium will continue for years
- Wind turbines reach for new heights
- Fight to stop huge Ontario wind farm begins legal battle
- Ontario court dismisses wind turbine appeal brought by farm family
- Anti-turbine families in Ontario fight $340K legal bill from wind farm companies
- http://www.goodnewsnetwork.org/shimmering-leaves-paris-actually-tiny-wind-turbines/
- http://www.reuk.co.uk/wordpress/wind/hong-kong-micro-wind-turbine-arrays/

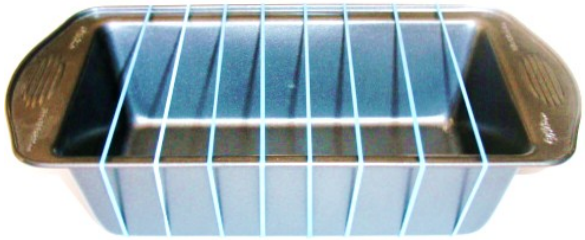
## 12. Making Music: Good Vibrations

- Browse books, the web and if time, music stores to select an instrument you want to make on your own.
- Use the Scientific Method to test your product.
- See samples below:

https://s-media-cache-ak0.pinimg.com/736x/9a/70/5f/9a705fa5557176f26af921dbb4b44f18.jpg

https://s-media-cache-ak0.pinimg.com/564x/3f/ac/47/3fac47a8fc3ec28c18b600d0270f1112.jpg

http://blog.customboxesnow.com/wp-content/uploads/2016/02/cardboard_box_guitar_2-576x1024.jpg



http://2.bp.blogspot.com/-YDkolXe649c/TWZseZ4BmNI/AAAAAAAAAWM/y_pMdZixW6Y/s1600/Sound+Exper+-+musical+instrument.jpg

- How might you use what you know about sound in your device?
- Which properties of sound will be most useful to you in your device?

- What challenges might you encounter, and how can you overcome them?

**Musical Instrument Design Experiment**

**Prediction & Hypothesis:**

**Procedure:**

**Observations:**

**Findings:**

## Recommendations:

**Extension: River Dance**

The dance and musical production 'Riverdance', features much more than Irish dancing. Find out more about how this production formed its band from different instruments all over the world, and how the beat of music knows no boundaries. How are dance forms and musical instruments similar in different parts of the world? Create a video or PowerPoint to share with your classmates…how 'the beat goes on'... http://www.ehow.com/info_8193784_instruments-used-riverdance.html

http://www.celticpiper.net/Images/ulpipe2.jpg

- Perhaps your whole family created an instrument and you want to share a musical performance at our Hawk Exhibition. Let us know if you would like to perform. (optional)

## TECH CHECK:

- http://www.howcast.com/videos/501425-how-to-cut-decorate-a-homemade-guitar-musical-instruments/
- http://kiddley.com/2013/07/09/10-great-musical-instruments-to-make-at-home/
- https://ehomerecordingstudio.com/home-recording-studio-essentials/
- http://youtu.be/89LJyK4drtI (Edmondo use) make an instrument
- http://www.sciencekids.co.nz/experiments/makemusic.html

## 13. The Foley Room

What is a Foley sound, and what is a Foley Room? Foley is the term used for a room and the sounds made in the room that replicate everyday sound effects needed to be added in to media, such as movies. These reproduced sounds can be **anything** from the swishing of clothing and footsteps to squeaky doors and breaking glass.

A **Foley** artist creates this sound art. Matching sounds with what is happening in a movie is not an easy job! When movies are made, you can't hear doors opening and shutting. These sounds have to be added into the movie after it is made. The **Foley** artists make viewers believe that the sound effects are actually real. The viewers should not be able to realize that the sound was not actually part of the filming process itself.

https://pbblogassets.s3.amazonaws.com/uploads/2015/03/Foley-Stage.jpg

**Sound** effects (or audio effects) are artificially created or enhanced **sounds**. They are used to emphasize important parts of movies, television shows, live performances, animation, and video games. Foley artists can make up to $340 per day!

