toys

science at play

Education kit

scienceworks

Contents

Acknowledgments

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Introduction

This education kit has been written for students in Years 2 - 8. It supports the *Toys* exhibition at Scienceworks.

The kit contains information to assist with:
- planning a successful excursion
- making curriculum links
- setting a context for the excursion so that students can get the most from their visit
- exploring further the science and technology of toys.

It also contains a range of school-based activities that may be adapted to suit a number of developmental levels. These may be completed before or after the visit.

The writers have assumed that students have some concept of energy and energy transformations, forces and materials although kit activities will assist teachers in exploring these further. It also assumes that teachers have read the contents of the kit and prepared the students for their visit.

The following text types have been included to enable teachers to enhance the scientific literacy of students:

- Exposition
- Procedure
- Recount
- Description
- Explanation

The science concepts explored in this education kit are energy and energy transformations, forces and motion, simple machines, materials and their uses.

Student worksheets are indicated by the symbol in the top right hand corner.

Essential preparation

What to do before you visit *Toys*

Research has shown that setting objectives for a museum visit is extremely important for students. It makes the purpose of the visit clear to them and assists their ability to focus and cooperate during the visit.

Creating interest in the subject is vital to a successful and enjoyable visit to Scienceworks. Prior to your visit, take some time in class to discuss your excursion to Scienceworks and assess students' knowledge and understanding about toys. The information in the education kit can be used to assist and focus the discussion.

Suggested activities to undertake before you visit *Toys:*

- Photocopy the Scienceworks site map on your yellow confirmation letter and discuss with students what they will be doing on their visit. Get them to locate toilets and the amphitheatre (lunch space), as well as the exhibition galleries that they are booked into.
- Photocopy the exhibition map on page 16 and discuss the zones on the exhibition, how they will move through them and what they think they might see. The zones are called **Mysterious**, **Imaginative**, **Moving**, **Creative** and **Timeless**. Discuss what these names mean and what might be included in these sections.
- Brainstorm our favourite toys and why they are favourite
- For older students, think of toys that incorporate electricity, magnetism, chemical reactions, sound, light, stored energy, springs, balance and so on.

In addition, this education kit contains suggestions for hand-on activities you may choose to do either before or after your visit. See pages 18 - 58.

Please check your confirmation letter to ensure that the details for your excursion are correct. If there is a problem with your booking, please call Bookings on 9392 4819.

What to bring to your visit to *Toys*

- the yellow confirmation letter
- **photocopy of the exhibition map p.16**
- students should bring their own pencils and clipboards if you choose to give them activities to do during the visit (see p 6).

What to do during your visit to *Toys*

Piaget said:

> *play is the vehicle with which children react with their environment and construct their knowledge.*

The *Toys* exhibition is highly interactive and provides students with the opportunity to play alone, in pairs or in larger groups. Creative play develops imagination, spatial and fine manipulation skills. Students practice communicating and negotiating when they play together. For this reason there are no pathway sheets provided for students to complete in the exhibition. We recommend that your students should focus on **doing** rather than **writing** whilst in the exhibition.

Zones

There are five zones in the exhibition. To ensure that all students have equal time in all five zones, we ask you to divide your students into five groups. Each group will begin in a different zone. The groups will have approximately 10 minutes in each zone. Please assist Scienceworks staff who will ask your group to rotate through the zones.

Older students could be asked to list down toys that fall into different categories - for example, you may wish to ask them to find and list four or five toys that use or transform different types of energy such as:

- electrical energy
- kinetic energy
- potential energy
- light energy
- sound energy

or you could ask them to find and list toys that rely on gravity, spin, magnetism or balance.

To encourage students to look in the display cases, you might also ask them to find:

- bush toys
- chemical toys
- old toys
- toys that fly
- home-made toys
- space toys
- dolls and action figures
- executive toys
- toys with wheels
- construction toys

Toys exhibition information

The *Toys* exhibition is divided into five areas; **Mysterious**, **Imaginative**, **Moving**, **Creative** and **Timeless**. Each section contains play tables, hands-on demonstrations of some of the scientific principles behind the toys in that section and display cabinets of related toys.

Mysterious

This area explores toys that work using gravity, balance, spin and magnetism.

Magnetic fishing

Use a fishing rod with a magnet to test your hand-eye co-ordination. Challenge a friend to see who can catch the most fish!

Mix and match

Use the magnetic pieces to make mixed-up characters. Magnets defy gravity by holding onto a metal surface.

Magnetic robot

Turn the robot to point to a question. Then place the robot on the star and she will tell you the answer! The robot has a magnet in its base which moves when you point to the question. This lines up with another magnet under the correct answer.

Fuzzy faces

Move the magnet under the table to create an interesting hair-do on the face. The 'hair' is iron filings which become magnetised when the magnet is close by.

Magnetic or not

Use the magnet to test which objects are magnetic and which are not. The magnet will only attract metals containing iron. It will not attract materials such as plastic, wood or glass.

Hula hoops

Have a go at a hula hoop. Your body is pushing against the hula hoop and this force overcomes the force of gravity.

Balance beam

Use your balancing skills to walk across the beam. To balance we use feedback from our eyes, ears and muscles, then we make small adjustments with our limbs.

Spinning tops

Spin tops of different shapes and sizes to observe how they stay up and which ones go longer. Tops that are well balanced and have their weight lower down will spin longer. use the gyroscopes and compare how they are different to the tops.

Building blocks

Construct unusual buildings using different types of blocks.

Heavy-ended blocks

Construct unusual buildings with blocks that are heavier at one end. See if you can make a staircase that reaches out over the edge without falling. Their centre of gravity is at one end so you can build structures that are impossible with normal blocks.

Feel the spin

Spin the wheel, then try to change the angle. Feel the forces. The momentum keeps the gyroscope from falling over.

Display cabinets

Tops and gyroscopes, Executive toys, Mobiles and hanging toys, Spinners in motion, Experimental magnets, Magnetic toys.

Imaginative

This area explores the imaginary games that you can play using miniature models, dolls and optical instruments.

Small worlds

Use miniature models to work in a farm, a construction site or inside a house. This sort of play develops imagination, as well as spatial and social skills. Small scale models are important tools in architecture and animation.

Periscopes

Use a periscope to see over a wall. Light moves in straight lines. The periscope contains two mirrors which bend the light rays at right angles.

Kaleidoscope

Look through the kaleidoscope. The mirrors inside the kaleidoscope create multiple reflections of the coloured beads. As the kaleidoscope is turned, the beads move and the pattern changes.

Weird-o-scopes

Look through two tubes that contain faceted lenses to give an unusual view of the world that our brain has difficulty interpreting.

3D viewer

Look into the viewer to see a three dimensional image. In the viewer each eye is looking at a slightly different picture. Our brains combine the two pictures to produce a three-dimensional image.

Zoetrope

Spin the drum and look through the slits to see a moving image. When you look through the slits you see one picture followed rapidly by a slightly different one. Your eye retains each image for a fraction of a second after it has moved on. Your brain merges the images creating the illusion of motion. This process is known as persistence of vision.

Thaumatrope

Spin the disk to combine two pictures into one. When you spin the disc, you see one picture followed rapidly by the other one. Your eye retains the first image for a fraction of a second after it has moved on. Your brain combines the two images into one.

Phenakistoscope

Spin the disc and look through the slits at the mirror. When you spin the disc, you see one picture followed rapidly by the other one. Your eye retains the first image for a fraction of a second after it has moved on. Your brain combines the two images into one.

Talk to me

Have a go at three different types of talking toys. One speaks when you pull a spring-loaded string. One makes a funny sound when you tip a tube and the air rushes past a reed inside the tube. The third contains a computer chip with a sound recording which is activated when you push a button.

Robotic cat and bird

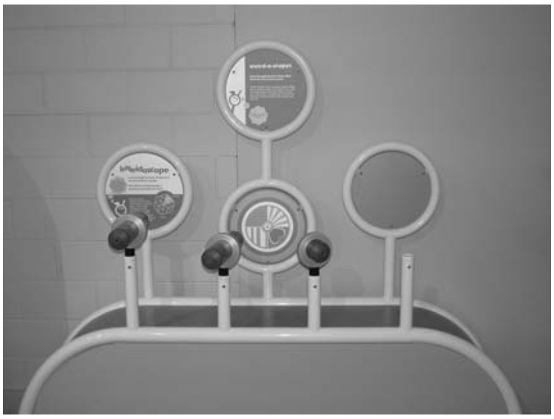
When you make a noise, an electronic sensor in the cat or the bird is activated. The sensor is connected to other electronic devices which make the toy move.

Build and move

Use the trucks to move around the building bricks. Build and demolish different structures.

Display cabinets

Magnifiers, Distance and 3D viewers, Superhero and action figures, Space toys, Character dolls, Living dolls.



Moving

This section explores stored energy toys that work using flywheels and springs, toys with wheels and toys that work using friction.

Flywheel car

‘Rev up’ the car to make it go. The car’s gears help you to make the flywheel move fast. The heavier the fly wheel, the more energy it can store, and then transfer to the car’s wheel. You can also try a large fly wheel by turning the crank handle in the table.

Flywheel

Turn the flywheel handle to make it spin. The flywheel is used to store energy and can spin for a long time.

Pin ball

Use the spring loaded 'shooter' to send your ball to a good spot. When you pull back the shooter you store energy in the spring. When you release the shooter, the energy in the spring is transferred to the ball to make it move. Challenge a friend to see who can get the most points from five goes.

Come back cans

When you roll this tin can along the ground it stops and rolls back to you! Inside the can is a thick rubber band attached to a weight. As you roll the can away from you, the rubber band twists. The twisted rubber band stores energy. As it untwists, it causes the can to roll back to you.

Loop the loop

Let the car go from the top of the ramp for a ride through the loop. The car will stay on the track if it has enough energy to overcome the downward force of gravity acting on it at the top of the loop.

Rolling ride

Let your ball go from different parts of the track. How it goes will depend on how much potential energy it had at the start.

Helicopter pilot

Use the controls to change the height and direction of the helicopter. By angling the direction of the helicopter, you can make it go forward or backwards.

Jumping frogs

Press the back of the frog to make it jump. This is a simple fun toy that stores energy in a springy piece of plastic. The stored enegy is transformed into movement when you let go.

K'nex

Use the K'nex pieces to build your own model. These can be static buildings and bridges, or they can be moving models with wheels, gears and levers.

Atollo

Use the Atollo pieces to build your own model. The hinge and socket join in different ways to make flexible flowing shapes.

Display cabinets

Chemical and electrical energy, Stored energy toys, Wheels, Flying toys, Construction, Girls construction toys, Art and craft, Chemical toys.

Creative

This section explores musical instruments and how sounds are produced and transmitted.

Sound phones

Use these versions of the old fashioned string telephones to communicate. Sound travels more quickly through the string than it does through air. Use the spring version to create some weird sounds or use the voice tube to transport your voice.

Animal sounds

Use different toys that make sounds like the animals they depict. These include a croaking frog and a moo tube.

Visible vibrations

Alter the pitch and volume of a sound to make foam beads clump together to form patterns. Sound is a form of energy which moves through the air as a wave. In the tube, the sound waves push the beads and make them clump together.

Musical teeth

Turn the handle to operate a mechanical music box. See how the teeth push against different bumps on the drum to make a tune.

Sound effects

Use different equipment to record sound effects for a short film clip then play it back to see how good you would be as a Foley (sound effects) artist.

Display cabinets

Handful of puppets, Sophisticated sounds, Play around with sound, Toy musical instruments, Homemade instruments.

Timeless toys

This section includes a brief history of some toys, as well as exhibits that show how toys have changed over time.

Polar jigsaw puzzle

The first jigsaws were made of maps. Put the pieces together to complete the map of the Earth viewed from the North Pole, then turn it over and do the same for the South Pole.

The way we played

Press the button to view toys and games from the past.

Toy birthdays

Look at toys from the 1900's through to today. You may notice that the technology used to develop the toys mirrors technological developments. You will also notice that many of the toys are still popular today.

Scientists' toys

See the favourite toys of some Australian scientists.

Favourite toys

We asked six children to name their favourite toys. Some use the latest technology and others are reinventions of classic toys.

Display cabinets

Bush toys, Old toys, Give me a hand Gran!, Paper, Pegs and pop sticks.

Glossary

Angular momentum

Tendency of a body to keep spinning in the one direction.

Centre of gravity

The centre of gravity is the balancing point of an object. It is also the point at which gravity seems to act on that object.

Compass

An instrument used for finding direction. The needle is magnetised so that the needle always points Magnetic North.

Electromagnet / temporary magnet

A temporary magnet that can be created by wrapping coils of wire around a piece of soft iron, then passing an electric current through the wire. When an electric current flows through a wire, it creates a magnetic field around the wire. Putting a piece of soft iron inside a coil makes the magnetic field stronger because it becomes a magnet itself when the current is flowing. The soft iron acts like a temporary magnet at the flick of a switch.

Electron

A particle found inside an atom that has a negative charge.

Energy

Energy is an abstract concept that describes the ability of an object to do work.
It can be transformed from one form to another, but cannot be destroyed.

Flywheel

A heavy wheel that regulates the speed of a machine. It stores and releases energy.

Friction

Friction is a type of force that resists the motion of one surface across another surface. There are three basic types of friction.

- **Static friction -** occurs when surfaces aren't moving relative to each other
- **Sliding friction -** occurs when one surface slides across the other
- **Rolling friction -** is between the wheel and the surface across which it is rolling

Gears

Toothed wheels that are used to change the speed or direction of the original motion.

Gravitational Potential Energy

Stored energy obtained from the force of gravity. Any object that has height above the surface has stored gravitational potential energy relative to that suface.

Gravity

It is a force that exists between objects. It is a very weak force when the objects are small. When at least one of the objects is big, like the Earth, the force of attraction is stronger. Gravity is the force that pulls us and all other objects towards the Earth.

Gyroscope

A device containing a disc rotating on an axis that can turn freely in any direction. Regardless of the movement of the surrounding structure or framework,
the rotating disc retains the same orientation (as long as the disc rotates).

Kinetic energy/movement energy

A type of energy that an object has when it is moving.

Kaleidoscope

A tube shaped toy lined with angled mirrors that has coloured objects (such as marbles, paper, beads) stuck at one end of the tube so that colourful patterns can be seen when viewed through a hole at the other end. The patterns are created by multiple reflections in the mirror.

Magnet

A piece of iron, steel or loadstone that has the ability to attract iron.

Magnetic field

An area around the magnet in which the force of attraction is felt. The magnetic field is strongest close to the poles (or the ends) of the magnet.

