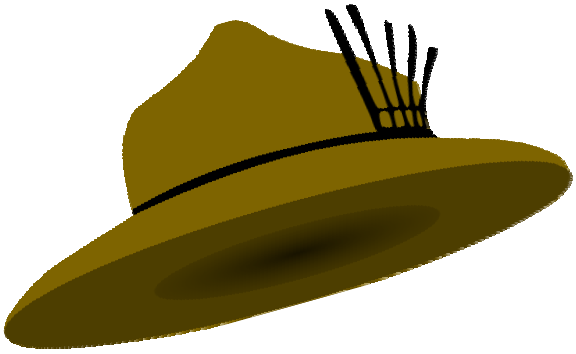
Discovery Challenge

Learn How Things Work

A boy carries out suggestions more wholeheartedly when he understands their aim.

Sir Robert Baden-Powell



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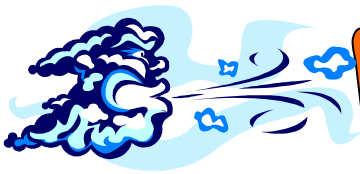


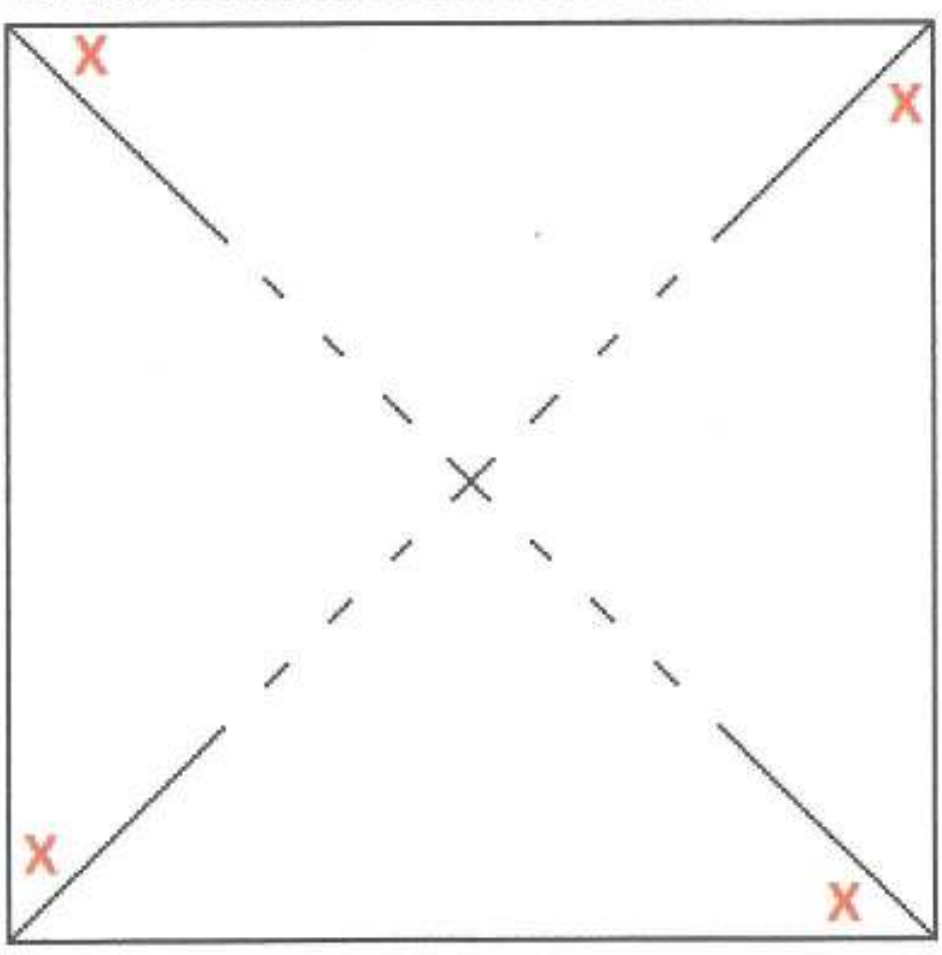
Wind Power

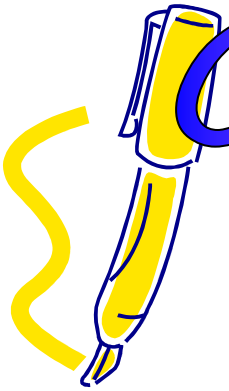
How to do it:

- Craft out a square of bright paper, 10 x 10xcm
- Cut halfway down from each corner to the middle.
- Fold the corners marked X to the middle and glue them down.
- The folds should curve and not lie flat.
- Make a hole in the middle with a pencil and push a straw through. Secure it in position with a poster tack
- Now tape a paperclip to a second straw. Then push the windmill straw through the paperclip.
- Cut a piece of cotton thread about the length of two straws. Stick a lump of poster tack to one end.
- Tape the thread to the windmill straw. Wind the thread around it, leaving some hanging down.
- Hold the other straw and blow to the side of the windmill. It will spin around, making the thread roll up.

What is happening?

Your breath acts like wind and turns the windmill. This provides energy to pull up your small load of poster tack. Wind farms use much bigger windmills in the same way. The windmills turn machines and supply energy to generators to make electricity.

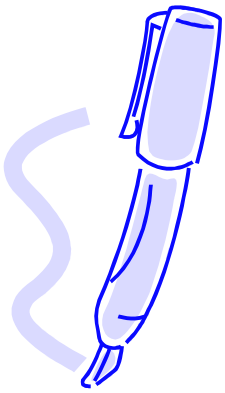




Climbing Ink

The ink in most felt-tip pens contains a mixture of different colours. Some colours dissolve more easily in water than others. These colours spread quickly up the paper.

Other colours do not dissolve so easily in water. These colours stick to the paper and so do not move up the paper as water spreads.



How to do it:

- Cut some white blotting paper into strips slightly longer than
- the depth of a large plastic tub.
- Make a dot with a different coloured felt-tip pen a little way up each strip. Write the colour at the top in pencil
- Pour just enough water into the tub to cover the bottom.
- Then tape a piece of string across the top of the tub.
- Fold the strips over the string, so that the ends near the dots are in the water but the dots are not.
- The appear will start to soak up water. Lift out the strips after ten minutes.