If you like making messes, this is the job for you!

http://blog.benztown.com/imaging/wp-content/uploads/2014/09/11-Bottle-breaking-session-in-the-foley-room.jpg

**TECH CHECK:** Check out these videos of what happens in a Foley Room!

- https://www.youtube.com/watch?v=UO3N_PRIgX0
- https://www.youtube.com/watch?v=Gqs1KO_HKWY

- Plan to make a 3-minute video about sound – that includes action.
- Keep track of the exact time in the video when the action occurs.
- Try to replicate the timing of the action using sounds like you are in a Foley Room.

| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

# 14. Other Sound Careers

https://static1.squarespace.com/static/56f04afb2fe131e766421765/t/57c8f93db3db2b6e1697dfd3/1472995997808/

**Sound technicians** assemble, operate and look after the equipment used to record, amplify, enhance, mix or reproduce **sound**.

An audio **engineer** focuses on the technical aspects of sound during the recording, mixing, and reproducing of music. Audio **engineers** often help musical artists and record producers.

A **mix engineer** is responsible for combining different sonic parts (ie. vocals and instruments) of a piece of recorded music into the final song.

**Extension:**

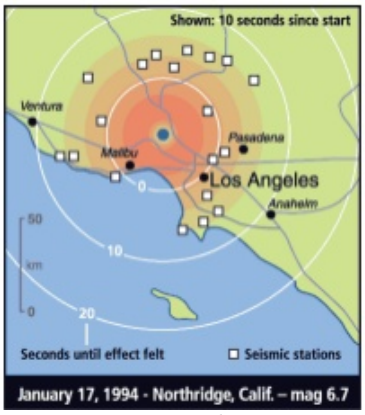
- Research what is involved in creating a local radio station
    - http://www.wikihow.com/Start-a-Low-Power-FM-Radio-Station
    - https://www.hobbybroadcaster.net/contact.php

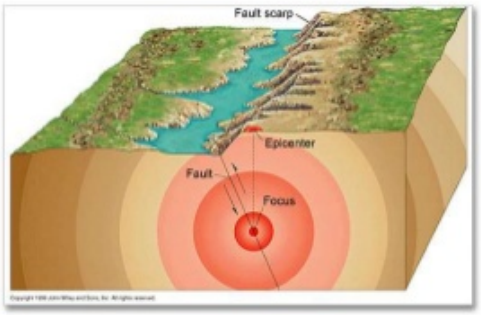
# Other Waves

## 15. Seismic Waves

### How Earthquakes Travel

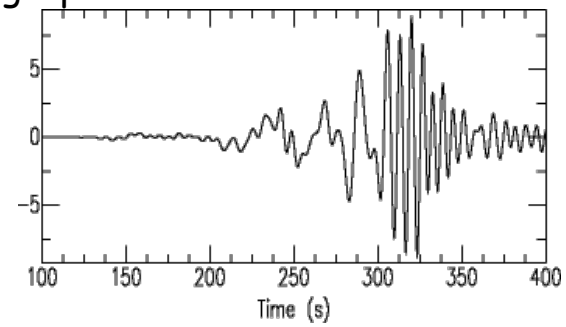
- **Seismic waves**—vibrations that travel through Earth caused by EQs




https://image.slidesharecdn.com/seismicwaves6th-141216130057-conversion-gate01/95/seismic-waves-6th-5-638.jpg?cb=1418734899

Seismic waves are waves of energy caused by sudden rock breaking within the earth. These energy waves travel through the earth and are recorded on seismographs.




http://eqseis.geosc.psu.edu/~cammon/HTML/Classes/IntroQuakes/Notes/Images_specific02/dispersed_wave.gif

**Extension:**

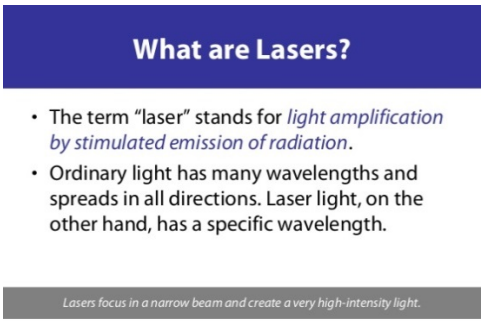
- Read this web article together to find out how sound waves and seismic waves (underground) are alike.