Magnetism

Magnetism is a force that you can see or feel the effects of when one magnet is brought close to another. The magnet either attracts or repels the other magnet.

Momentum

It is the tendency of an object to keep on moving in the same direction as it was moving.

Oboe

A double reeded woodwind instrument with a penetrating tone.

Periscope

An optical instrument that uses angled mirrors to give a view of objects on a different level. They are used on submarines to look out from underneath the water.

Phenakistoscope

A revolving disk on which a sequence of pictures are seen successively making it appear as though the picture is moving like a cartoon. It works on the principle of 'persistence of vision'.

Sound

Sound is made by vibrations. Sound is produced when something is moved backwards and forwards very quickly.

Stored energy/potential energy

Energy that has the potential to be changed from one form into another. Examples include gravitational potential energy, chemical energy and elastic potential energy.

Thaumatrope

An optical toy that relies on 'persistence of vision'. Two different pictures are drawn on a card on opposite faces so that when it is spun around rapidly, the two pictures appear to combine into the one picture.

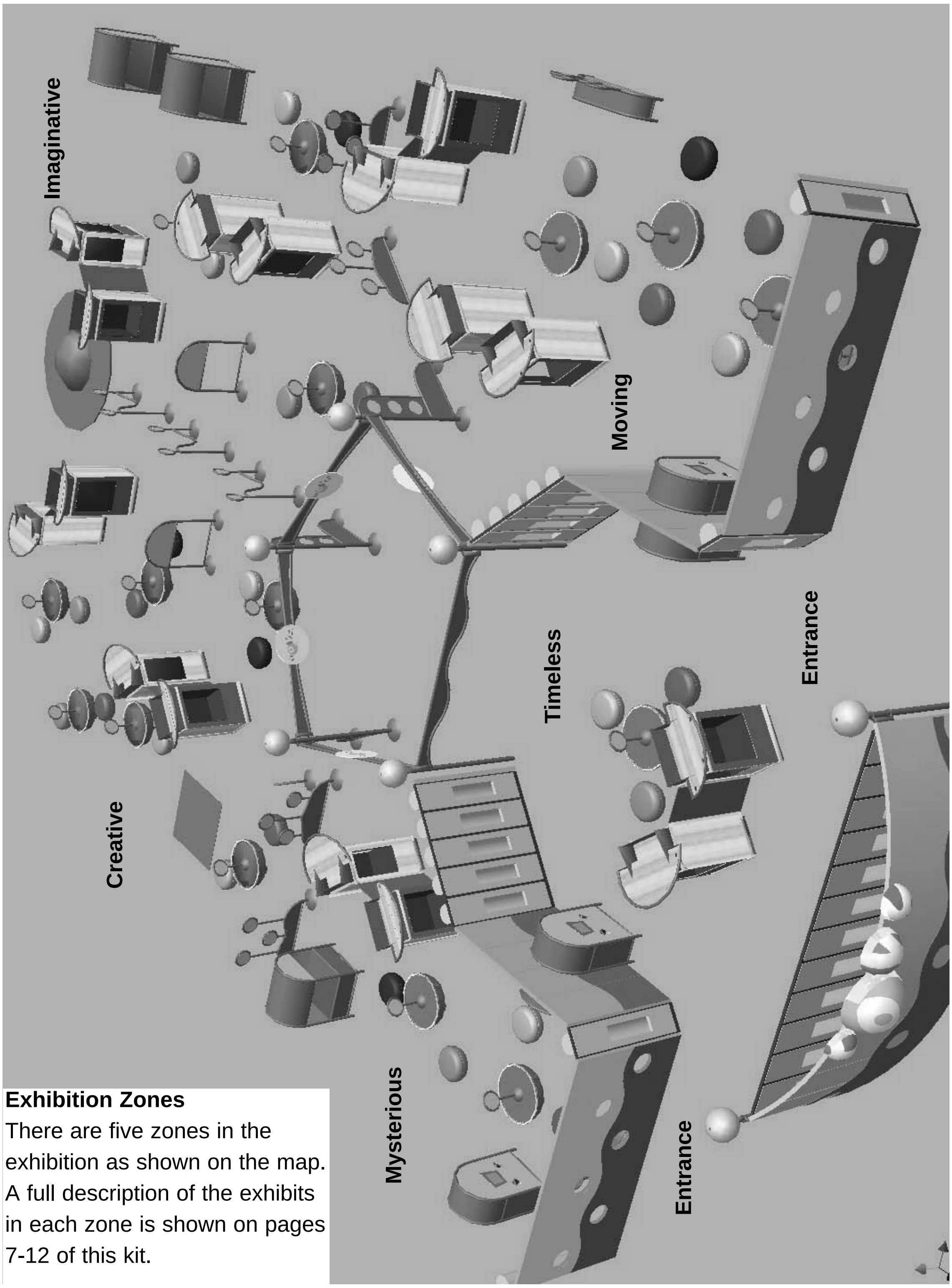
Weight

A measure of how much force is applied to a body due to the gravity acting on it.

Zoetrope

An optical toy that has a series of pictures revolving on the inside of a cylinder. When viewed through slits in its circumference, the picture appears to move. It works on the principle of 'persistence of vision'.

Toys exhibition map



Exhibition Zones
There are five zones in the exhibition as shown on the map. A full description of the exhibits in each zone is shown on pages 7-12 of this kit.

Mysterious explores toys that work using gravity, balance, spin and magnetism.
Imaginative explores imaginary games that use miniature models, dolls & optical instruments.
Moving explores stored energy toys that work using flywheels and springs, toys with wheels and toys that work using friction.
Creative explores musical instruments and how sounds are produced and transmitted.
Timeless toys includes a brief history of some toys, as well as exhibits that show how toys have changed over time.

Curriculum relevance

Relationship of suggested activities to the Victorian CSF II.

Learning outcome	School based activity
Level 2 Science	
Identify simple patterns in observations arising from explorations of readily observable phenomena	Activity 1, Activity 3, Activity 4
Level 3 Physical science	
3.1 Identify transformations of energy involving electricity, light, sound and movement	Activity 3, Activity 10, Activity 11, Activity 12 Activity 16, Activity 17, Activity 18, Activity 19 Activity 20
3.2 Identify the action of forces in everyday situations	Activity 1, Activity 2, Activity 3, Activity 4, Activity 10, Activity 11, Activity 12, Activity 14, Activity 15, Activity 17
Level 4 Physical science	
4.1 Design, build and describe the operation of simple devices that transfer or transform energy	Activity 3, Activity 10, Activity 11, Activity 12, Activity 19, Activity 20
4.2 Describe the motion of objects in terms of simple combinations of forces.	Activity 10, Activity 11, Activity 12, Activity 15 Activity 16, Activity 17
Level 4 Biological science	
4.2 Explain how selected systems of animals function (visual perception)	Activity 5., Activity 6, Activity 7, Activity 8
Level 5 Physical science	
5.1 Describe the characteristics and applications of the transmission and reflection of energy in the form of heat, light and sound	Activity 9, Activity 18
5.3 Describe simple magnetic and electrostatic effects in terms of a field model	Activity 2, Activity 3
5.4 Explain how mechanical systems can direct and modify force and motion	Activity 10, Activity 11, Activity 12

Background information - electricity and magnetism

Why do magnets stick to the fridge?

Magnets stick to the fridge because they are attracted to the metal of the door. Magnets do not stick to all metals, only those that contain iron (eg steel), cobalt or nickel. The invisible force of magnetism in this case comes from the make-up of the magnet itself. The individual atoms in the magnet are like tiny magnets which combine to give overall magnetic properties.
Materials that are attracted by a magnet, such as iron, steel, nickel, and cobalt, have the ability to become magnetised. These are called magnetic materials. Materials, such as paper, wood, glass, or tin, which are not attracted by magnets, are considered non-magnetic.

How can you make a magnet?

You can magnetise a piece of steel such as a needle or nail by rubbing it with a magnet. At first all the atoms in the steel are randomly aligned and they have no overall magnetic effect. If you stroke the needle or nail in one direction with a magnet, you line up the atoms and it becomes a magnet. Magnets have two poles (called North and South). When you hold opposite poles near each other they attract and when you hold like poles together they repel. In bar magnets the poles are at the end, in flat disc magnets they are on the top and bottom surfaces.

Can you see magnetism?

Magnetism is an invisible force. You can see its effect when two magnets snap together, or feel it when two magnets repel, but you can't see magnetism itself. The force of a magnet spreads out in the space around it and this is called a magnetic field. This field is strong near the poles and weaker at greater distances from them. You can create a 'picture' of the magnetic field around a magnet using iron filings. The iron filings become temporarily magnetised by the field and stick together in chains.

Electricity and magnetism

When an electric current flows in a wire, it creates a magnetic field around the wire. Because an electric current can be switched on or off, this can be used to create a temporary magnet.

Electromagnets

An electromagnet is a temporary magnet that can be created by coiling a wire around a piece of soft iron, then passing an electric current through the wire. The soft iron inside the coil makes the magnetic field stronger because it becomes a magnet itself when the current is flowing. Soft iron is used because it loses its magnetism as soon as the current stops flowing. Soft iron forms a temporary magnet. The electromagnet can be switched on and off by turning the electricity on and off.

Steel forms a permanent magnet. If steel was used inside the coil, it would continue as a magnet after the electricity was switched off. It would not be useful as an electromagnet. Electromagnets are used in electric bells, circuit breakers, loudspeakers and microphones.

Activity 1: Fishing game

Aim

Students will investigate which materials are magnetic and which are not, while designing and making their own fishing game.

What you need

- string
- magnets
- card
- a selection of materials such as paper clips, pins, aluminium, old plastic fridge magnets, plastic ice cream container lids, buttons, coins, wood (match sticks or pop sticks), aluminium foil, lolly wrappers, rubber bands, string, twist ties
- fish templates
- sticky tape
- a large bowl or box

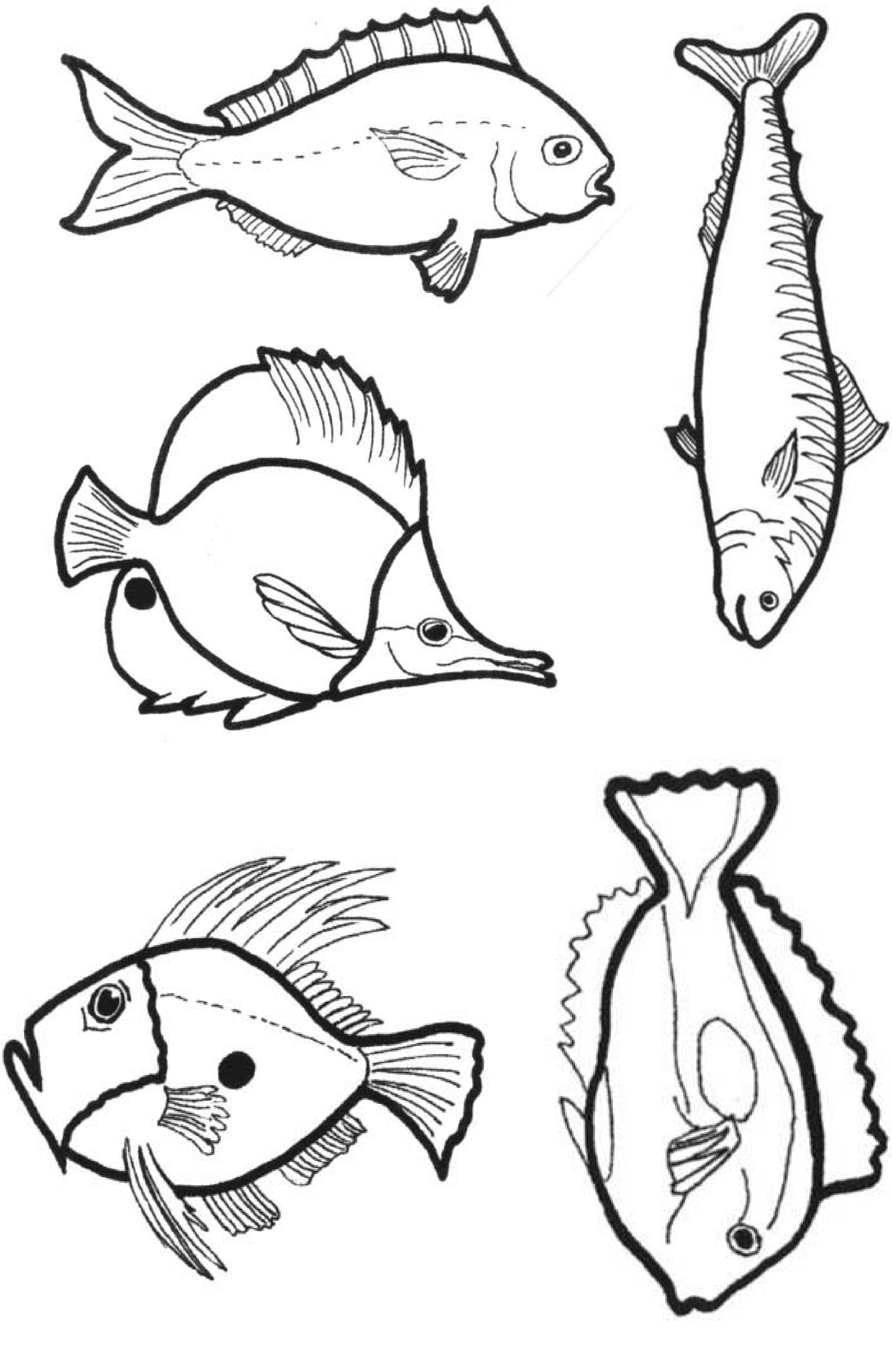
What to do

1. Attach the magnet to the end of a length of string to make a fishing line.
2. Cut a number of different fish out of card using the templates provided. Colour in the fish.
3. Use the sticky tape to attach a different material to each fish. The ice cream container lids, foil, string and fridge magnets can be cut up into small pieces.
4. Put all the fish into the bowl.
5. Use the fishing line to ‘catch’ the fish.

Optional

- Make a list of the materials that are magnetic and those that are not.
- In pairs, develop rules for a game that can be played using the fishing line and the magnetic fish. Include some type of point system.
- Swap game ideas with your class-mates. Play different games.
- Do some research and find out where magnets are used every day.
- Ask students to predict whether objects around the classroom or home are magnetic or not.
- Use the magnet on the fishing line to test these predictions.
- Instead of using the fish templates provided, design and create your own.

