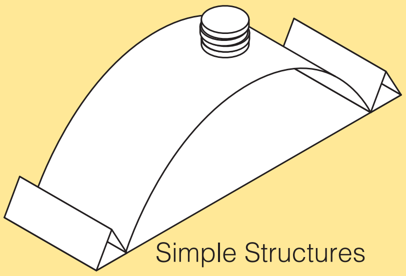
SCIENCE LAB PROJECT NOTES

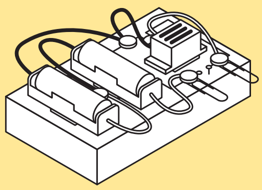
Introduction

Welcome to our Science Lab which we have designed for those teaching KS1 & KS2 Science.

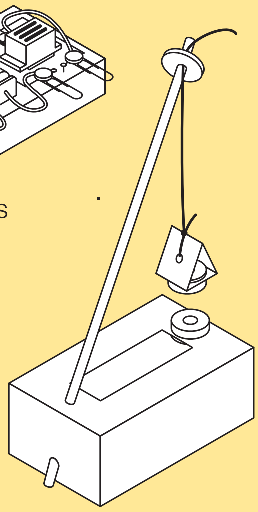
The Lab contains everything you need to build nine hands-on models to explore 5 key topics.



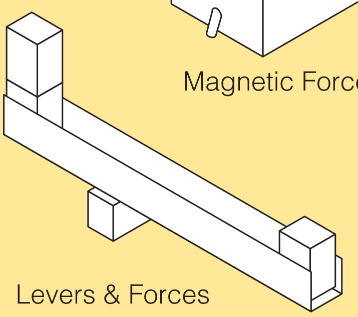
Simple Structures



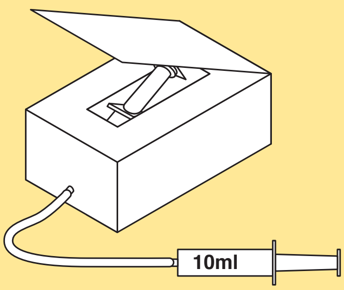
Simple Circuits



Magnetic Force



Levers & Forces



Simple Machines

TechCard is all about hands-on learning and the belief that difficult topics are easier to comprehend, and learning is more memorable, given the opportunity to build and operate a simple working model.

There are several ways you can use the TechCard Science Lab. You can assemble the models as you tackle each topic as you progress through the curriculum. Alternatively, the Lab can be used as the basis of a ‘Science Day’. A class of thirty pupils can be divided into groups of six and each given a set to build and explore and then present their findings to the rest of the class.

The project notes for each topic begin with introductory information about the topic. This is followed by a description of the models to be built and how they work. Next are the assembly instructions for the models for that topic followed by a page asking the pupil to use their model and investigate how it works.

CONTENTS

3 x Project Bases, 5 x Bases, 6 x Beams, 1 x Girders, 8 x 5cm Wheels, 8 x 2.5cm Discs, 1 x 2cm & 1 x 4cm Pulley, 4 x Axles, 50 x Rivets, 2 x Rubber Bands, 1 x 5ml & 1 x 10ml Syringe, Tubing, 2 x Battery Holders, 1 x Buzzer, 6 x Magnets, 6 x Washers, 4 x Wood Blocks, 1 x Ramp Board, 4 x Foam Pads, 2 x Paperclips.

TOOLS

Only simple tools are required: Use a good quality PVA glue. Paperclips are handy as clamps while the glue dries. A ruler, pencil and scissors. A junior hacksaw or craft knife. Batteries not included.