**Sound Waves Can Trigger Earthquake Aftershocks in Science Daily**
(adapted from https://www.sciencedaily.com/releases/2008/01/080103124649.htm)
Date: January 3, 2008
Source: DOE/Los Alamos National Laboratory

Using a novel device that simulates earthquakes in a laboratory setting, a Los Alamos researcher and his colleagues have shown that seismic waves--the sounds radiated from earthquakes--can induce earthquake aftershocks, often long after a quake has subsided. The research provides insight into how earthquakes may be triggered and how they recur…In a letter appearing in *Nature*, Los Alamos researcher Paul Johnson and colleagues Heather Savage, Mike Knuth, Joan Gomberg, and Chris Marone show how wave energy can be stored in certain types of granular materials…Perhaps most surprising, researchers have found that the release of energy can occur minutes, hours, or even days after the sound waves pass; the cause of the delay remains a tantalizing mystery.

Earthquakes happen when the Earth's crust slips along cracks, known as faults. Major faults can be found at tectonic plates. Each earthquake releases seismic waves--vibrations near or below the range of human hearing--that travel through the Earth. These waves can trigger aftershocks in a zone several to tens of miles away from the radiating main earthquake, known as a "mainshock."…at Pennsylvania State University, Marone developed an apparatus that mimics earthquakes by pressing plates atop a layer of tiny glass beads. ... Johnson wondered whether sound waves could induce earthquakes in such a system. His colleagues originally believed sound would have no effect. Much to their surprise, the earthquake machine revealed that when sound waves were applied for a short period just before the quake, they could induce smaller quakes, or, in some instances, delay the occurrence of the next major one…More surprising still, the team found that the granular beads could store a "memory"…"The memory part is the most puzzling," Johnson said, "because during an earthquake there is so much energy being released and the event is so violent that you have to wonder, why doesn't the system reset itself?" The research has helped confirm that earthquakes are periodic events and that sound can disrupt them. "What we've created in the laboratory has provided the basis for an understanding of dynamic triggering of earthquakes, something that has mystified people for years," said Johnson. Other institutions besides Los Alamos National Laboratory involved in the research include Penn State, the University of California-Santa Cruz, the University of Wisconsin, the United States Geological Survey, and University of Washington.

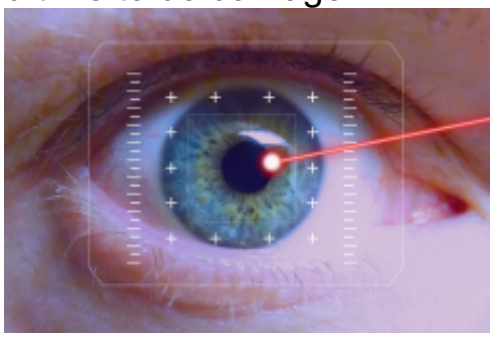
# 16. Laser Beams and Motion Detectors




https://image.slidesharecdn.com/medicallaserprocedures2-130507121640-phpapp01/95/medical-and-veterinary-laser-fumes-2-638.jpg?cb=1367929049

Lasers produce narrow beams of intense light. They often have pure colors. They are dangerous to eyes. Lasers are more than powerful flashlights. "The difference between ordinary light and laser light is like the difference between ripples in your bathtub and huge waves on the sea." (http://www.explainthatstuff.com/lasers.html) A laser starts off with weaker light and keeps adding more energy. This concentrates the light so it can cut through metal or travel great distances (kilometers).