Activity 1: Fishing game template



Activity 2: A simple electromagnet

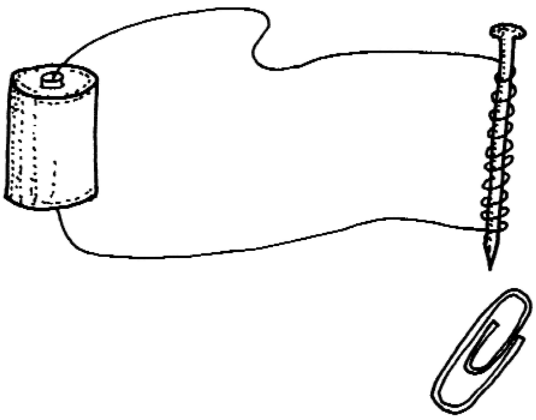
Aim
Students will investigate the relationship between electricity and magnetism and make a simple electromagnet.

What you need
- large nail or bolt
- long piece of insulated wire
- 1.5V cells
- a packet of paper clips

What to do
Ask the students to:
1. Strip the insulation from each end of the wire and twist the strands together.
2. Wind the wire around the nail about 15 times.
3. Connect the two ends of the wire to opposite ends of the battery.
4. Hold the nail close to a small pile of paper clips.
5. Count how many paper clips were picked up and record the number in the table on the Electromagnet worksheet.
6. Repeat steps 2-5 changing the number of coils of wire wrapped around the nail, each time recording the number of paper clips picked up by the electromagnet.
7. Try connecting two batteries in the circuit and repeat steps 2-6.

Questions
Record your findings on the *Electromagnet worksheet* and answer the questions.

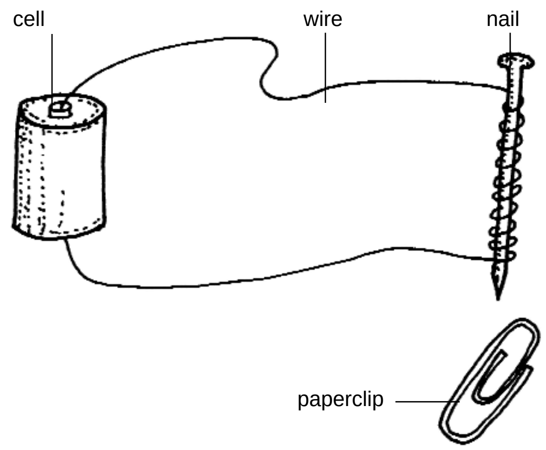
Optional
Encourage the students to experiment with various combinations of the number and size of batteries and the number of coils of wire around the nail.



Activity 2: A simple electromagnet worksheet

Fill in the number of paper clips lifted in each column.

		Number of winds of wire			
		15	20	25	30
Number of cells	**1**				
	2				



Use the results in the table above to answer the following questions.

Questions

1 How many paperclips can be picked up using 15 coils and one cell?

2 How many paperclips were picked up using 25 coils and two cells?

3 Did connecting more cells in the circuit affect the number of paper clips picked up?

4 What affects the number of paperclips that can be picked up?

Activity 3: Dancing dolly

Aim

Students will make an electromagnetic toy.

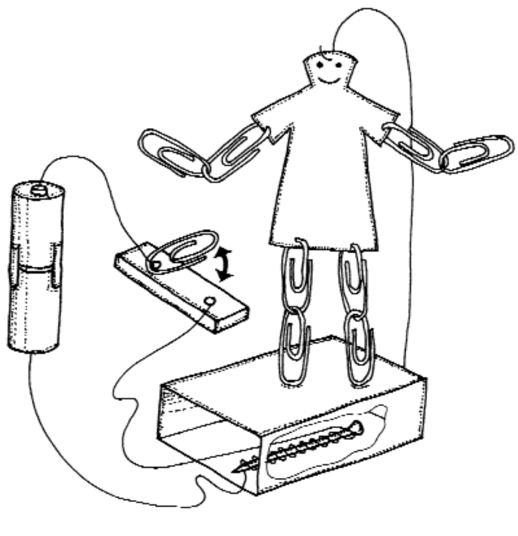
What you need

- thick steel bolt
- insulated wire
- stiff paper
- scissors
- pencils
- paper clips
- small cardboard box (about the size of an individual fruit drink box is suitable)
- two 1.5 V cells
- tape
- rubber band
- wire coat hanger
- two drawing pins
- small cork.

What to do

Ask the students to:

1. Make a switch using the drawing pins, the cork and a paper clip.
2. Press one drawing pin into the side of the cork so that it anchors the single end of a paper clip.
3. Push the other drawing pin into the other end of the same side of the cork.
4. Swivel the paper clip so it is able to touch the other drawing pin. This closes the switch.
5. Wind the wire around the bolt about 100 times.
6. Connect to the switch and the two cells taped together. (See diagram below.)
7. Place the cardboard box over the electromagnet making sure the magnet is close to the top of the box.
8. Draw and cut out a doll body from stiff paper. Use two paperclips for each arm and each leg of the doll.
9. Connect wire from the coat hanger to the box with tape and twist the free end so that the doll can hang just above the box with the aid of a rubber band.
10. Press and release the paperclip switch and the doll will dance.



Background information - balance

We are so used to living with gravity that we take it for granted. It is an invisible force which makes us and all other objects fall towards the Earth. Children often 'play' with gravity: coasting downhill on bicycles or billy carts, going down slides, bouncing balls, running model cars down slopes and flying paper darts. In these activities gravity supplies the force which makes things go.

Falling over and balancing

Balance is also a key part of many games and toys. Children learn in a physical way about the principles of balance as they walk along a wall, sit on a see-saw or build sand castles and block towers. The concept of balance, from a scientific perspective, is achieving stability by equalising the forces that act upon a system. When a system is balanced, the competing forces are equal. In addition, a balanced system will return to its original state if it is slightly disturbed.

Balance point

Finding an object's 'balance point' or 'centre of gravity', enables us to predict if it will fall over or balance. With a long thin object such as a ruler or broomstick, you can support it on both hands and gradually move your hands together. Where your hands meet the object should balance. This is its centre of gravity.

With uniform geometric shapes such as building blocks, the centre of gravity is in the centre of the object. As long as the centre of gravity stays above the point of support the block will stay upright but if you tip it over and the centre of gravity moves outside the base of support it will fall over. In general terms to make an object more stable you can make its centre of gravity lower or its base of support wider. Toys such as punching people ('Bop Bags') and balancing chime baby toys are weighted at the bottom and have a rounded base so they can be tipped or hit and will bounce back upright.

Some toys actually have their centre of balance below their point of support, which makes them extremely stable. They look as though they are doing an amazing balancing act but in reality they can be considered to be hanging rather than balancing. Examples of this are balancing birds where a bird sits on a perch, but has a weight in its tail and executive toys such as a figure standing on a point and holding a curved bar with weights on each end. Even more dynamic versions of this effect include toys with a wheel 'balancing' on a string rather like a tightrope walker.

Activity 4: Balance bird

Aim
Students will investigate centre of gravity and how it affects balance.

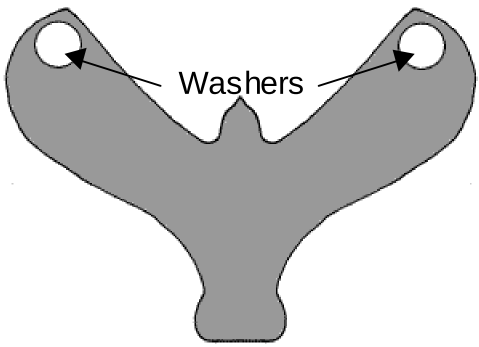
Background information
Without weights, the centre of gravity of the bird is near its neck. By adding weights, the centre of gravity moves forward outside the bird, in front of the beak! It looks like it is balancing but it is actually hanging. If you gently nudge the bird it will swing back into place.

What you need
- stiff paper or cardboard with a bird shape
- scissors
- sticky tape
- two weights (washers or coins)
- a pin
- thread with a small weight to make a plumbline
- red and blue pen

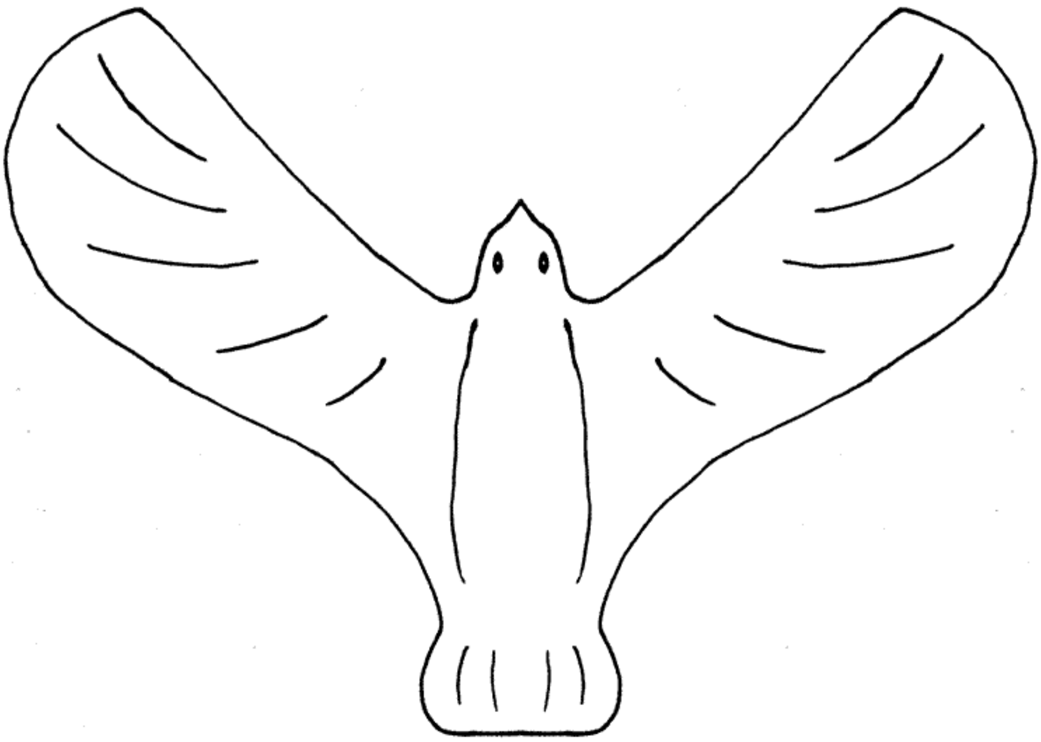
What to do
1 Carefully cut the bird shape out of the cardboard. Try balancing it on your fingertip.
2 Find the centre of gravity of the cardboard bird by pushing a pin anywhere into the bird so that it swings freely. Tie the plumbline to the pin, then use a pencil to trace the line of the thread.
3 Repeat step 2 by pushing the pin into another point on the bird. The point at which the two lines cross is the **centre of gravity**. Mark this with a red dot.
4 Tape the washers underneath the bird wings, near the tips. Test your bird by resting the beak on the end of your finger. Does it stay there? If not try adjusting it.
5 When your bird is correctly adjusted, it should be quite stable on the end of your finger.
6 Repeat steps 2 and 3 to find the centre of gravity of the weighted bird. Mark the new centre of gravity with a blue pen.

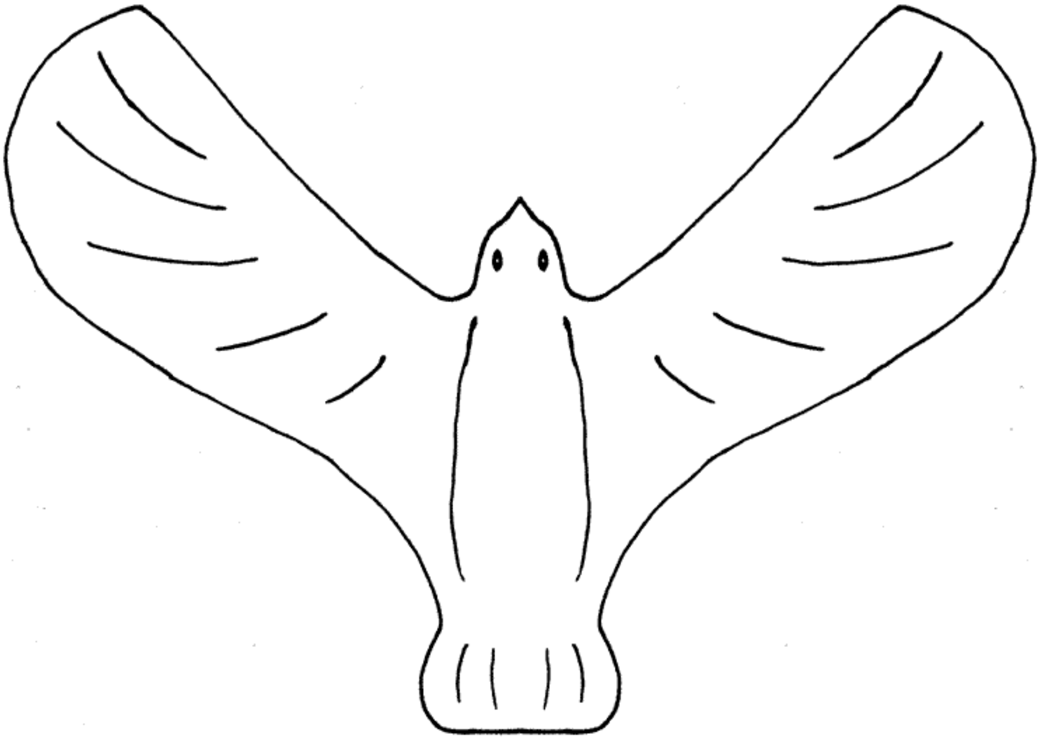
Amaze your family and friends by balancing your bird on your nose or the point of a pencil.

Questions
1 Was the bird easier to balance with or without the weights?
2 What happened to the centre of gravity when the weights were added to the bird?
3 How do you think you could make the bird even more stable?



Hints for adjusting your bird
If it is falling backwards try bending the tips of the wings down a little or making the tail shorter
If it is falling forwards try moving the weight back a little, away from the wing tips. If it is leaning to one side make sure the weights are on the same part of each wing, and that one wing is not bent down more than the other.





Background information - spinning

Tops

Once a top is spinning, it seems to stay spinning for a long time and it only falls over when it has nearly stopped. Tops are made up of a disc or a regular shaped body and an axle. The axle is a rod that passes through the top's centre of gravity and the top spins around it. The top will eventually slow down because of friction. Friction occurs at the point where the axle touches the surface it is spinning on. Friction is reduced by making the tip of the axle into a sharp point and also by making it out of a hard material. The length of time that a top spins before it falls over depends on how stable it is. Tops that have a low centre of gravity are more stable and spin longer than those with a high centre of gravity.