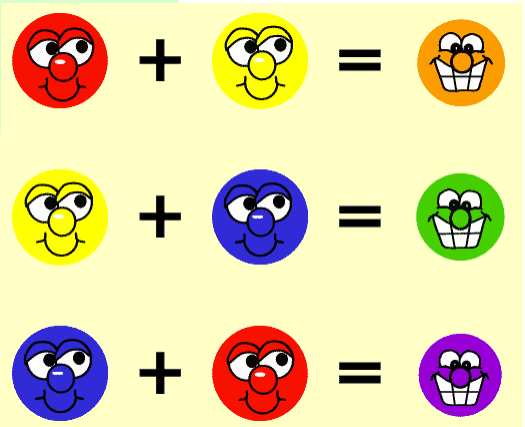
What has happened to the dots?

Primary and Secondary Colours

Primary Colours: Primary colours are yellow, red and blue. These are the 3 starter colours and cannot be created using an other combination of colours. Hence their name: Primary Colours.

Secondary Colours: Secondary colours are orange, purple and green. They are made by mixing two primary colours. Green is a perfect example of a secondary colour, which is made by mixing yellow and blue. It's important to remember that to create secondary colours you need to start with true primary colours.

All other colours are created using various combinations of primary and secondary colours.



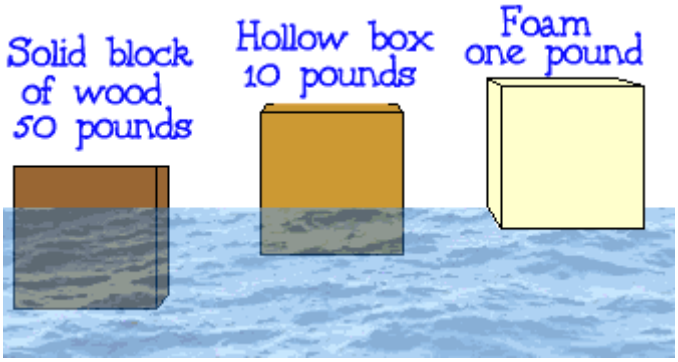
Colour mixing is a matter of proportion. How much of each colour that goes into the mix determines the outcome. It is always best to start your mix with the lightest of the pigments you are using, and add the others to it.

Colours will look different if you mix them on your paper rather than in your palette. Some artists like to only mix their colours on paper, to give a blend while others like the control of colour that mixing in the palette gives. You can experiment with both methods to find the way that suits you. Are you interested in learning how to mix colours? Have you ever mixed red, blue and yellow paint to find out what new colours you get? Want to know how to create secondary Colours? Now it's time to learn how!

How Boats Float

A boat, or any other object designed to float, is based on a theory by a very old cool guy and his name was **Archimedes (Ark-i'-meed-eez)** [shown in picture]. His principle explains how things float.

If you fill your bathtub with water, what happens when you get in? The water rises, right? (And sometimes goes over the side.) That is because you "displaced" some of the water with your body and it had to go somewhere. The key to floating is that the object must displace an amount of water which is equal to its own weight.



For example, suppose you had a block of wood that was 1 foot square. Let's say that this block of wood weighs about 50 pounds. Now say we lower that wood into the water. The wood will move down into the water until it has displaced 50 pounds of water. That means that 50 pounds of water are pushing back up on the block and making it float.

The principle of floating is pretty easy, however, if you want to remain inside the boat and actually get where you want to go, your boat must have "stability" as well as being able to float. Stability means that it is designed not to tip over easily.

As an experiment fill in a small tub of water and see what household items float and what sink.

How Trains Work

- There are all kinds of different trains that are built for a range of purposes and environments. Mainly they are built to transport passengers or cargo along rail tracks.
- Trains can be powered by a variety of energy sources including steam, diesel and electricity.
- Early trains relied on ropes, horses or gravity.
- The use of steam locomotives developed through the 19th century before diesel and electric locomotives began to replace them in the 20th century.
- Cargo trains are typically powered by a locomotive which pulls from the front.
- Some trains have a second locomotive which helps by pushing from the back.
- Passenger trains often feature self-propelled carriages that can be joined with other units. Trains such as these are more energy efficient but may require more maintenance than a single locomotive vehicle.
- Some high speed rail services can reach speeds over 300 kph (186 mph).

- In operation since 1964, Japan's Shinkansen (bullet train) is a well known example of a high speed passenger rail system.
- Opened in 1994, the Channel Tunnel carries passengers between the UK andFrance on a high speed railway.
- Technologies such as magnetic levitation may provide faster, more efficient train travel in the future. Magnetic levitation propels trains forward using magnets, keeping the vehicle levitated but close to the track.
- Monorails feature a single rail and are often elevated above ground.
- Funicular railways feature two cars/trams attached by cables that counterbalance each other as they move up and down a steep slope.

Matchbox Train Set

What you'll need:

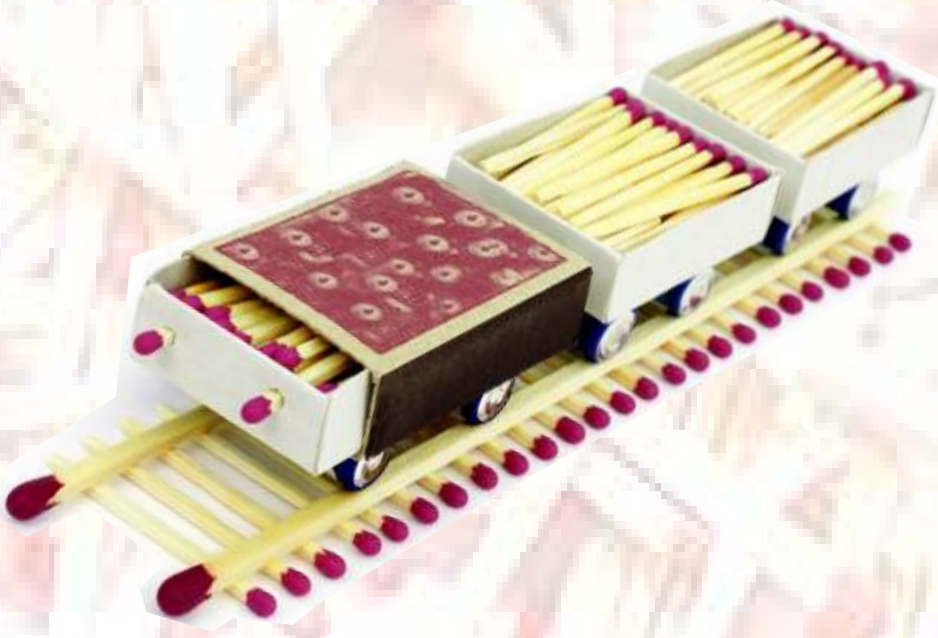
- 3 Full small match boxes
- 2 long matches
- 6 batteries
- Glue
- Cardboard paper (Brown for soil, Grey for a dirt road or simply white)
- Decorations—Trees, bushes, rocks, beads, etc