Lasers were discovered in the sixties, and now we use them in our homes (ie. music players; laser printers), in stores (ie. barcode scanners), and they are widespread in hospitals and manufacturing (ie., eye surgery, fiber-optic cables, clothes cut with lasers). The US military developed laser-guided weapons and missiles… long-range laser weapons called SDI (Strategic Defense Initiative), better known as the 'Star Wars' program. The original idea was to use space-based lasers to destroy incoming enemy missiles before they had time to do damage.



http://angelasanalysis.com/wp-content/uploads/2015/05/lasers-495751_1280.png

**Extension:** Read the following article and respond to the questions.

**Laser Beams**

I am very interested in the development and use of lasers. I first became interested after I saw the movie Star Wars. Curious if lasers were ever used in the real world, I began studying their origins. I did research at the library and found that a pulse laser is basically a device used for storing energy and then releasing it all at once to give an intense beam of light. Also, the word laser is an acronym for "Light Amplification by means of Stimulated Emission of Radiation." The different types of lasers are: solid state, gas, semiconductors, or liquid.

The first pulse laser was invented in 1960 by Theodore Maiman. It contained a ruby crystal and produced a short flash of light. His pulse laser has been improved and can now produce light ten million times the intensity of sunlight. In recent years, the laser has been used for many important tasks. In construction, the laser beam can be used for precise alignment in the building of tunnels and pipelines. Laser beams can also be used to measure distance and speed. For example, the Apollo astronauts used a laser beam and a special mirror to accurately measure the distance from the earth to the moon. New uses for lasers are currently being developed in the medical world. Eye surgery and skin cancer treatment are performed with lasers. Also, lasers are beginning to replace radio waves in communication. Laser beams can carry many more channels of information than radio waves. I now understand that laser beams are more than weapons in science fiction movies. Laser beams are instruments of the future. Research should continue to develop new and improved uses for the laser beam.

Which of the following is not mentioned as a modern use of the laser?

A. The laser beam can be used in construction.

B. The laser beam is used in meteorology to detect air layers.

C. The laser beam can be used to measure distance and speed.

D. The laser beam can be used to treat skin cancer.

The laser can produce light _____.

A. slightly weaker than sunlight

B. ten million times the intensity of sunlight

C. one million times the intensity of sunlight

D. slightly stronger than sunlight

## Motion Detectors


Never fear, motion detectors are near.

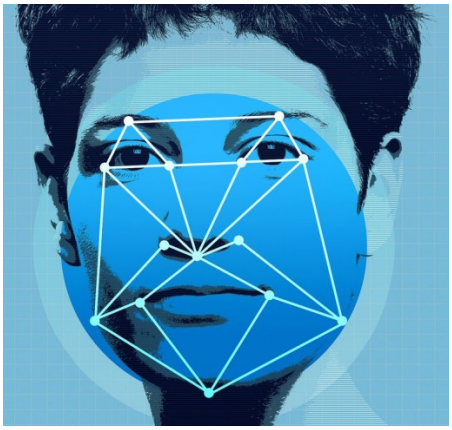
A **motion detector** detects moving objects, particularly people. Passive infrared **motion detectors** (PIR) detect emitted infrared energy – given off by humans and animals in the form of heat. When there is a sudden increase in infrared energy, an alarm is sounded.

https://www.safety.com/wp-content/uploads/2013/02/burglar-and-motion-detector.png

Motion detection devices can be used for many purposes including security, automatic lighting (at a dock at night when your boat pulls up), home heating and cooling control.


https://images-na.ssl-images-amazon.com/images/G/01/aplusautomation/vendorimages/d9152d9d-b240-4cae-bebc-eb5e9bf79b26.jpg._CB316629156_.jpg

Security at airports, for instance use sensor waves for facial recognition:



https://cdn.vox-cdn.com/thumbor/jf1w8CLddmG6Ht9IByX9HXeK_Jk=/0x0:2040x1360/1200x800/filters:focal(814x1034:1140x1360)/cdn.vox-cdn.com/uploads/chorus_image/image/54312673/jbareham_170417_1617_0002.0.jpg