Yoyos

A yoyo is made of two discs joined together by an axle. A piece of string is attached to and wrapped around the axle. When you use a yoyo, the string unwinds and makes the discs spin. When the string has completely unwound, it keeps spinning and winds up the string again. The yoyo will come back up to your hand.

Hula hoops

The hoop doesn't fall down because you give it an upward force by swinging it round your body. Once you have got the hoop spinning, the trick is to move your body at just the right rhythm to keep it going around.

Hoops of cane, vines or bamboo have been a children's toy for thousands of years. In 1958 a hula hoop craze started when plastic hoops were mass produced - millions sold in the first year.

Arthur Melin and Richard Knerr began to market hula hoops (Wham-O) after getting the idea from a friend who saw school children in Australia twirl bamboo hoops around their waist for exercise. Merlin and Knerr were actually reincarnating a toy that was probably used as long ago as 1000 B.C. in Egypt, and, later, Greece and Rome. In the first year of production, 15 million hula hoops were sold.

Activity 4: Colour spinner

Aim

Students will investigate spinning by making and testing tops. They will also investigate visual illusions created by patterns on the tops.

Background information

White light is made up of all the colours of the rainbow. These colours are red, orange, yellow, green, blue, indigo and violet. When white light is broken up, for example by drops of rain, it is split into these individual colours and we see a rainbow.

When the circle spins quickly, you cannot see each colour separately. What you do see is the colours of the rainbow blending together to give the effect of white light.

What you need

- card
- scissors
- a bamboo skewer cut to 5cm length
- coloured pencils or felt pens (red, orange, yellow, green, blue and violet)
- plasticine

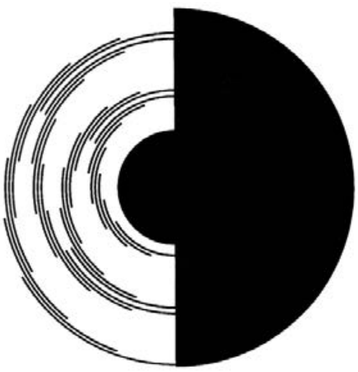
What to do

1. Colour each section using 6 colours of the rainbow in this order: red, orange, yellow, green, blue and violet.
2. Push the stick through the hole in your colour spinner disc.
3. To stabilise your colour spinner, mould a pea-size portion of plasticine around the base of your stick about 1 cm from the end.
4. Spin the disc quickly.

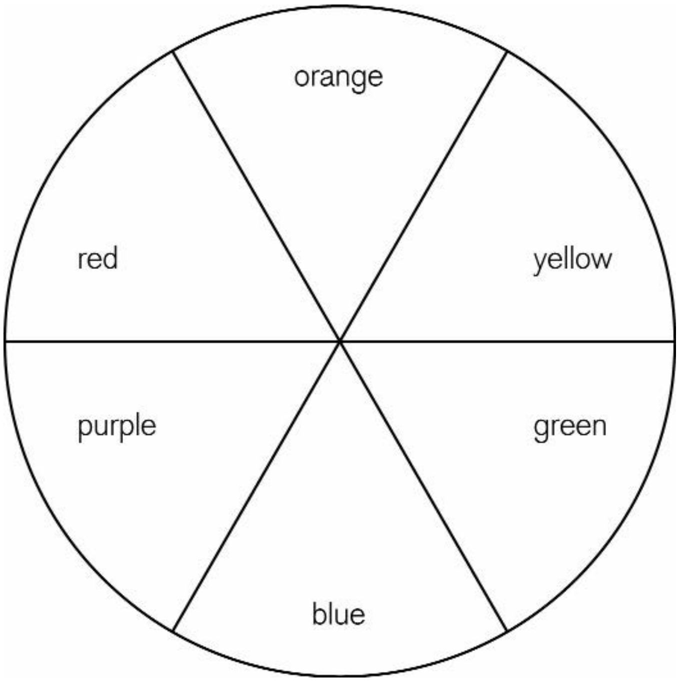
Questions

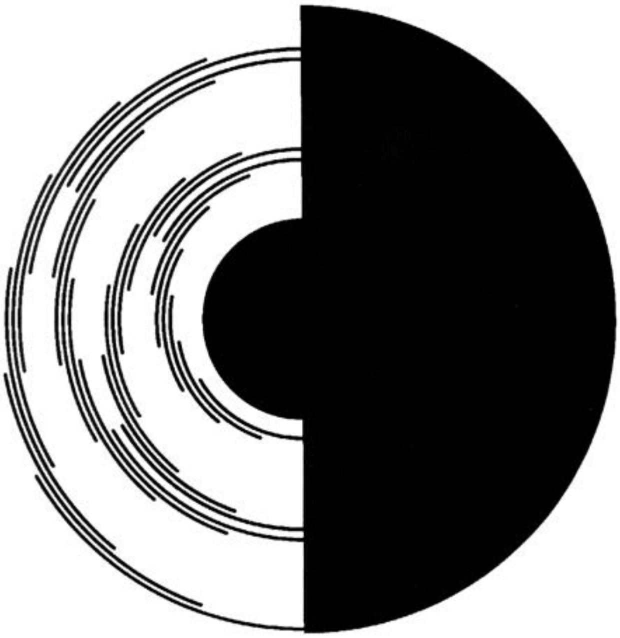
1. Describe what colour you see when you spin your wheel.
2. Try to explain why you see this colour?
3. Try different colour combinations and see what happens?
   Red and Blue?
   Red and Yellow?
   Blue and Yellow?
4. Try to guess what you might see, then try it.

Benham was a 19th Century toy maker.
He once made a black and white top like the one on the right.
When he spun the top he was surprised to see flashes of colour in the black and white pattern.
You can make a top and see the flashes too.



Activity 4: Colour spinner template





Background information - light and seeing

Persistence of vision

You are able to turn a sequence of pictures into a moving image because of ‘persistence of vision’. Your eye retains a ‘picture’ of a stimulus for a fraction of a second after the source has disappeared or moved on. Your brain receives this information and merges it with the next image you see. If you flick though the pages of a flick book or spin a phenakistoscope or thaumatrope the pictures merge together and appear to move.

Zoetropes have been used for entertainment since the 1880s. In a zoetrope there are a series of pictures around the inside of a drum. When you spin the drum there is not enough time for one image to fade before the next image appears. We interpret this series of images as one, continuous moving image.

Movies and television

Movies and television also rely on this ‘persistence of vision’ to give us the impression that we are seeing continuous movement. If they were played at a slower speed we would see that they are made up of a series of still photographs, each a little bit different from the one before. Movies are usually shown at a rate of 24 frames per second which is too fast for our eyes and brains to separate into individual pictures.

3D viewers

Our left eye has a slightly different view of the world than our right eye because its position on our face is a few centimetres to the left of our right eye. We have eyes with overlapping fields of view. When we look at an object our brains can use the slightly different images from each eye to give us a three dimensional (3D) perspective that enables us to judge the distance of the object. We find it harder to judge distance with one eye alone.

In 3D viewers there are two pictures or photos, each taken from a slightly different position that mimics the different viewpoint of our two eyes. When we look at the two pictures, our brains interpret two viewpoints as they would in real life and perceive the object in three dimensions. Children may need the pictures slightly closer together than adults to get the same effect because their eyes are slightly closer together.

Activity 6: Thaumatrope

Aim

Students will investigate ‘persistence of vision’ by making a thaumatrope.

What you need

- picture provided below
- scissors
- a drinking straw
- sticky tape
- glue

What to do:

1 Cut around the box outside the two pictures.
2 Fold the pictures back-to-back along the dotted line, and unfold.
3 Tape the straw to the centre back of one of the pictures.
4 Apply glue to the back of the picture with the straw attached
5 Fold the pictures back-to-back again along the dotted line to finish your Thaumatrope! You can colour it if you like!
6 Hold your Thaumatrope between the palms of your hands.
7 Make it spin by rubbing your hands together quickly, twirling the straw as shown in the diagram.
8 You should be able to see both pictures at once. The pictures from each side will appear to merge together.

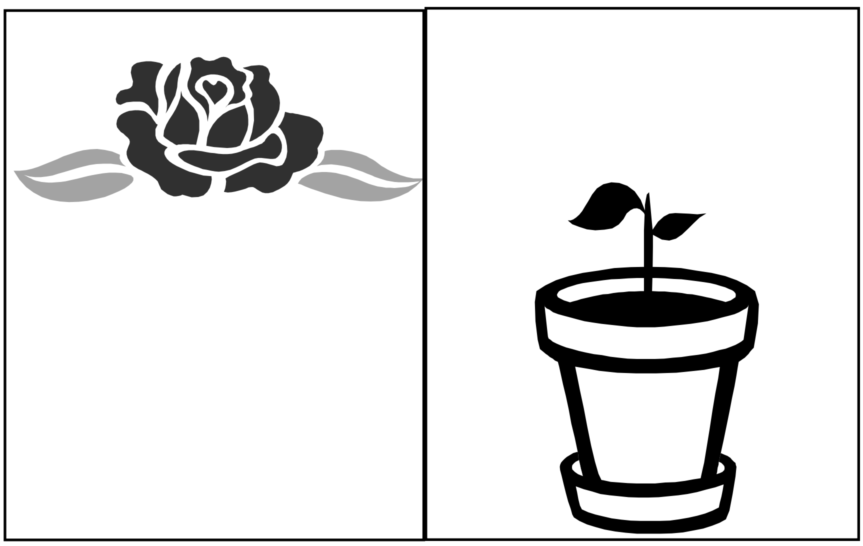
Questions

1 What is ‘persistence of vision’?
2 How does the thaumatrope work?

Optional

Think of other images you could use to design your own thaumatrope. You could put a

- fish in a bowl
- smile on a clown
- bird in a cage
- jack in a jack-in-a-box



Activity 7: Flick book

Aim

Students will design a short animation and make it into a flick book.

What you need

- a sheet of A4 paper
- a ruler
- coloured pencils
- scissors
- a stapler

What to do

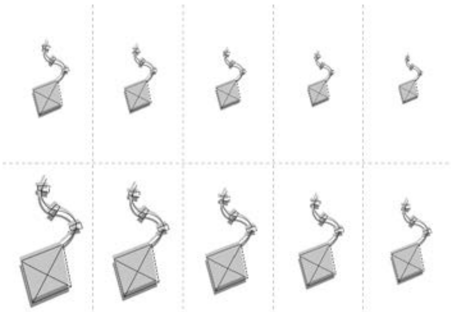
1. Use the ruler to divide the sheet of paper into 3 x 6 = 18 evenly sized squares. Number each square in the top left hand corner.
2. Think about a simple moving picture that you could draw by using 3 or 4 different images repeated over and over. For example, it could be a smiling face, a stick figure walking or a flower opening and closing.
3. Carefully draw the images at exactly the same size on the same place on each square.
4. Cut up the page to make 18 individual ‘frames’.
5. Stack the frames neatly on top of each other, in order with number one at the top.
6. Carefully use the stapler to staple the ‘frames’ together along the left side.
7. Hold your flick book firmly along the stapled edge and flick through the pages with your thumb.
8. Can you see a moving picture?
9. If your picture seems a bit ‘jumpy’ try redesigning it.

Questions

1. Why does it look like the figure is moving when you flick through the pages of your flick book?
2. What are some other things that rely on ‘persistence of vision’?
3. Investigate the types of movement you can display with the flick book.
4. Find out how cartoonists use something like this to make cartoon shows.

Optional

- Try drawing a sequence of three or four frames then use a photocopier to make the repeat sequences.
- If you have access to a program such as ‘Powerpoint’ on your computer, try making a simple animation by scrolling through slides on the computer screen.



Activity 8: 3D glasses

Aim

Students will make 3D glasses and use them to see a 3D image.

Background information

The 3D viewer has a blue filter on one side and red filter on the other side. The filters separate the views or images going to each eye. Our brain then fuses them into one 3D image of the cube.

What you need

- 3D image templates
- A piece of A4 paper
- red cellophane
- blue cellophane
- cardboard for making glasses
- scissors
- glue or sticky tape
- red and blue coloured pencils or felt pens

What to do

1 Design a pair of glasses and cut them out of the cardboard.
2 Glue or tape red cellophane over one eye of the glasses and blue cellophane over the other eye.
3 Use the template on page 34 to trace a 3D cube on a single piece of paper. Trace over the red template with a red pencil or pen. Line up the marker cross with the blue template and trace over it with a blue pencil or pen.
4 Look at the cube through the glasses.

Questions

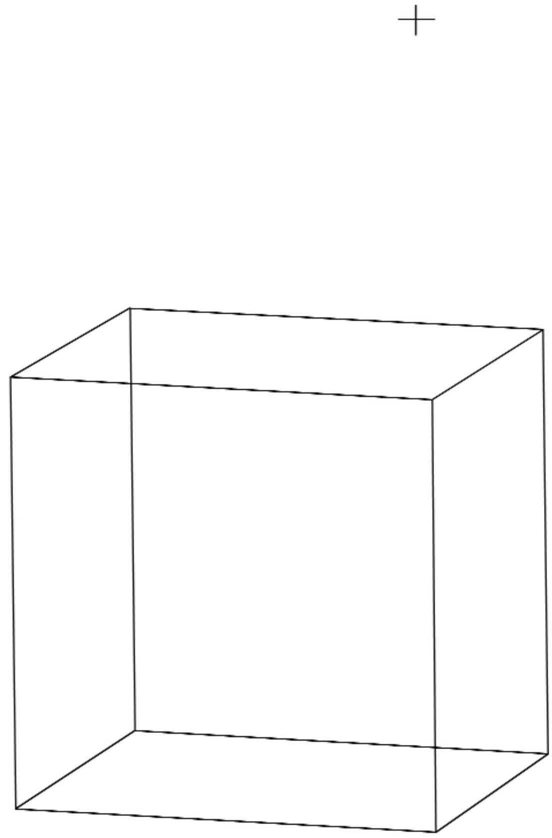
1 What can you see?
2 What colour is the cube that you see?
3 Does it make a difference if the eye colours are swapped around?
4 Why are we able to see objects in 3D?