How to do it:

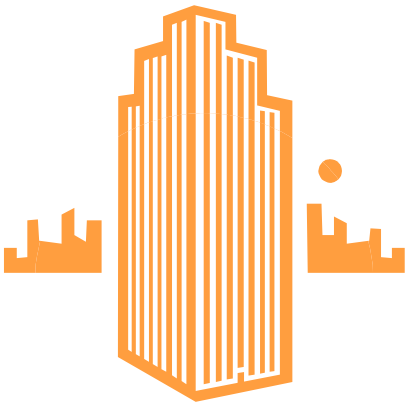
- Glue the batteries to the bottom of the match boxes.
- Punch two holes in one of the boxes and insert two small matches through. These will be your train headlights.
- Lay the small matches like train tracks and glue them to the cardboard paper.
- Lay the long matches across the small ones and glue them. These will be your train rails.
- Put the match box train set on the tracks.
- Fill in the boxes with the left over matches or other items such as beads, gummy bears, and other small items that can fit.
- Decorate the landscape around your train with rocks, small pieces of bushes, etc.

Warning Safety Tip:

Since we are dealing with fire matches, it is imperative that Beaver Scouts are kept under strict supervision at all times. Unless you remove the tips of the matches with scissors.

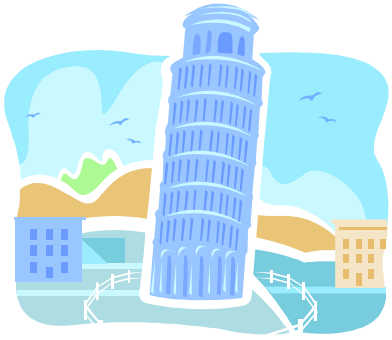


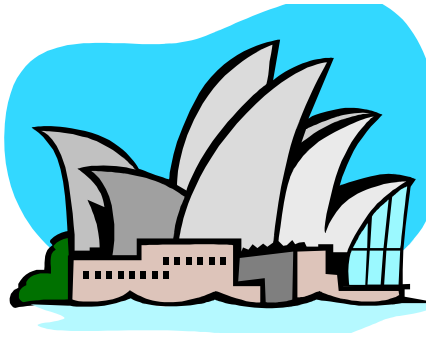
Buildings around the world...



- A skyscraper is held together by a steel skeleton of vertical columns, horizontal girder beams and often diagonal beams for extra support. This structure distributes the immense weight in a way that ensures the integrity and safety of the building.

- Restoration work in 1990 and 2001 shifted the Leaning Tower of Pisa back to an angle of 4 degrees after it was previously leaning at an angle of 5.5 degrees.



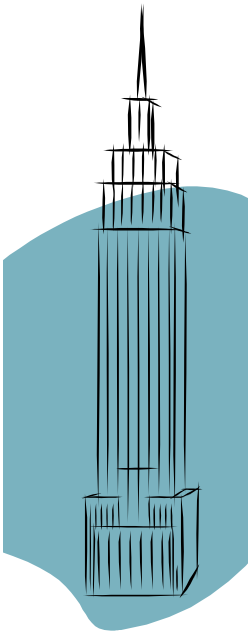


- The roofs of the Sydney Opera House are covered in a total of 1056006 tiles.

- The Colosseum in Rome, Italy, is an elliptical amphitheatre that was completed in 80 AD. It held around 50000 spectators and was used for a variety of events including gladiator contests, animal hunts and mythology based dramas.

- Around 20000 workers helped build the Taj Ma Hal, a famous mausoleum and landmark in Agra, India, that attracts millions of visitors every year.

Buildings around the world...

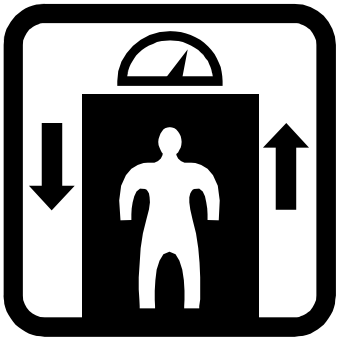


- The Empire State Building in New York was the first building t o have over 100 floors and was the tallest building in the world from 1931 until 1972.

- The Chrysler Building in New York was built at a time when there was a strong desire to build the world's tallest skyscraper, before being overtaken by the Empire State Building, the Chrysler Building was the world's tallest for around 11 months. During the construction, floors were being completed at a staggering four per week. Despite the rush, no workers died during its construction.

- The world's largest office building by floor size is the Pentagon in Virginia, USA, with over half of its 650,0000 square foot (604000 square metre) floor area used as offices.

- Tall buildings need fast elevators, recent developments have led to elevators that can travel up to, and sometimes over, 1000 metres a minute (3280 feet a minute).



Make some noise!

Make your own Kazoo

What you'll need?

- Toilet paper roll or kitchen roll tubes
- Wax paper
- Rubber bands
- Sharp pencil (to poke holes)
- Paint & Paint Brushes
- Decorations—stars, glitters, etc
- Scissors (round tip)

How to do it:

- Cover the end of your cardboard tube with wax paper.
- Secure it with a rubber band.
- Poke a hole in the side of the tube using the sharp pencil
- Put the open end of the tube up to your mouth and hum or say "do" over and over to make sound come out of the kazoo
- Paint your kazoo
- Let it dry thoroughly
- Decorate. Be careful not cover any of the holes.

How is sound created:

The wax paper vibrates from the sound of your voice, amplifying it.

The Wheel

Do you like to roller-blade? How about riding your bike or skateboarding? All these vehicles use wheels to go. Cars, planes and trucks also use wheels. So do baby strollers. A pencil sharpener has a wheel and clocks have wheels with teeth. The teethed wheels interlock with one another.