Make a list of 3 things you encounter in a week that you think might be using sensors:

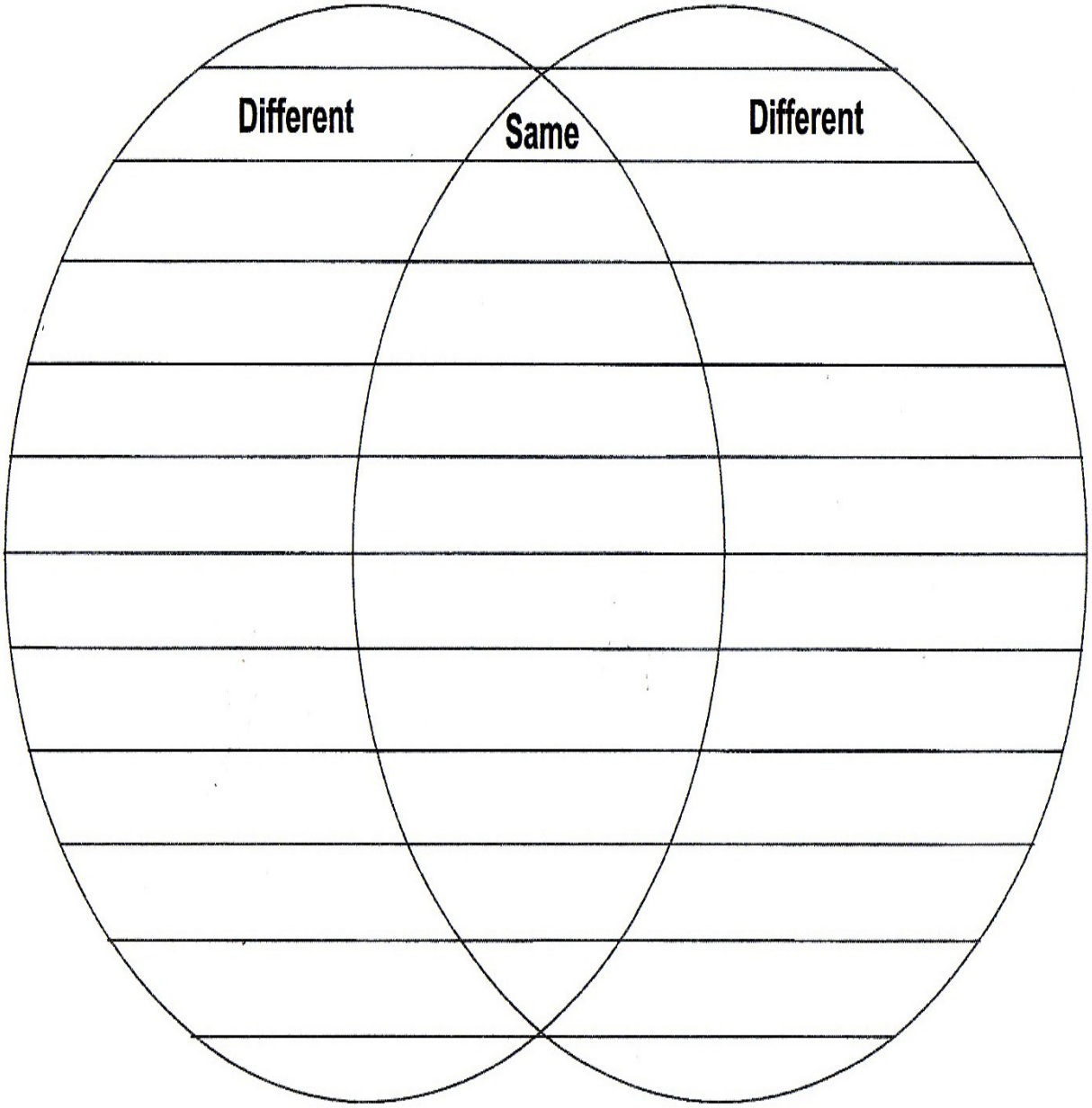
| | | | |
|---|---|---|---|
| How well did I do on this task? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
| | | | |