Optional

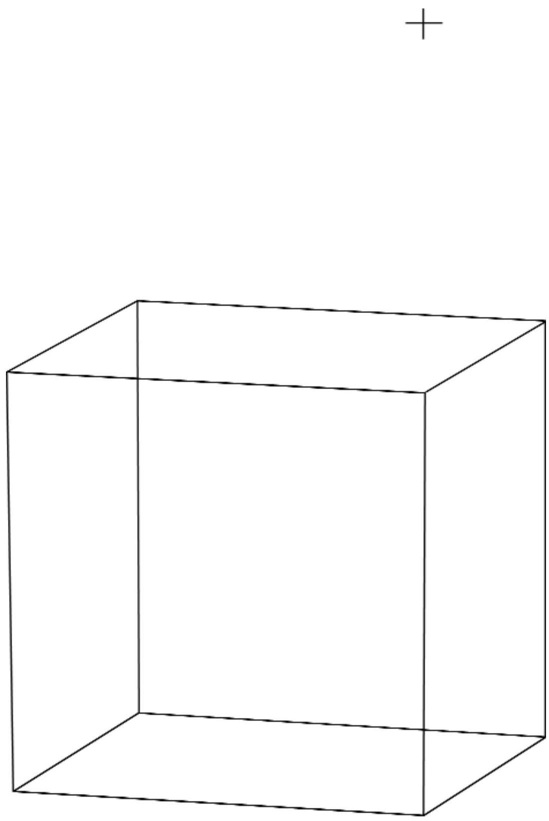
Try designing other 3D shapes and see if they appear to come out of the page.

Activity 8: 3D image template

green template



red template

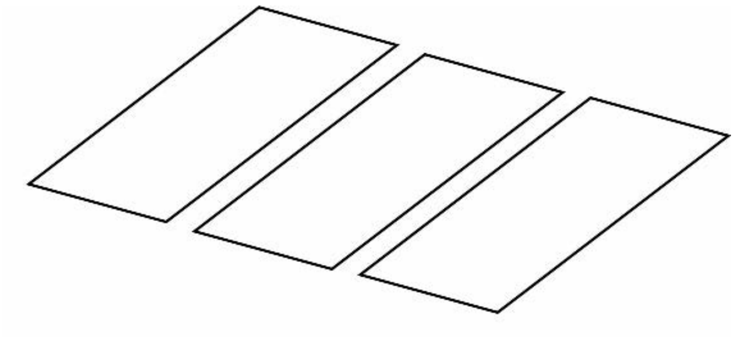


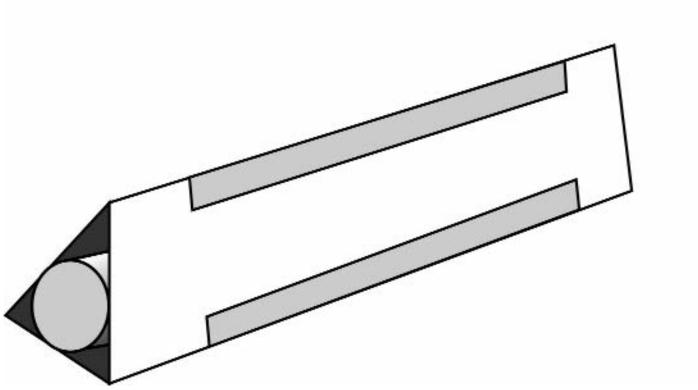
Activity 9: Kaleidoscopes

Aim
Students will investigate reflection by making a kaleidoscope.

What you need
- kaleidoscope
- three rectangular unbreakable mirror pieces
- cardboard tube
- sticky tape
- clear plastic
- coloured cellophane
- beads and sequins

What to do
1. Use the kaleidoscope to discuss its construction and how it works.
2. Brainstorm ideas for the construction of kaleidoscopes.
3. Write or draw a design brief for a kaleidoscope.
4. Use the material listed above to construct a kaleidoscope. (Hint: use the cardboard tube to hold the three mirrors into a triangle shape)
5. Test and modify the designs of the kaleidoscopes.





Background information - energy

Energy

The word ‘energy’ itself conveys an abstract concept that is hard to define. It is easier to describe the changes that happen when energy is transformed from one form to another or transferred from one place to another than to define what energy is.

Although energy can be changed from one form into another, it can never be created or destroyed. This is the principle of conservation of total energy – one of the unifying concepts of science.

Energy can be found in different forms such as sound, heat, light, electrical, nuclear, chemical, elastic, gravitational and kinetic energy. Other forms of energy that we talk about in everyday speech, such as solar and wind energy are more accurately seen as sources of energy rather than different forms of energy. Solar energy is a source of light and heat. Wind energy is a source of kinetic energy.

kinetic energy is due to an object's movement (from the Greek word Kinema, from which we also get the word cinema). Different types of kinetic energy include:

- electrical energy is due to the movement of electricity
- heat energy is due to the movement or vibration of particles (atoms or molecules). The higher the temperature of an object, the faster the particles move or vibrate.
- sound is a type of energy caused by vibrating surfaces

potential energy is stored energy

Stored energy

Stored energy, which is often called potential energy in physics, is energy that has the potential to be changed from one form into another form. For example, a compressed spring such as a spring in a Jack-in-a-Box with a closed lid has potential energy that is changed into movement (kinetic energy) when the spring returns to its original shape and the Jack-in-a-Box pops out.

How can energy be stored?

Energy can be stored in readiness for conversion into another form of energy. When someone buys a loaf of bread, they have bought some stored chemical energy that they can later eat and convert to energy for their breathing, walking and other functions of daily life. Similarly a battery is a stored source of chemical energy that can be used to light a torch, move a toy car or play a music synthesizer.

If you hold a ball high in the air, you give it stored energy (gravitational potential energy). The higher you hold it, the more stored energy you give the ball. When you let the ball fall, its bounce will depend on how much stored energy you have given it, what the ball is made of and the type of surface it is dropped on.

Coiled springs provide another means of storing energy. They were used in watches before small, efficient batteries were developed. People used to wind up their watches each night and their clocks each week. In doing so they tightened a spring and gave it potential energy. As the spring gradually slackened, the potential energy changed into kinetic energy as it turned gears, which turned the hands of the watch or clock. Springs are still used in some toys today. For example, wind-up toys have springs inside them. A person who winds up a toy uses some of their chemical energy to turn the key of the toy. This tightens the spring of a wind-up car. As the spring gradually unwinds it transfers its stored energy to turn the car axle, which turns the wheels and makes the car move.

Activity 10: Returning tin can

Aim

Students will investigate energy transformations by making a ‘Returning tin can’.

What you need

- a tin can with a removable metal lid (for example a coffee can)
- a long rubber band
- a heavy nut or bolt
- scissors
- a ‘punch’ type can opener

What you do

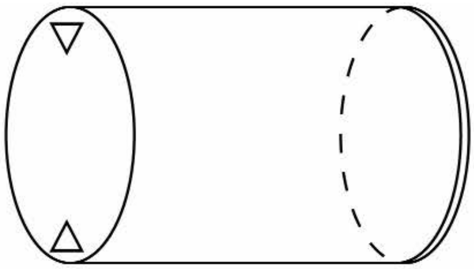
1 Use the can opener to ‘punch’ two holes on opposite sides of the base of the can.
2 Punch two matching holes in the lid of the tin can as shown in the diagram.
3 Cut the rubber band to make one length of rubber.
4 Carefully thread each end of the rubber through the bottom holes so that it is even. Cross the ends of the rubber over and tie the nut or bolt onto the rubber so that it is in the centre of the can.
5 Thread the free ends of the rubber through the holes in the lid. Put the lid on the can so that the bottom holes and the top holes line up.
6 Tie the two ends of the rubber together firmly outside the lid.
7 Gently roll the can along the ground away from you.

Questions

1 What happens to the can when you roll it along the ground?
2 Why do you think it stops?
3 Where does the can get the energy to roll back to you?
4 What do you think is happening inside the can?
5 What are the energy transformations taking place?

Activity 10: Returning tin can instruction template

1



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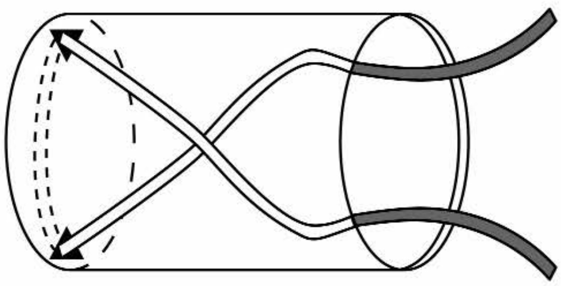

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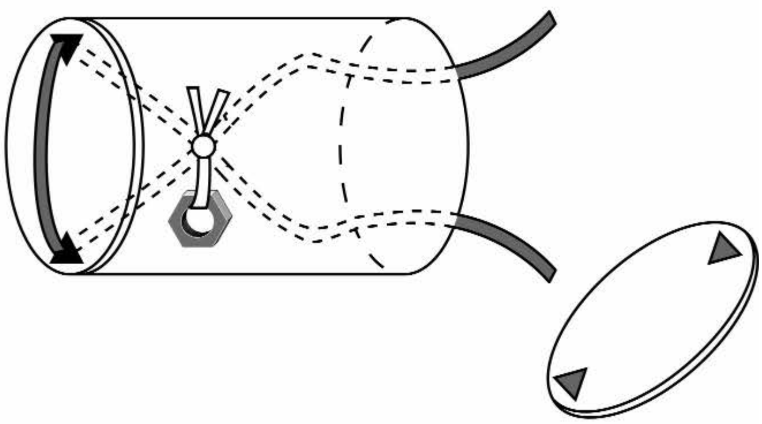

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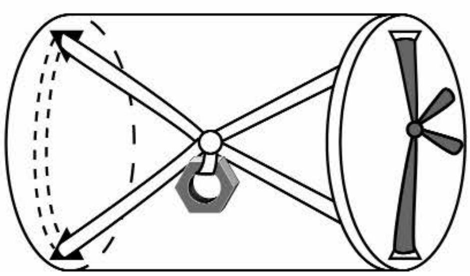


Activity 11: Make your own powerboat

Aim

Students will make a powerboat from simple materials and investigate energy transformations with it.

What you need

- a piece of polystyrene (8cm x 5.5cm x 1cm)
- two icy pole sticks
- a rubber band
- an ice cream or margarine tub lid
- scissors
- sticky tape

What to do

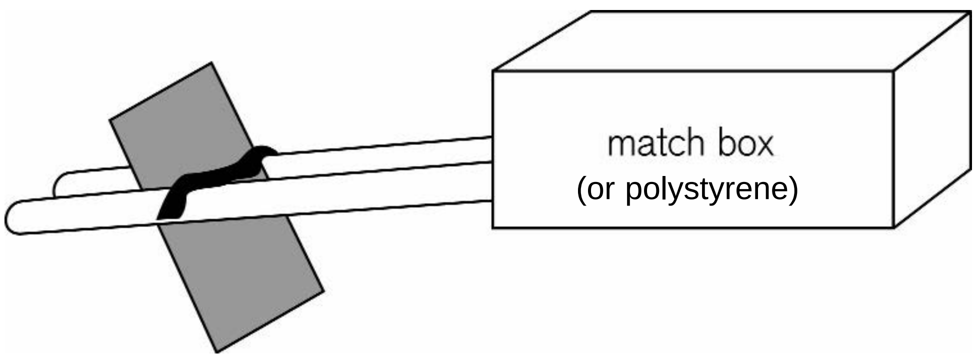
1 Place the icy pole sticks on either side of the piece of polystyrene.
2 Angle both sticks downward so that they will point into the water when you float your boat
3 Hold the icy pole sticks to the polystyrene by wrapping sticky tape around them both.
4 Place a rubber band over the icy pole sticks towards the free ends.
5 Cut a rectangular piece of plastic from your ice cream lid. This will be the paddle for the boat so its size will depend on the size of your polystyrene. It will have to be small enough to spin freely between the sticks, but large enough to make your boat go fast (for an 8cm x
5 .5cm x 1cm piece of polystyrene, a 2cm x 5cm paddle is perfect).
6 Slide the paddle through the rubber band and wind it backwards. Keep a hold of it…
7 Put your boat in water, release the paddle and watch it go.

Questions

1 What type of energy is being transformed into kinetic energy?
2 What other types of energy may it be transforming into?
3 Investigate ways to make your paddle boat go faster.

Optional

You can also use an empty matchbox instead of polystyrene. To waterproof your boat for durability, wrap up the empty matchbox using cling wrap or contact paper. Safety tip: Never play with matches. Ask an adult for an empty box.



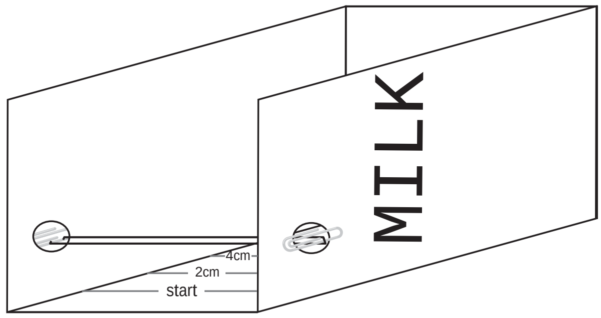
Activity 12: Car launcher

Aim

Students will investigate potential and kinetic energy by making a machine to launch toy cars.

What you need

- toy cars
- rubber band
- one litre milk carton
- ruler
- paper clips



What to do

1 Cut the top and one side from the milk carton.
2 Attach the rubber band to the inside front of the carton using paper clips.
3 Use the ruler to mark distances at one centimetre intervals back from the rubber band.
4 Use the rubber band to launch the toy car from the 1 cm mark, measure how far the car travels.
5 Repeat step 4, launching the car from increasing distances.
6 Record your results.

Launching distance (cm)	Distance travelled by car
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Questions

1 What type of energy does the car gain when the rubber band is stretched?

2 What type of energy does the car have once it is moving?

4 What happens to this energy when the car eventually stops?

5 How does the car get more energy and go faster and further?

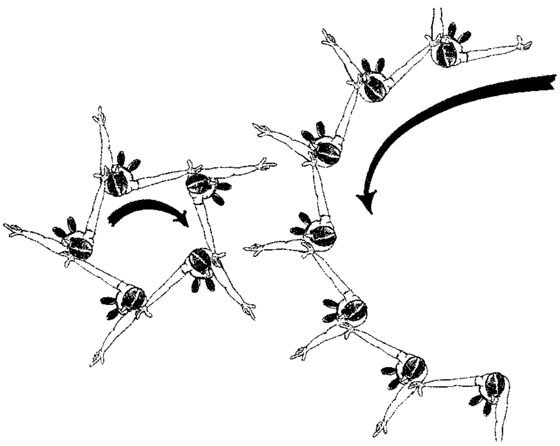
Activity 13: Getting into gear

Aim
Students will investigate gears through role play.