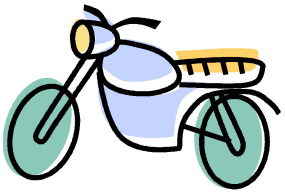
Only humans use wheels, and compared to other inventions, wheels are a fairly recent invention. The first wheels were probably wheels to make pottery. They were invented in Sumeria around 5,500 years ago. Later, people figured out how to use wheels to draw wagons and carriages. Before the wheel, people had to walk everywhere they went or ride on camels or other animals. They pulled or dragged things on sleds.

The back wheel of a bicycle is propelled by cog wheels. The cog wheels and a chain turn the back wheel around. If you change gears, the bicycle wheels turn slower or faster.

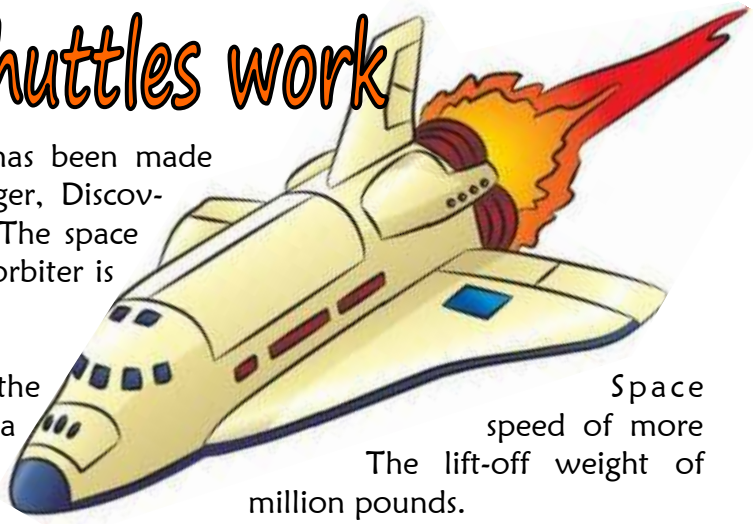
Wheels on cars, roller skates, baby strollers and other things have axles. An axle is a pole that runs through the wheel. The wheel turns around it.

Items with wheels:

- A wheelchair
- Pizza cutting wheel
- A watch or Clock
- Motorbikes
- Scooter
- Chairs
- Supermarket Trolleys
- Toys
- Horse drawn carriage
- Push Chair

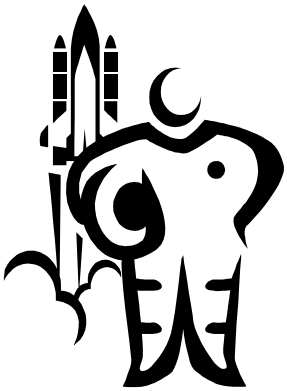


how do space shuttles work



- The space shuttle fleet has been made up of: Columbia, Challenger, Discovery, Atlantis, and Endeavor. The space shuttle is 184 feet long. The orbiter is 122 feet long.

- It takes only 8 minutes for the Space Shuttle to accelerate to a speed of more than 17,000 miles per hour. The lift-off weight of the space shuttle is 4.5 million pounds.



- While in orbit, the space shuttle travels around Earth at a speed of about 17,500 miles (28,000 kilometers) per hour. At this speed, the crew can see a sunrise or sunset every 45 minutes.

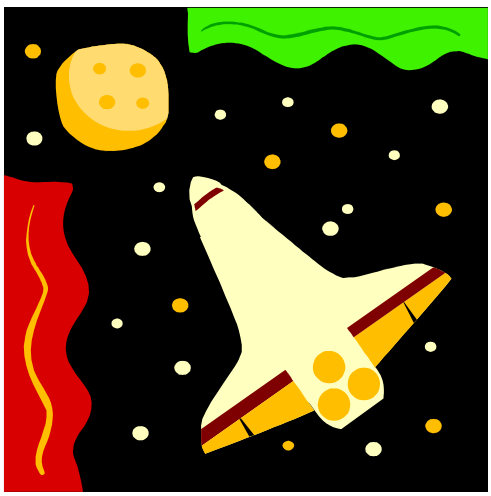
- The main engine on the Space Shuttle weighs as much as a train locomotive, but puts out as much horse power as 39 locomotives.

- The Space Shuttle is one of the most complicated and innovative machines ever built. It was a huge leap in technology when the first shuttle was launched, because it represented space craft that was re-useable.

- Space Shuttle Columbia was the first ship in the NASA fleet. It completed 27 missions .

- Crews range in size from five to seven people. Over 600 crew members have flown on shuttle missions. It has also sent more than 3 million pounds of cargo into space. The longest any shuttle has stayed in orbit is 17.5 days, in November 1996.

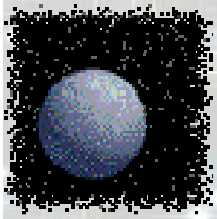
- A Space Shuttle and its boosters ready for launch are the same height as the Statue of Liberty but weigh almost three times as much.



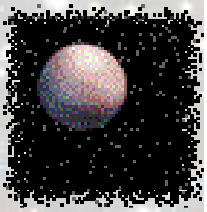
- The shuttle launches like a rocket, orbits like a spacecraft and lands like a plane.

- Endeavor was the last shuttle launched into space in September 2010. It was the 134th space shuttle flight.

Stars In the Sky

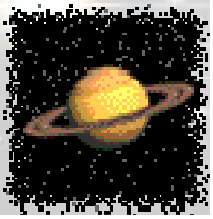


- A star is a massive, bright, sphere of very hot gas called plasma which is held together by its own gravity.
- Stars radiate energy created from nuclear fusion, which is a process that takes place in a star's core and involves hydrogen fusing (burning) to make helium.
- As a star is near the end of its life, it begins to change the helium into heavier chemical elements, such as carbon and oxygen, and the star will begin to change colour, density, mass and size.
- The nearest star to Earth is the Sun.