## TECH CHECK:

- http://www.nrcan.gc.ca/node/9371 (Microwave oven)
- http://science.howstuffworks.com/magnetism-channel.htm
- http://science.howstuffworks.com/x-ray.htm
- https://www.youtube.com/watch?v=IgOiD-oMjvY (radiation)

## Quiz

- Use a Venn diagram to compare sound and light waves



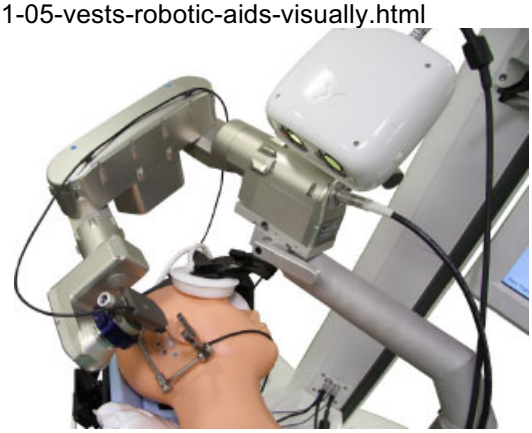

| How well did you examine light and sound? | Trailblazer (Expert) | Pathfinder (Apprentice) | Rookie (Not Yet) |
|---|---|---|---|
| | | | |

# Sight or Hearing Impairment Invention Paired Project

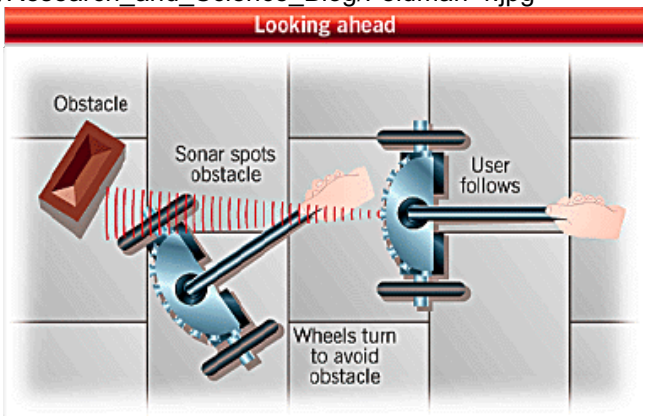
- Create a robotics solution to help people with seeing or hearing impairments.
- Start by browsing some websites and viewing some images.

## TECH CHECK:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2279150/
- https://www.sciencedaily.com/releases/2015/05/150512112253.htm
- http://gajitz.com/more-human-than-human-scary-robot-helps-deaf-to-speak/
- https://www.youtube.com/watch?v=yZ6vSn7PaPI
- http://www.hearingreview.com/2017/03/researchers-develop-high-precision-surgical-robot-perform-cochlear-implantations/
- http://www.roboticstrends.com/article/how_baxter_the_robot_can_help_blind_people_navigate
- https://www.technologyreview.com/s/540961/researchers-employ-baxter-robot-to-help-the-blind/
- http://www.unr.edu/nevada-today/news/2015/robotics-to-help-blind-navigate
- https://www.sciencedaily.com/releases/2015/09/150911141112.htm
- https://www.livescience.com/47505-robotic-walking-stick-improves-mobility-nsf-ria.html
- https://phys.org/news/2011-05-vests-robotic-aids-visually.html



http://www.flir.com/uploadedImages/Research-Science/Blog/Research_and_Science_Blog/Feldman-4.jpg




http://www.robotbooks.com/robot2.gif

**Task and Materials:**

- Make some predictions using these questions:
    - Will it work better than what currently exists?
    - Will it be a time savor?
    - Will it cost less?
    - Will it do several things at one time?
    - Will it help someone move easier?
    - Will it help someone be entertained more?
    - Will it use renewable/non-renewable energy?
    - Will it include a list of safety rules for use?
    - Wil your invention fit through a door?