What you need
- rope or chalk to mark circles on the ground

What to do
Ask the students to:
1 Make a large circle of 15 or 20 students so that each person is facing the back of the person in front.
2 Instruct students to place their inside hand on the inside shoulder of the person in front. They then need to extend their outside arms to make the teeth (cogs) of a gear wheel.
3 Mark the circle on the ground with chalk or the rope. This marks the path the students are to follow.
4 Repeat these steps to make a small gear wheel with 5 students. Make sure the students are facing the correct way and that the two circles are close enough together so that one arm of one wheel will fit between two arms of the other wheel.
5 Ask the large gear wheel to walk slowly once around their circle. Make sure that each tooth fits between two teeth from the other wheel.
6 Try different numbers of teeth on each wheel, for example (16, 4), (10, 5), (10, 10) and so on.

Questions
1 How many times did the small wheel turn when the large wheel turned once?
2 What was it like being in either wheel?
3 In which direction did the wheels turn (clockwise/anticlockwise)?
4 How could you use gears to speed up or slow down a rotation?
5 Investigate the gear box of a car.
Find out how many gears a car has.
6 Investigate gears on a bike.
7 What type of energy transformations take place in a gear box?
8 What type of energy transformation took place in this role play



Background information - flying toys

Some toys fly because they are lighter than air (helium balloons, hot-air balloons, soap bubbles). Aeroplanes, frisbees and boomerangs fly because of the way the wind moves over their surfaces as they move through the air. Helicopters are lifted into the air by air screws. Toy rockets move as a reaction to gas being shot out in the opposite direction to their motion.

Aeroplanes

Aeroplanes, kites and other heavier than air flying machines work because of the way which air flows over them. A modern aeroplane works because as it moves through the air at high speed, air rushes over the wings creating a partial vacuum above the wings giving lift and creating greater air pressure below the wings also giving lift.

Helicopters

Helicopters work because the blades on the top are shaped like aircraft wings and as they are turned, the air rushes over them creating a partial vacuum above them and higher pressure below them, so lifting the helicopter off the ground. As well as lifting the helicopter off the ground, the blades also move the helicopter in different directions. Tilting the angle (pitch) of the blades individually as they sweep around, creates more lift on one side than the other, so the helicopter moves to one side.

Boomerangs

The boomerang is probably the first human invented 'flying machine'.
Traditional returning boomerangs are basically two wings connected together in one banana-shaped unit, but you can find a number of different boomerang designs available these days, some with three or more wings. Most returning boomerangs measure 30 to 60cm across, but there are larger and smaller varieties. When thrown correctly, a returning boomerang flies through the air in a circular path and arrives back at its starting point. Returning boomerangs are not suited for hunting - they are very hard to aim, and actually hitting a target would stop them from returning to the thrower, defeating the purpose of the design.

Returning boomerangs evolved out of non-returning boomerangs. These are also curved pieces of wood, but they are usually heavier and longer, typically one metre or more across. Non-returning boomerangs do not have the lightweight and special wing design that causes returning boomerangs to travel back to the thrower, but their curved shape does cause them to fly easily through the air. Non-returning boomerangs are effective hunting weapons because they are easy to aim and they travel a good distance at a high rate of speed.

How boomerangs work

If you throw a straight piece of wood that's about the same size as a boomerang, it will simply keep going in one direction, turning end over end, until gravity pulls it to the ground. So the question is, why does changing the shape of that piece of wood make it stay in the air longer and travel back to you?

The first thing that makes a boomerang different from a piece of wood is that it has at least two component parts, whereas a straight piece of wood is only one unit. This makes the boomerang spin about a central point, stabilising its motion as it travels through the air. Non-returning boomerangs are better throwing weapons than straight sticks because of this stabilising effect: They travel farther and you can aim them with much greater accuracy.

The returning boomerang has specialised components that make it behave a little differently than an ordinary bent stick. A classic banana-shaped boomerang is simply two wings joined together in a single unit. This is the key to its odd flight path.

The wings are set at a slight tilt and they have an airfoil design - they are rounded on one side and flat on the other, just like an aeroplane wing. The air particles move more quickly over the top of the wing than they do along the bottom of the wing, which creates a difference in air pressure. The wing has lift when it moves because there is greater pressure below it than above it.

How the boomerang moves through the air and makes a circular path is complex, but could be shown in animation.

Activity 14: Paper toys

Aim

Students will investigate flying toys by making paper planes

What you need

- sheets of A4 paper
- paper clips
- sticky tape
- paper toys template
- pencil

What to do

Traditional paper plane

Note: Each step below has a corresponding diagram.

1 Fold the paper in half long ways, then open it up.
2 Fold the two top corners into the centre fold line.
3 Fold corners in to the centre fold line.
4 Fold in half along the centre fold line.
5 Divide the end of each wing into three equal parts with a pencil. You will be folding your wing down on a line from the inner pencil mark to the nose tip.
6 Fold one wing down along the fold line.
7 Do the same with the other wing. The wings should extend below the centre fold.
8 Lift the wings into a horizontal position and tape as shown.
9 Try modifying the design to make your plane fly further.

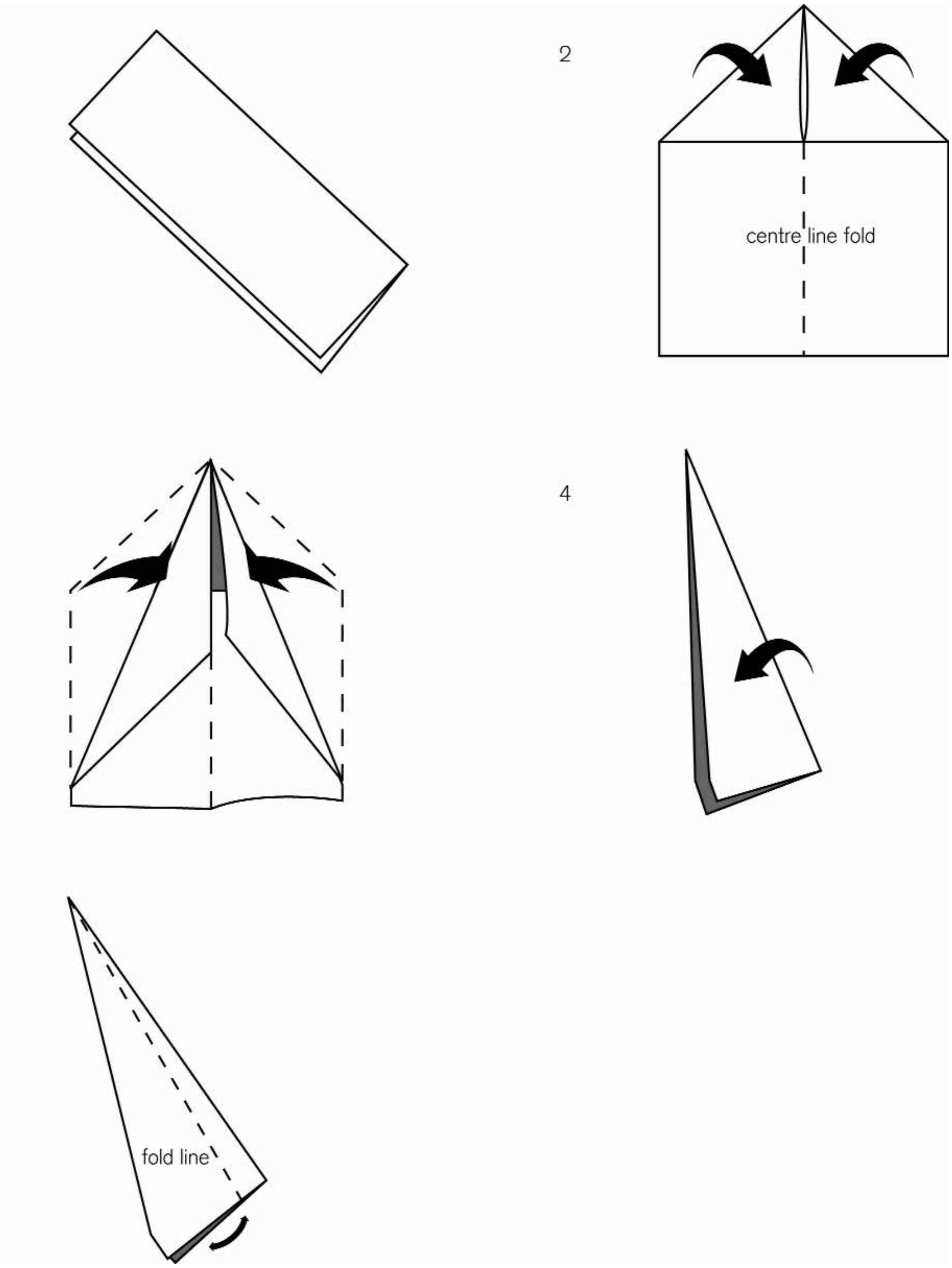
Flying loop

Note: Each step below has a corresponding diagram.

1 Fold an A4 paper diagonally as shown.
2 Hold the fold with two hands and fold over about 1 cm across, three times as shown.
3 Run the folded section over the edge of a table to make it curve.
4 Slot ends together to make a loop.
5 Hold the flying loop between your thumb and middle finger, throw it and watch it fly.
6 Try modifying the design to improve your flying loop and make it fly further.

Activity 14: Paper toys instruction template

Traditional paper plane



Activity 14: Paper toys instruction template

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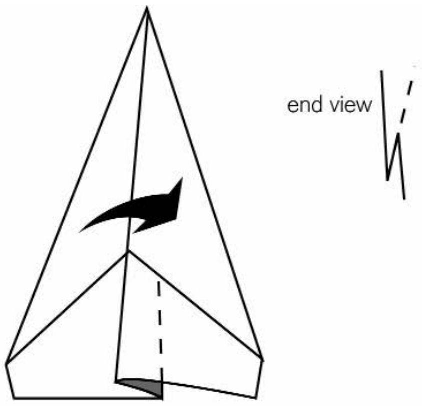

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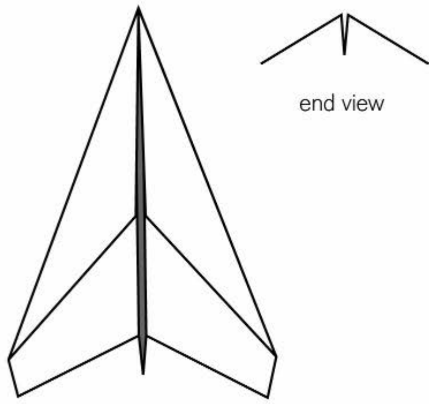

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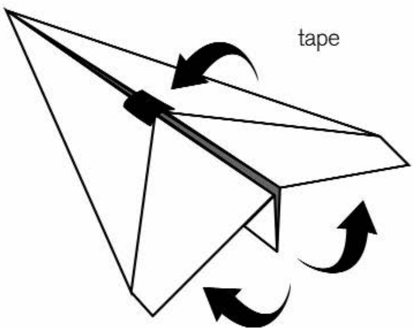
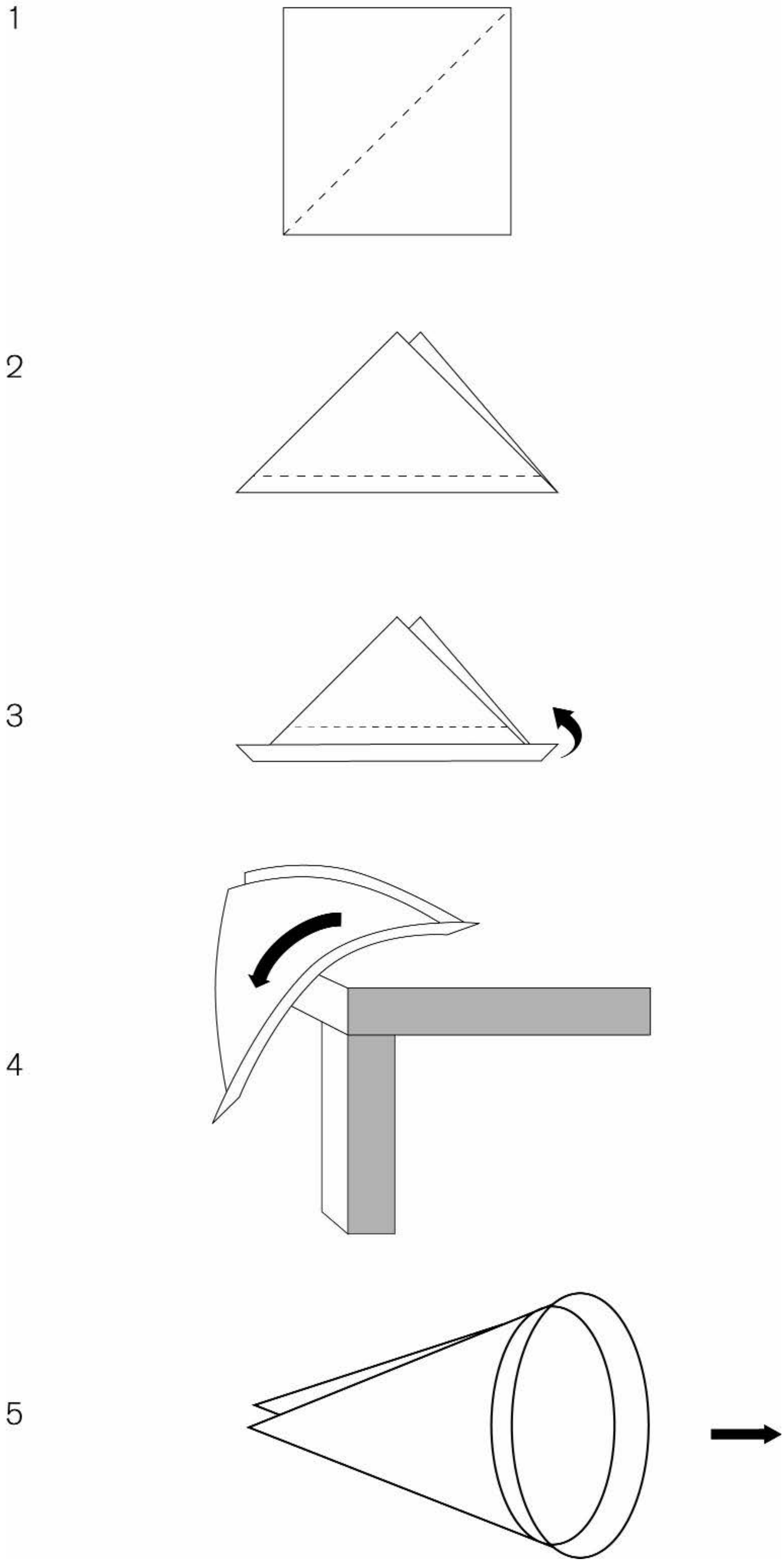


Activity 14: Paper toys instruction template

Flying loop



Activity 15: The power of the wing

Aim
Students will investigate how the shape of a wing helps to lift a plane into the air.