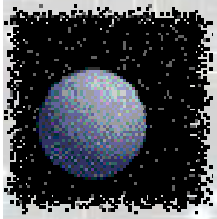
- After the Sun in our Solar System, the nearest star to Earth is *Proxima Centauri*. It is about 39.9 trillion km away or 4.2 light years. This means it takes light from this star 4.2 years to reach Earth. Using the newest, fastest space probe propulsion systems would still take a craft about 75,000 years to get there.
- There are approximately 200-400 billion stars in our Milky Way Galaxy alone.
- Each galaxy contains hundreds of billions of stars and there is estimated to be over 100 billion galaxies in the universe.

- Stars are usually between 1 and 10 billion years old. Some stars may even be close to the age of the observed Universe at nearly 13.8 billion years old.
- Binary stars and multi-star systems are two or more stars that are gravitationally linked, they orbit around each other.
- Stars form in nebulas, which are large areas made out of gas.
- Once nuclear fusion has began in the core, a star is sufficiently fuelled to spend the majority of its life as a main sequence star in its most stable form.
- The most common star, are red dwarves. They are less than half the size and mass of our Sun, and burn their fuel very slowly so live longer than any other type of star, over 100 billion years.

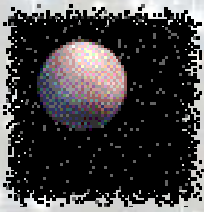


- Red dwarves are cooler than most stars and so shine less, eventually getting dimmer.

Stars In the Sky

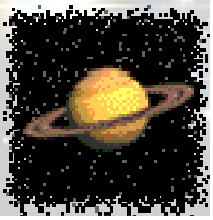


- A brown dwarf forms if a star cannot get hot enough to reach nuclear fusion. Its failed to become a proper star but is still not a planet because it does glow dimly.
- As yellow dwarf stars like our Sun start to run out of hydrogen fuel, the core shrinks, heats and pushes out the rest of the star turning it into a red giant.
- Red supergiants, such as Betelgeuse in the constellation Orion make our Sun look small, 20x its mass, and 1,000x larger. Red hypergiants such as the largest known star VY Canis Majoris are even bigger, over 1,800x the size of the Sun.
- When smaller stars such as red dwarfs or red giants use up all their fuel and nuclear fusion slows they start to die, and become small “white dwarf” stars which will emit white light until they finally darken into "black dwarfs".



- Big stars like supergiants and hypergiants have shorter lives as they consume their fuel at a faster rate than smaller stars. As these massive stars die they explode as massive bright supernova. Very heavy stars that have gone supernova can actually turn into black holes.
- Other supernova leave behind very small 20 to 40km (25 mi) in diameter white neutron stars, that have dense cores made of neutrons.

- Star matter blown away by supernova explosions form new stellar nebula and the process of making stars begins again.
- Stars range in colour depending on how hot they are, in order from lowest to highest temperature they are can be brown, red, orange, yellow, white, or blue in colour.
- The light from stars takes millions of years to reach Earth, therefore when you look at the stars you are literally looking back in time.
- Stars do not actually twinkle. They only appear to twinkle due to turbulences in the Earth's atmosphere deflecting the light that reaches our eyes.
- The stars have played a very important role throughout human history. They have formed part of religious practices, been grouped into constellations, used in astrology star signs, helped to design calendars and were very important navigational tools for early explorations across land and seas.



Constellations

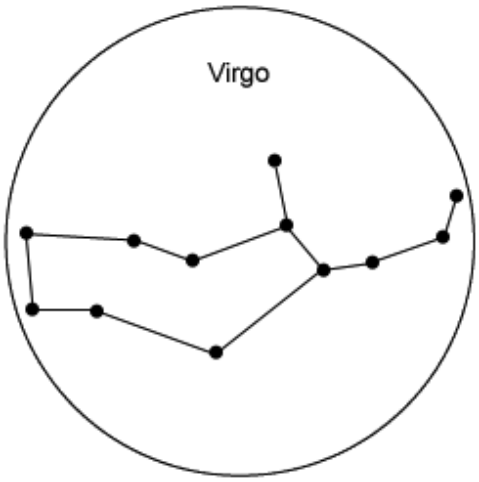
What is a Constellation?

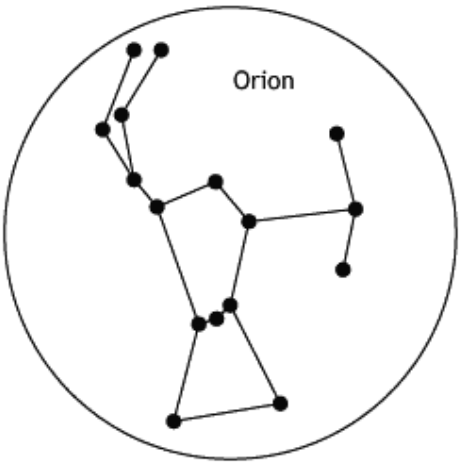
A constellation is a group of visible stars that form a pattern when viewed from Earth. The pattern they form may take the shape of an animal, a mythological creature, a man, a woman, or an inanimate object such as a microscope, a compass, or a crown.

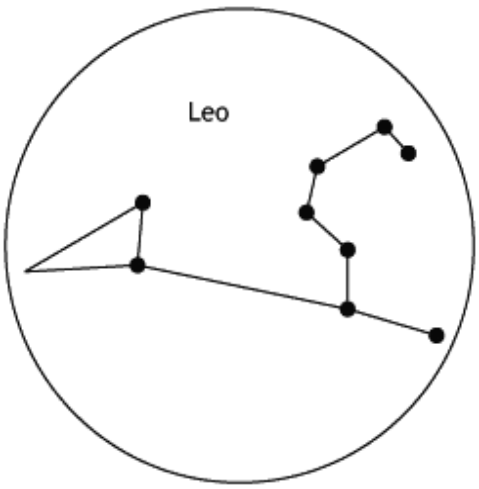
How many constellations are there?

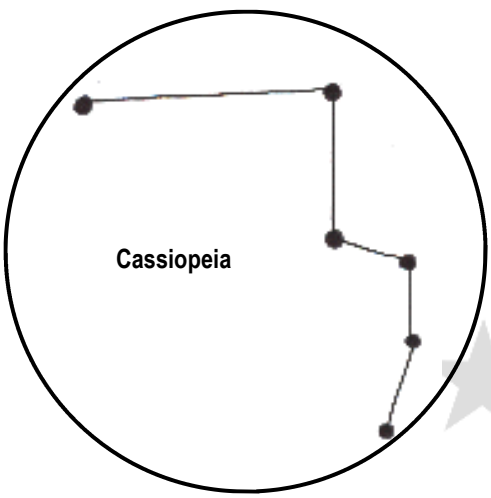
The sky was divided up into 88 different constellations in 1922. This included 48 ancient constellations listed by the Greek astronomer Ptolemy as well as 40 new constellations.