- At first you can go back and forth between designing blueprints of your ideas – and building samples.
- At the end of the semester everyone will talk about and share their invention with classmates, teachers and family members.

**Starter Materials:** pencil, duck-tape, boxes (large and small), scissors, magnet strips, material, buttons, safety pins, crayons, newspapers, magazines.

- Use your Learning Journal to make and label diagrams
- _List other things you might need for your invention.
- At the end, your report should be labeled with accurate measurements of size, weight, volume/capacity, temperatures, and costs of various parts and materials used in the invention
- At the end of the semester, create an experiment report using these headings:
    - Prediction
    - Procedure
    - Observations
    - Findings
    - Recommendations

## The STEM Measurement Quiz

- Create Test Questions for the STEM Measurement Quiz (using the following things you need to know)
- Submit questions on separate index cards - to your teacher – with questions on the front and your answers on the back.
- Be sure to ask for help if/when you are stuck ☺

Using a ruler, draw a pencil that is 5 cm long.
How many mm in a pencil that is 5cm long?
Using a ruler, draw a line that is 115mm long.
How many cm in a 110mm line?
What is larger or smaller, using mm, cm, dm, km?
Solve a problem about sound or light with a 50cm object and a 1m object.

Tell time in to the minute using 1 and 24 hour clock.
How many weeks in a year?
How many minutes in week?
How fast is the speed of light?
How fast is the speed of sound?
How many decades ago were laser beams discovered?
In what decade did Chuck Yeager break the sound barrier?
What kinds of music were popular in different centuries?

Create a time lapse problem like:

- If you wake up at 7:30 a.m., and it takes you 10 minutes to eat your breakfast, 5 minutes to brush your teeth, 25 minutes to wash and get dressed, 5 minutes to get your backpack ready, and 20 minutes to get to school, will you be at school by 9:00 a.m.?
- You are travelling from Toronto to Montreal by train. If the train departs Toronto at 11:30 a.m. and arrives in Montreal at 4:56 p.m., how long will you be on the train?

**Extension:**
How many grams are in one serving if 1.5 kg will serve six people?

## Final Check

What method do scientists use to discover things?

What are waves?

What is a light spectrum?

What makes sound?

Bonus ☺
What does a Foley Room do?

# Appendix A:
# Ontario Ministry of Education and Training Light and Sound SCIENCE Expectations

**4C. UNDERSTANDING MATTER AND ENERGY: LIGHT AND SOUND**

4C1.1 assess the impacts on personal safety of devices that apply the properties of light and/or sound, and propose ways of using these devices to make our daily activities safer

4C1.2 assess the impacts on society and the environment of light and/or sound energy produced by different technologies, taking different perspectives into account

4C2.1 follow established safety procedures for protecting eyes and ears

4C2.2 investigate the basic properties of light

4C2.3 investigate the basic properties of sound

4C2.4 use technological problem-solving skills to design, build, and test a device that makes use of the properties of light or sound

4C2.5 use scientific inquiry/research skills to investigate applications of the properties of light or sound

4C2.6 use appropriate science and technology vocabulary, including natural, artificial, beam of light, pitch, loudness, and vibration, in oral and written communication

4C2.7 use a variety of forms to communicate with different audiences and for a variety of purposes

4C3.1 identify a variety of natural light sources and artificial light sources

4C3.2 distinguish between objects that emit their own light and those that reflect light from other sources

4C3.3 describe properties of light, including the following: light travels in a straight path; light can be absorbed, reflected, and refracted

4C3.4 describe properties of sound, including the following: sound travels; sound can be absorbed or reflected and can be modified

4C3.5 explain how vibrations cause sound

4C3.6 describe how different objects and materials interact with light and sound energy

4C3.7 distinguish between sources of light that give off both light and heat and those that give off light but little or no heat