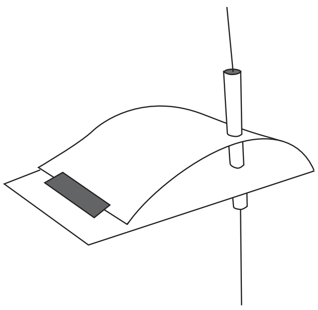
Background information
The wing on a car acts in the opposite way as the wing on a plane. The wing is able to lift a plane from the ground and keep it in the air because of its shape. The air flowing over the top of a wing travels further and faster than the air below it. This causes a difference in pressure at the top and the bottom of the wing and the air below the wing pushes the wing up. This upward force is called ‘lift’.

The wing on an formula one car acts in the opposite way than the wing on a plane. It is an upside down wing that causes a downward force called ‘negative lift’ and pushes the car down on the track. This improves cornering ability and increases the grip of the car.

What you need
- A4 sheet of thin cardboard
- Sticky-tape
- Straw
- Scissors
- Half a metre of fishing line
- Pen

What to do
1 Fold the piece of cardboard in two, pushing the top half 2cm from the edge .
2 Tape the ends together.
3. Use a pen to pierce a hole about a third of the way from the curved edge of the wing.
4 Carefully push the straw through the hole.
5 Thread the fishing line through the straw.
6 Hold the ends of the fishing line, one in each hand.
7 Check that the curved side of the wing is facing upwards.
8 Hold both ends of the fishing line tautly, spin around in a circle and watch what happens.

Questions
1 Describe what happens to the wing when you move in a circle?
2 What force pushes the wing up?
3 How is this wing similar to the wing on a formula one car?
4 How is this wing different to the wing on a formula one car?
5 Why is the wing on a formula one car useful?
6 What is the name of the force that pushes the wing up on a plane?
7 What is the name of the force that pushes the wing down on a car?



Activity 16: Helicopters

Aim

To make a helicopter propeller and investigate what happens when the design is modified.

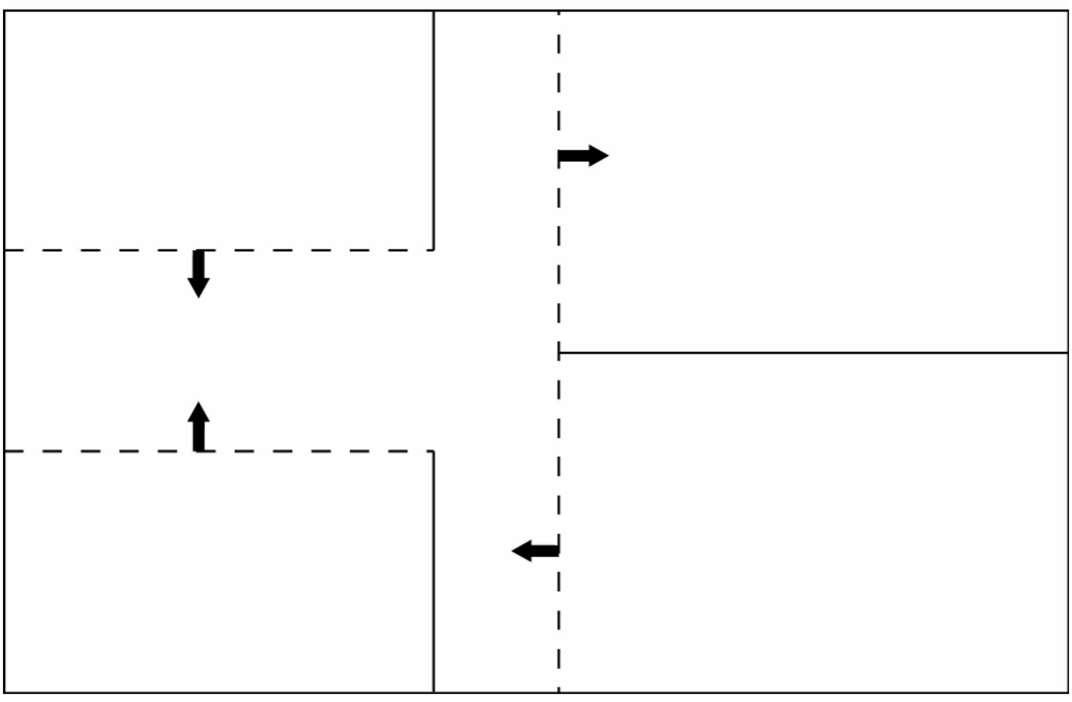
What you need

- helicopter propeller template
- scissors
- paper
- pencil
- ruler

What to do

Ask your students to:

1 Cut along the solid lines
2 Fold along the dotted lines in the directions of the arrows.
3 About 1cm from the bottom, fold a ‘foot’.
4 Drop your helicopter propeller from a good height
5 Fold the vanes in the opposite directions and watch what happens.
6 Using the same size piece of paper, investigate ways to modify the design so that the helicopter propeller comes down faster.
Have a race with your class mates and drop them from the same height and see who wins.
Investigate putting paper clips on different parts of the propeller to see if they make a difference.



Background information - force and motion

Forces

Force is a push or a pull
Forces can change the motion or shape of an object.
Force is measured in newtons (N)

Weight is the force of gravity that acts on an object. On the Earth it is equal to the mass (in kilograms) of the object multiplied by 10. It is measured in newtons. For example, a child whose mass is 30 kilograms has a weight of 300 newtons.

Buoyancy is the upwards force experienced by an object immersed in a liquid. It is equal to the weight force of the liquid displaced. Buoyancy makes things float. An example of a toy that uses buoyancy is the Cartesian diver.

Friction is another type of force. It is the force that resists the motion of one surface across another surface. There are three basic types:

- static friction occurs when the surfaces aren't moving relative to each other
- sliding friction occurs when one surface slides across the other
- rolling friction is the friction between a wheel and the surface across which it is rolling. Rolling friction is much smaller than static and sliding friction.

Forces can also be made by magnets. The poles of magnets can pull the magnets together (attraction) or push the magnets apart (repulsion). Magnets do not attract all metals. They only attract metals that have iron, nickel or cobalt in them.

Activity 17: Climbing monkey

Aim

Students will investigate friction by making a rope climbing toy.

What you need

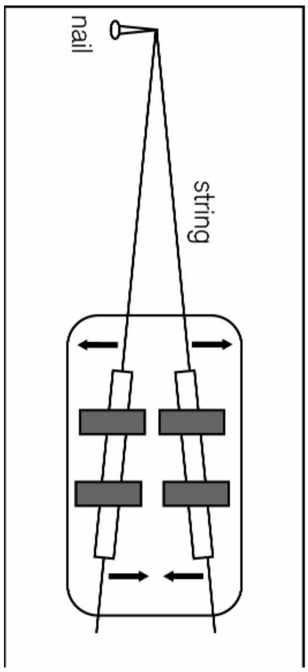
- stiff card
- a drinking straw
- string
- sticky tape
- scissors
- two weights (Modelling clay or washers)
- a thumb tack
- access to a pin board
- Monkey template

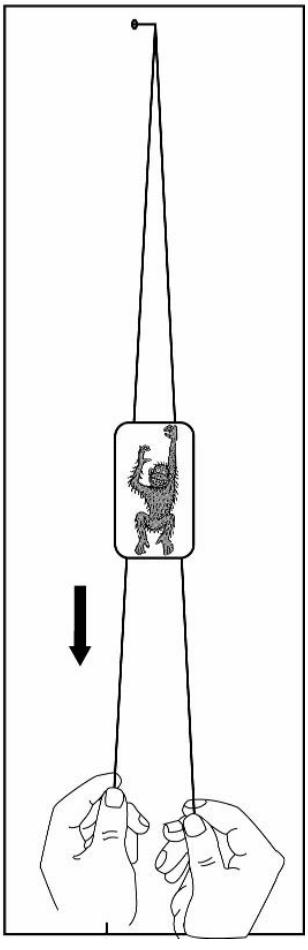
What to do

1. Colour the picture of the Monkey, cut it out and glue onto a piece of card.
2. Cut two 5cm pieces from the straw; attach them to the back of Monkey as shown in diagram. Tie the weights onto the ends of the string.
3. Put a thumb tack into a pin board or some other vertical surface.
4. Thread the string through the straws and attach weights to the ends as shown in diagram.
5. Hang up the monkey from the thumb tacks. Make Monkey climb by pulling on the weights.

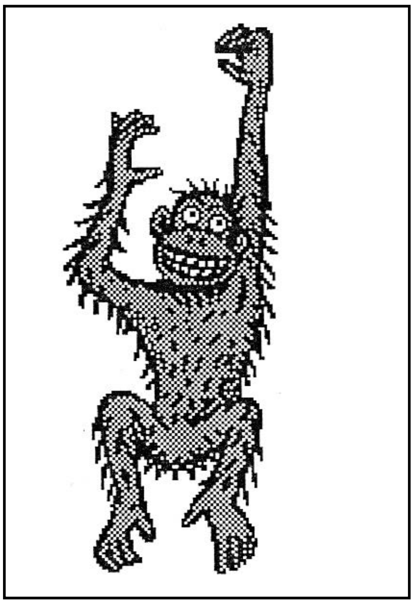
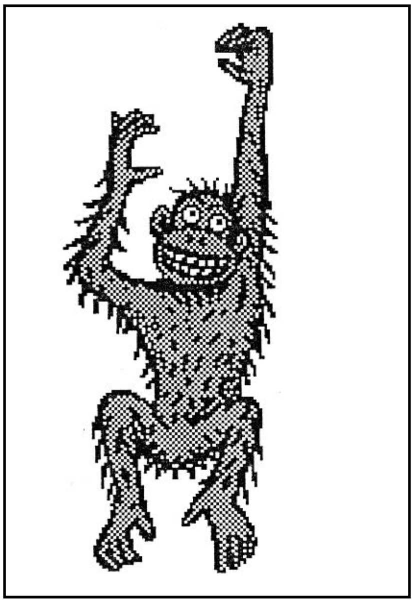
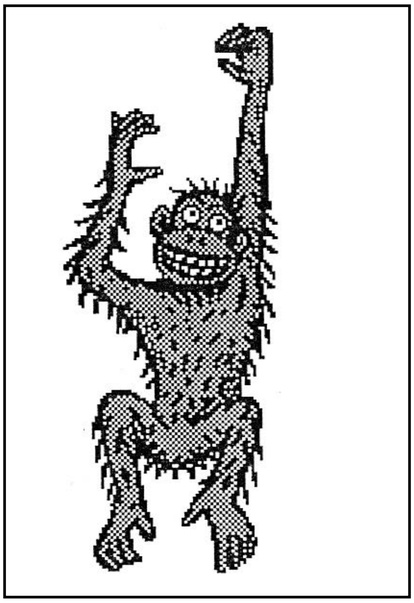
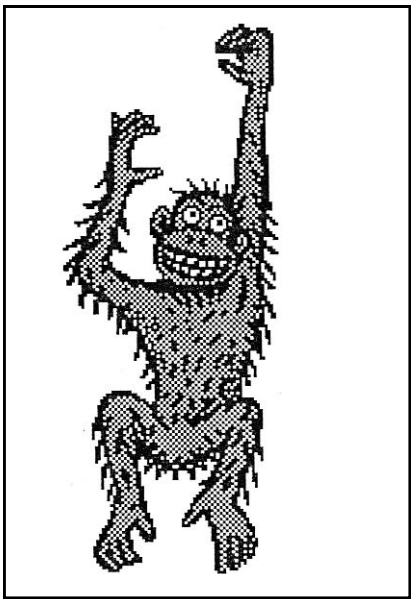
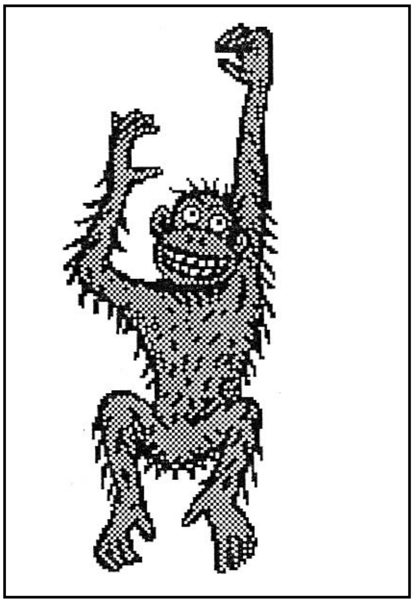
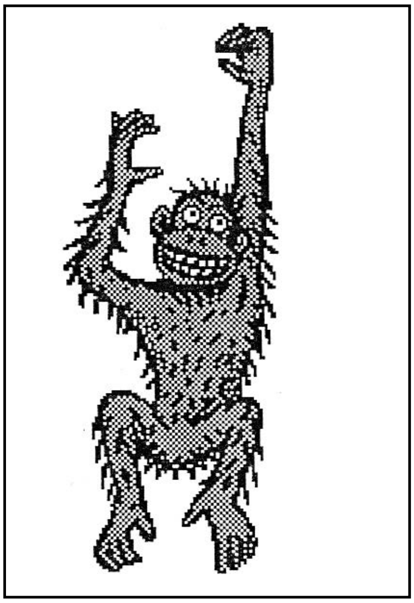
Questions

1. What force stops Monkey from falling down the string?
2. What force is pulling down on the monkey?





Activity 17: Climbing monkey template

Background information - music and sound

What is sound?

Sound is made when something moves backwards and forwards (vibrates) very quickly. The vibration sends a compression wave through the air. When that compression wave reaches our ear drums, it makes them vibrate too, which in turn is amplified by the middle ear, encoded by the cochlea and sent as a nerve message to our brains. Our brains interpret the vibration of our ear drums as sound.

How does a compression wave travel through the air?

When an object vibrates it moves the air particles around it. As the object moves one way, the air particles receive a push, which compresses the air, a bit like the push you give to air when you pump up a bicycle tyre. The pushed air particles bump into the air particles next to them and a wave of compressed air passes out from the object. When the object moves the other way, it creates an area of low pressure, which pulls the air particles towards it. This creates a wave of low pressure. The alternating pulses of high and low pressure move out in all directions from the source of the sound. Our eardrums vibrate when these tiny pulses of pressure reach them.

A slinky can provide a model of a compression wave. Stretch the slinky out between two people. One person pulls a bunch of coils tight towards them and then releases them. The compression wave travels down the spring.