Famous Constellations









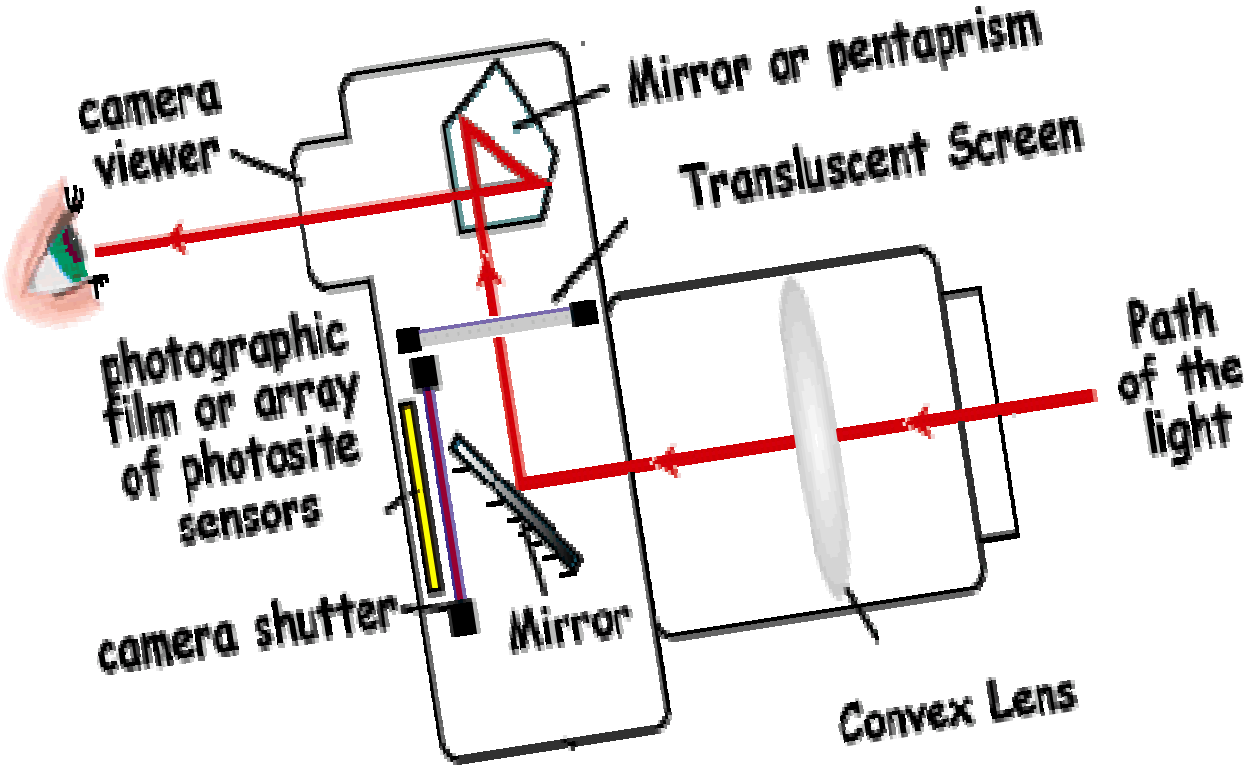
How does a Camera work?

When you press the button on your camera to take a photo it briefly opens the shutter (like opening a curtain), allowing light to pass through the lens on to the film or sensor inside.

In daylight situations the shutter may be open for just 1/200 of a second, in darker situations the shutter needs to stay open for longer, perhaps a few seconds, or even much longer in dark, night-time environments.

What are those large lenses for?

Professional photographers sometimes use large lenses, these are lenses which have a shorter physical length than focal length. They can be used to make objects appear much closer than they really are, perfect for sports or wildlife photography!



How does a Bagpipe work?

How a Bagpipe Works

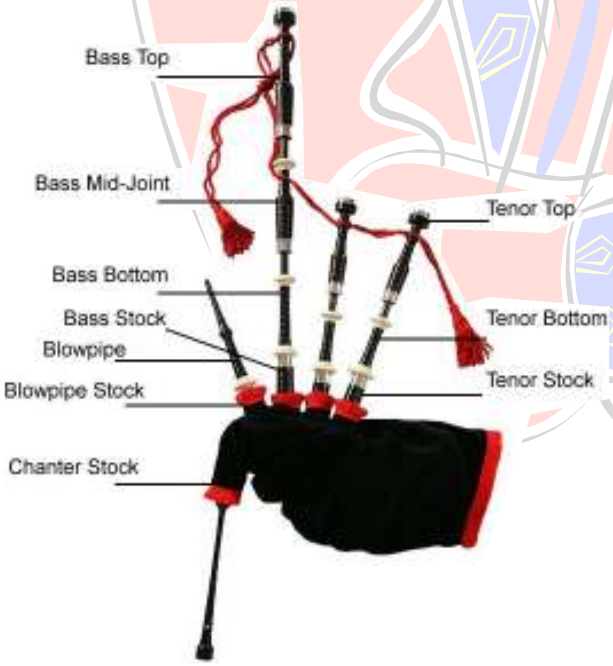
A bagpipe is a member of the woodwind family of instruments and works with a system of air and reeds. Instead of the piper putting his mouth directly on the reed to make music, however, a bag is used to propel the air through the reeds and create sound. The piper blows through a mouthpiece, sending air to the bag, which in turn keeps air flowing through the instrument's four reeds simultaneously. The piper will use his arm to apply pressure to the bag, making sure the sound flowing from the instrument remains steady and solid.

Important Parts of the Bagpipe

The pipe bag itself is the reservoir for the air that powers the reeds. This bag is usually made from leather, although modern bags are often made from synthetic replacement materials. Some bags are fitted with an internal desiccant process, which removes moisture that naturally goes into the bag from the piper's mouth.

The blowpipe extends from the bag, and is the device through which the piper blows air. This pipe is usually made with plastic on modern bagpipes and is fitted with a special valve that allows the piper to blow air through the valve without having air rush back at them when they take a breath.