4C3.8 identify devices that make use of the properties of light and sound

# Appendix B:
# Ontario Ministry of Education and Training MATHEMATICS Measurement Expectations

**3B. MEASUREMENT**

3B.1.2 draw items using a ruler, given specific lengths in centimetres (

3B.1.3 read time using analogue clocks, to the nearest five minutes, and using digital clocks, and represent time in 12-hour notation

3B.1.4 estimate, read, and record positive temperatures to the nearest degree Celsius

3B.1.8 choose benchmarks for a kilogram and a litre to help them perform measurement tasks; – estimate, measure, and record the mass of objects, using the standard unit of the kilogram or parts of a kilogram; estimate, measure, and record the capacity of containers, using the standard unit of the litre or parts of a litre

3B.2.1 compare standard units of length, and select and justify the most appropriate standard unit to measure length;

3B.2.2 compare and order objects on the basis of linear measurements in centimetres and/or metres in problem-solving contexts;

3B.2.5 compare and order a collection of objects, using standard units of mass and/or capacity;

3B.2.6 solve problems involving the relationships between minutes and hours, hours and days, days and weeks, and weeks and years, using a variety of tools

**4B. MEASUREMENT**

4B.1.1 estimate, measure, and record length, height, and distance, using standard units; – draw items using a ruler, given specific lengths in millimetres or centimetres

4B.1.2 estimate, measure, and represent time intervals to the nearest minute;

4B.1.3 estimate and determine elapsed time, with and without using a time line, given the durations of events expressed in five-minute intervals, hours, days,weeks, months, or years

4B.1.5 estimate, measure, and record the mass of objects, using the standard units of the kilogram and the gram;

4B.1.6 estimate, measure, and record the capacity of containers, using the standard units of the litre and the millilitre;

4B.1.7 estimate, measure using concrete materials, and record volume, and relate volume to the space taken up by an object

4B.2.4 compare and order a collection of objects, using standard units of mass and/or capacity

4B.2.5 determine, through investigation, the relationship between grams and kilograms

4B.2.6 determine, through investigation, the relationship between millilitres and litres

4B.2.7 select and justify the most appropriate standard unit to measure mass and the most appropriate standard unit to measure the capacity of a container

4B.2.8 solve problems involving the relationship between years and decades, and between decades and centuries

**5B. MEASUREMENT**

5B.1.1 estimate, measure (i.e., using an analogue clock), and represent time intervals to the nearest second;

5B.1.2 estimate and determine elapsed time, with and without using a time line, given the durations of events expressed in minutes, hours, days, weeks, months, or years

5B.1.3 measure and record temperatures to determine and represent temperature changes over time

5B.2.2 solve problems requiring conversion from metres to centimetres and from kilometres to metres

5B.2.3 solve problems involving the relationship between a 12-hour clock and a 24-hour clock

5B.2.9 select and justify the most appropriate standard unit to measure mass

**Extensions:**

**6B. MEASUREMENT**

6B.1.1 demonstrate an understanding of the relationship between estimated and precise measurements, and determine and justify when each kind is appropriate; – estimate, measure, and record length, area, mass, capacity, and volume, using the metric measurement system.

6B.2.1 select and justify the appropriate metric unit to measure length or distance in a given real-life situation

6B.2.2 solve problems requiring conversion from larger to smaller metric units

# Appendix C:
# Common Core State Science Standards:

## Sound – 5.2

- Sound travels in compression waves
- Transmission of sound through different medias (solids, liquids, gases) –vacuum
- Waves (sound) vs. rays (light)
- Pitch/frequency, vibrations, compression
- Hearing ranges (compare/contrast)
- Uses and applications (musical instruments, voice/hearing, sonar, animal sounds)
- Sound-form of energy
- Sound production
- Absorption

## Light – 5.3

- Visible light spectrum, ROYGBIV
- Light waves, wavelength, transverse waves
- Light travels in a straight line
- Reflection, refraction, absorption, transmission, velocity, dispersion
- Opaque, transparent, translucent
- Speed of light, & speed/ distance it travels from the sun