Sounds can carry through air because the air particles move to and fro and carry sound compression waves. However, when there is no air, such as in a vacuum, there are no air particles to carry the sound waves. When astronauts on a space walk want to talk to each other, they cannot talk normally because there are no air particles to carry the sound waves. They have to use radios instead.

The speed of sound in air

Sound waves travel in air at approximately 332 metres per second. The speed of sound is even faster at higher temperatures because the air particles move faster and collide more frequently. For each degree of increase in temperature the speed of sound is increased by 0.6 metres per second.

The speed of sound in liquids and solids

Sound waves travel faster and more effectively in liquids than in gases and travel even faster in solids. This is because the molecules of solids are more tightly packed together than in liquids, and those in liquids are more tightly packed than in gases. Vibrating effects are more easily passed on from one molecule to the next when they are close together. The string of the string telephone is a solid through which the vibrations of the speaker's voice are transferred quickly and effectively - much more effectively than if the speaker had talked through the air to the other person.

Activity 18: Understanding waves

Aim

Students will investigate sound waves.

What you need

- a slinky
- a toy xylophone
- 5-6 similar jars
- rubber bands (various thickness)
- empty boxes and plastic containers of different sizes

A series of demonstrations and activities to investigate rarefractions and compressions in sound waves

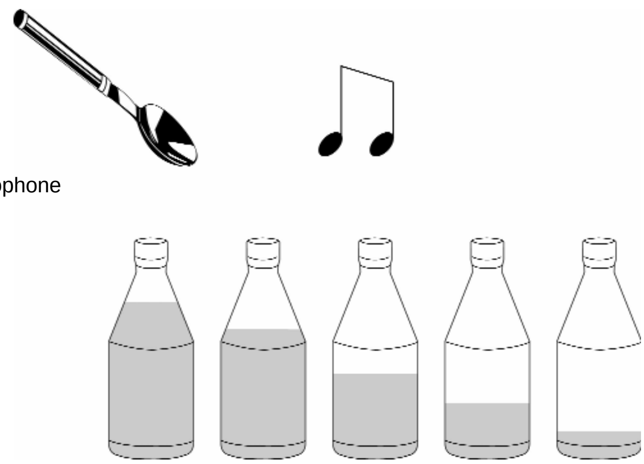
What to do

1. Use a slinky to demonstrate sound waves by stretching a number of coils in the slinky (about six) back and then letting go. Observe the motion of the spring and identify compressions and rarefractions in the spring.
2. Listen to different pitches on a toy xylophone.
3. Make a xylophone by filling the jars with different amounts of water.
4. Rubber bands of different thickness can be stretched across boxes and other small empty containers. Pluck the rubber bands to hear different pitches. Try to arrange the containers in order to make a xylophone.

Questions

1. Describe the movement of the coils in the slinky.
2. Which direction did the energy travel through the slinky?
3. Why can't we hear sounds in space?
4. How does the length of the bar on the xylophone and the height of the water in the jar relate to the pitch of the sound produced?
5. How does the thickness of the rubber bands relate to the pitch of the sound produced?
6. Does varying the boxes that the rubber bands are stretched across change the pitch in any way?

compression rarefraction



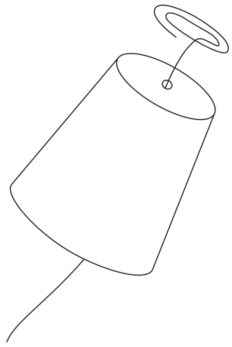
xylophone

Activity 19: Clucking cup

Aim

Students will gain an understanding of sound as a vibration and the use of a ‘sound box’ (the cup) to amplify the vibrations

What you need



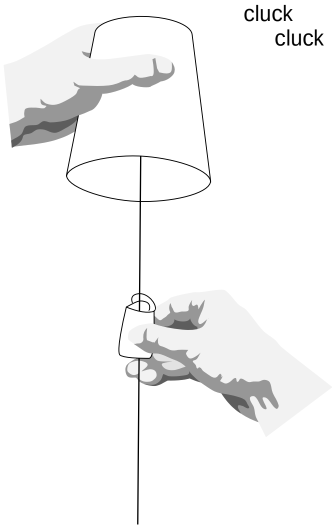
- plastic drinking cup
- bamboo skewer
- string
- scissors
- paper clip
- sponge
- eyes and beak cut-out
- chicken comb cut-out
- a small amount of salt or sugar

What to do

1 Carefully make a small hole in the bottom of the cup using the bamboo skewer.
2 Thread the piece of string through the hole.
3 Tie the string to the paper clip, so that it can't slip back through the hole.
4 Tie the piece of sponge to the end of the string.
5 Wet the sponge. Holding it firmly around the string, pull downward. Do you hear a loud clucking sound?
6 Cut out your chicken's eyes and beak and comb. Sticky tape them on to the cup to make it look like a chicken!

What's happening?

As the wet sponge moves down the string, it grips a little, then slips a little, then grips again, and so on. This makes the string vibrate. The vibrations travel up the string to the cup. The cup starts to vibrate too, amplifying the clucking sound (making it louder).



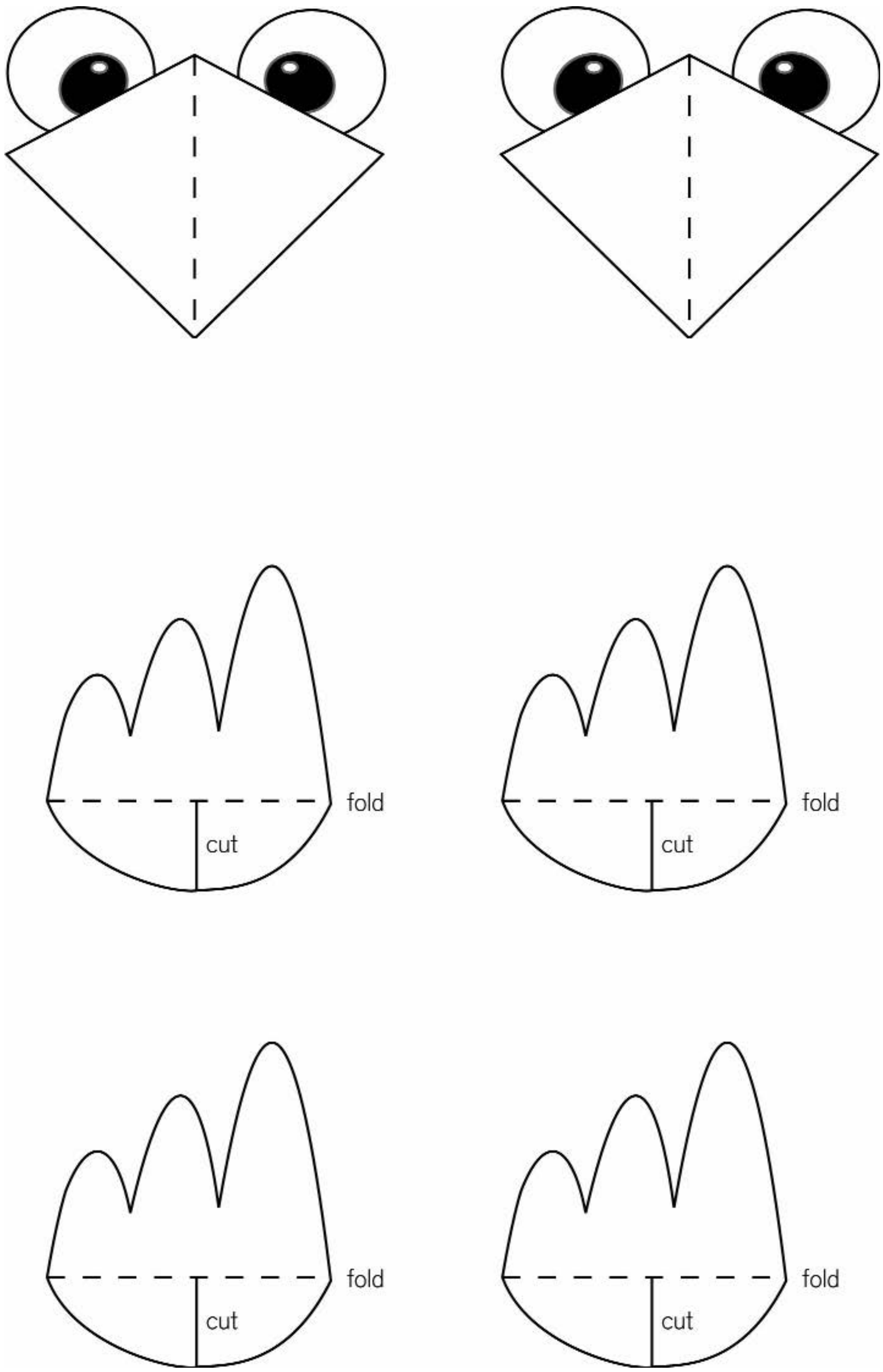
Questions

1 Put some sugar in the cup and watch what happens when you pull down the string with the sponge.
What happened to the sugar?
2 How does the clucker make a sound?
3 How can you make the sound louder?
4 What does the cup do to the sound?
5 What energy transformations occur when you make the chicken cluck?

Optional

Make a string telephone using a similar method to connect two cups by a long piece of string.

Activity 19: Clucking cup template



Activity 20: Strum a drum

Aim

Students will investigate how sound travels in solids while making a hybrid musical instrument.

What you need

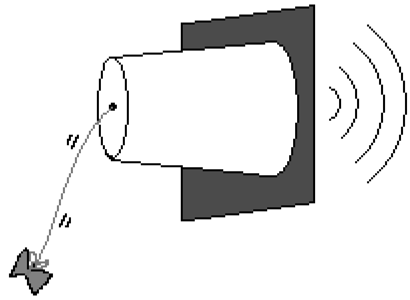
- a plastic drinking cup
- a rubber band
- a plastic ice-cream container lid
- a paper clip
- a small piece of sponge or foam (eg kitchen sponge)
- scissors
- sticky tape

What to do

1 Carefully make a small hole in the centre of the base of the cup.
2 Cut the rubber band to make one long piece of rubber.
3 Tie one end of the rubber to the paper clip.
4 Thread the loose end of the elastic band through the hole from the inside, so that the paper clip is on the inside.
5 Tie a piece of sponge to the other end of the rubber for a handle.
6 Cut a square from the ice-cream container lid. It should be just bigger than the top of the cup. (Trace a circle using the top of a cup as a guide, then make the square a bit bigger.)
7 Sticky tape the square base onto the top of the cup.
8 To play your instrument, hold the square base near your ear with one hand (but not too close). With your other hand, hold the foam between two fingers and use your thumb and other fingers to strum the rubber.

Questions

1 Describe the sound of your instrument.
2 Explain why we hear a sound when the drum is strummed.
3 What can you modify so that the instrument makes a different sound?
4 Investigate with different rubber bands and the sound they make. Is there a pattern?
5 Can you make the instrument sound louder? What would you need to modify?



Resources

Internet addresses

How toys work

To find out how a 'Magna-doodle' works
http://entertainment.howstuffworks.com/magna-doodle

To find out how boomerangs work
http://www.questacon.edu.au/html/aboriginal_technology.html

Toy history

History of toys and games
http://www.historychannel.com/exhibits/toys/
http://www.hants.gov.uk/museum/toys/history/index.html
http://inventors.about.com/gi/dynamic/offsite.htm?site=http://www.drtoy.com/drtoy/toyhistory.htm

History of the YoYo
http://www.spintastics.com/HistoryOfYoYo.asp

History of the top
http://www.spintastics.com/HistoryofTop.asp

An interactive site explaining the history of optical toys with demonstrations
http://web.inter.nl.net/users/anima/optical/index.htm

Toy hall of fame (USA)
http://www.strongmuseum.org/NTHoF/NTHoF.html

Toy museums

Delaware Toy and Miniature Museum
http://www.thomes.net/toys/

Aboriginal playthings from the Queensland Museum
http://www.mms.qld.edu.au/aboriginal-toys/

Bethnal Green Museum of Childhood (UK)
http://edward.vam.ac.uk/vastatic/nmc/

Toy activities

Make your own mechanical toys
http://users.bigpond.net.au/mechtoys/index.html

Toys to make
http://www.grmuseum.org/funstuff/fun.htm

Thinking fountain: great science exploration activities, look under topics such s 'spinning'
http://www.smm.org/sln/tf/nav/thinkingfountain.html

Science in Toyland: exhibition with online activities (USA)
http://www.bishopmuseum.org/exhibits/pastExhibits/toyland/toyland.html

Other toy sites

Toys based on company trademarks (American) displayed as a virtual museum
http://www.toymuseum.com/

Toys in space -NASA resources
http://core.nasa.gov/index.html

Kidsafe: The child accident prevention foundation of Australian Toy Safety Information
http://www.thegreenwebb.net.au/kidsafe/html/toy_safety.html

Films and videos

The following can be borrowed from the Australian Centre for the Moving Image (ACMI) by member schools. Go to http://www.acmi.net.au
and quote the catalogue number in the brackets

20 Things to make and do = 20 fun things to make and do (303077)
Babar and Father Christmas (300129)
Big (Captioned) (305528)
Buried treasure (302878)
Buying Toys (017650)
Christmas cracker (002062)
A Christmas dream [English version] (002063)
Christmas videos volume 2 (308651)
Dalekmania (312223)
A Day in the life of a child (305753)
Dinosaur tracks (305574) 1994
A Disney Christmas gift (304251) 1982
Fabulous Fleischer Folio. - Volume 1. (300767) 1983
Fips the trouble maker (003701) 1955
The Forgotten toys (306857) 1995
A Gumby adventure (307926) 1956
Jabberwocky (016460) 1973
Johnson and friends. - Volume 1. (301920) 1990
Johnson and friends. - Volume 3. (304559) 1991
Kaboodle. - Volume 4. (017746) 1987
Kites: a collage of kites and kite flyers (508752) 1980
The Little Giraffe (006312)
A Load of old rubbish; The World under our feet (303489) 1990
Madeline (504335) 1969
The Magic of the faraway tree. [Vol. 1] (316205) 1997
Maisy: birthday and other stories (317486) 1998
The New adventures of Pinocchio (318062) 1996
Small soldiers (310718) 1998
The Staunch tin soldier (010222) 1955
Stripey to the rescue: plus four other stories (310728) 1997
This model age (010860) 1959

Tops (012970) 1969
Toy story (306702) 1995
Toy story 2 (313537) 1999
Toy story (Captioned) (306737) 1995
Toy story [DVD] (317856) 1995
Toying with their future (305266) 1990