The drones extend from the chanter and are in many ways the most important element of the bagpipe. Most other parts are interchangeable (between brands and types), but the drones are the heart of the instrument, providing the sound with the clean, dulcet tones needed for fine music.



Chanter

If the bagpipe was a recorder or a flute, all you would see would be the chanter. It is the primary source of music for the bagpipe. It extends away from the bag, and air is expelled through the chanter. The piper uses her fingers to block holes on the chanter, creating the various notes. Bagpipes can either be fitted with single or double-reed chanters.

How does a Compass work?

If you are lost, your best chance of finding your way might be a tiny magnet.

A magnet is what makes a compass point North. The small magnetic pin in a compass is suspended so that it can spin freely inside its casing and respond to our planet's magnetism.

A compass needle aligns itself and points toward the top of Earth's magnetic field, giving lost explorers a consistent sense of direction.

How does it work ?

A compass points North because all magnets have two poles, a North and a South pole. The North pole of one magnet is attracted to the South pole of another magnet. (You may have seen this demonstrated by a pair of simple refrigerator magnets pushed end to end.)

The Earth is a magnet that can interact with other magnets in this way, so the North end of a compass magnet is drawn to align with the Earth's magnetic field. Because the Earth's magnetic North Pole attracts the "north" ends of other magnets.

The Compass ...

True north

While a compass is a great tool for navigation, it doesn't always point exactly north. This is because the Earth's magnetic North Pole is not the same as "true north," or the Earth's geographic North Pole . The magnetic North Pole lies about 1,000 miles south of true north, in Canada.

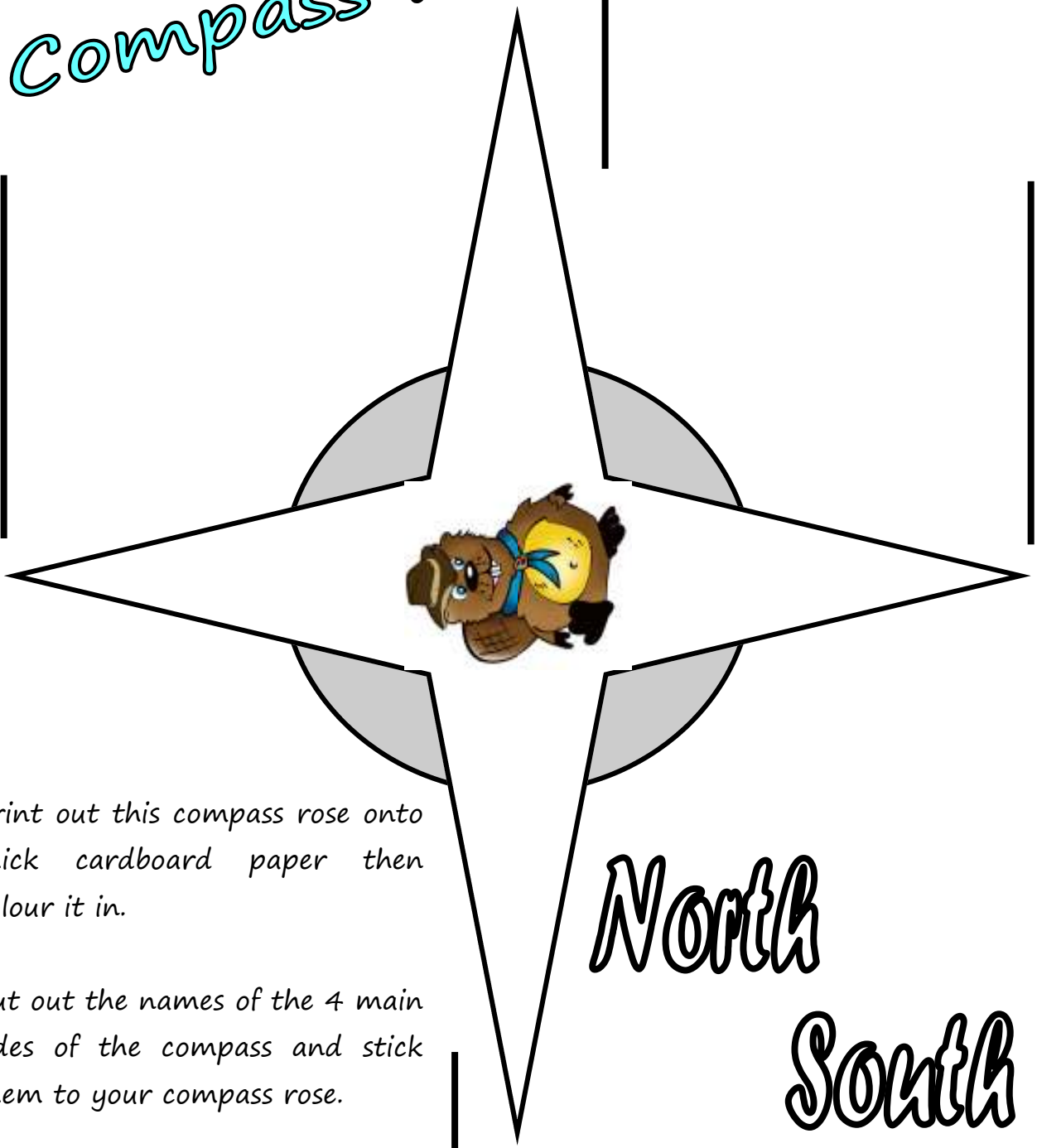
And making things even more difficult for the compass-wielding navigator, the magnetic North Pole isn't even a stationary point. As the Earth's magnetic field changes, the magnetic North Pole moves. Over the last century, it has shifted more than 620 miles (1,000 kilometers) toward Siberia, according to scientists at Oregon State University.

This difference between true north and the north heading on a compass is an angle called declination. Declination varies from place to place because the Earth's magnetic field is not uniform it dips and undulates.

These local disturbances in the field can cause a compass needle to point away from both the geographic North Pole and the magnetic North Pole. According to the United States Geological Survey, at very high latitudes, a compass needle can even point south.

By using charts of declination or local calibrations, compass users can compensate for these differences and point themselves in the right direction.

Make a Beaver Compass Rose



Print out this compass rose onto thick cardboard paper then colour it in.

Cut out the names of the 4 main sides of the compass and stick them to your compass rose.

LOG CHEW:

With the help of your Beaver Leader, use a real compass to find the North from your locality.

North

South

East

West

How does your Ear work?

- Our ears help us detect sound.
- Ears convert sound waves into nerve impulses that are sent to the brain.
- While your ears pick up the sound, it is your brain that does the hard work of making sense of it all.
- There is much more to the ear than the part you can see on the outside of your head.

- The middle part of the ear (behind the ear drum) amplifies sound pressure.
- The middle ear also contains the Eustachian tube which helps equalize pres sure and drain mucus.

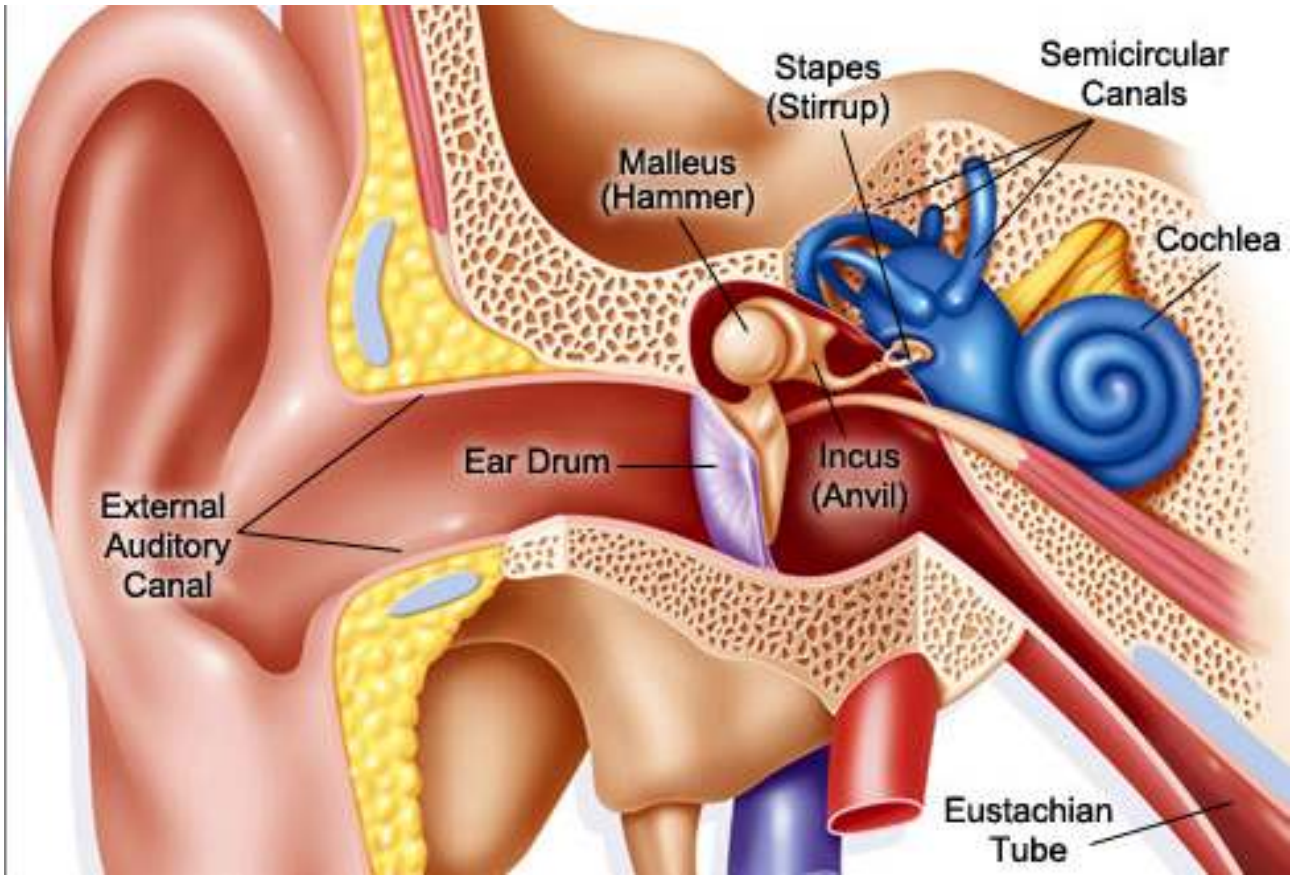
- The inner ear is found inside the temporal bone, the hardest bone in the human body.
- The inner ear contains the spiral shaped hearing organ called the cochlea as well as the vestibule and semicircular canals which help with balance.
- Sounds waves are passed from air to liquid in the inner air. The inner air also contains tiny hair cells which react to sound waves, triggering chemicals that are sent to the brain as nerve impulses.
- Abnormalities in the inner ear of humans can cause deafness.

- Skin glands in the ear canal produce ear wax which helps protect the ear by lubricating it and cleaning it of dirt and dust.
- Excessive ear wax can impair hearing, especially if it is pressed hard against the eardrum.

- Ear wax normally comes out of your ear naturally so it's not a good idea to try and remove it yourself unless it is causing health prob-lems (best to see your doctor first).
- Piercing earlobes and ornamenting them with jewellery has been common practice around the world for thousands of years for both for cultural and cos-metic reasons.

How does an Ear look inside?

Below is a colour full diagram clearly showing what is inside of our ear:



How does a Movie Projector Work?

- Movie projectors act to move the film, which arrives on reels, from frame to frame.
- Light travels from a projector bulb, which typically includes xenon and is mounted in the middle of a mirror.
- The mirror reflects the bulb's light and directs it onto the condenser, which acts to intensify the light and focus it on the main lens.

- The focused light is intercepted by the shutter, which is a small propeller device that spins 24 times each second, and makes sure the film runs smoothly without flickering. Without the shutter, the images would blur together.
- The movie projector's light passes through an aperture gate, which is a small metal frame that ensures the light illuminates only the images you want to see on the film, not the sprocket holes or audio information also imprinted on the film.
- The light finally reaches the film, casting the film's image through a lens and then onto the screen. This lens can be used to focus the image.

- Movie projectors read the audio so that it is synched up to the image.
- A white wall acts as a surface for the enlarged image.
- The audience enjoys what it sees.