CURRICULUM TOPICS

STRUCTURES	**KS1 (Year 1) KS2 (Year 2) Pupils should be taught:** Everyday Materials • Distinguish between an object and material it is made from • Describe the simple physical properties of a variety of everyday materials • Compare and group together a variety of everyday materials on the basis of their simple physical properties • Uses of everyday materials • Identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses • Find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.
LEVERS & FORCES	**KS2 (Year 5 & 6) Pupils should be taught:** Forces • Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object • Identify the effects of air resistance, water resistance and friction, that act between moving surfaces • Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.
MAGNETIC FORCE	**KS2 (Years 3 & 4) Pupils should be taught:** Magnetic Force • Notice that some forces need contact between two objects, but magnetic forces can act at a distance • Observe how magnets attract or repel each other and attract some materials and not others • Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials • Describe magnets as having two poles • Predict whether two magnets will attract or repel each other, depending on which poles are facing each other.
SIMPLE MACHINES	**KS2 (Years 5 & 6) Pupils should be taught:** Forces • Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object • Identify the effects of air resistance, water resistance and friction, that act between moving surfaces • Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.
SIMPLE CIRCUITS	**KS2 (Years 3 & 6) Pupils should be taught:** Simple Circuits • Construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, switches and buzzers • Recognise that a switch opens and closes a circuit and associate this with whether or not a buzzer sounds in a simple series circuit • Recognise some common conductors and insulators, and associate metals with being good conductors • Associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit • Use recognised symbols when representing a simple circuit in a diagram.

About TechCard

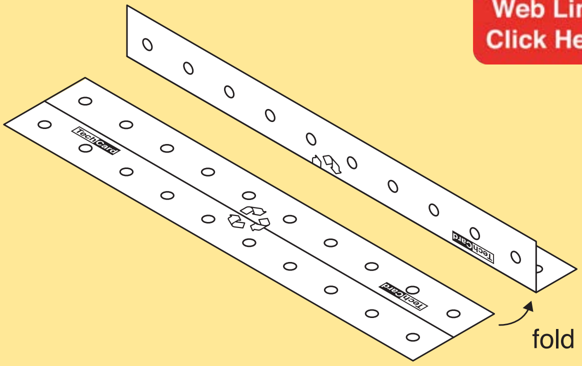
TechCard is a set of preformed card parts that can be cut, folded and glued to make structural forms. Card wheels, discs and cams and wood pulleys push-fit onto dowel axles.

Additional components such as motors, syringes for pneumatics projects and reusable rivets are supplied depending on the kit purchased.

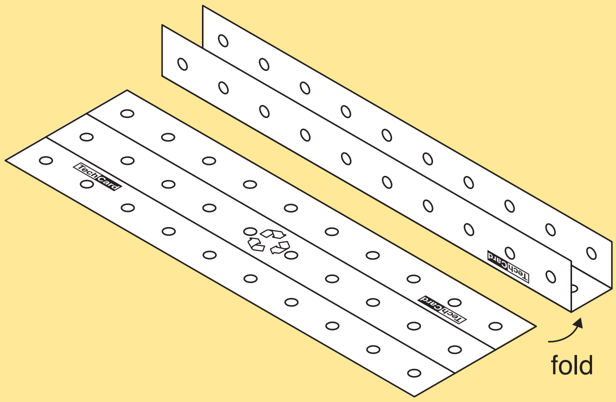
STRUCTURAL PARTS

TechCard Girder

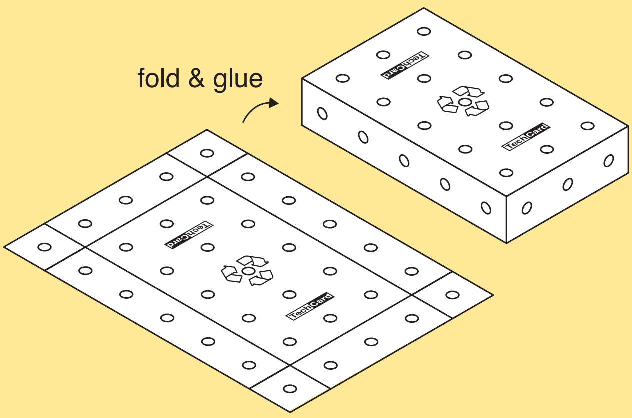
Web Link Click Here



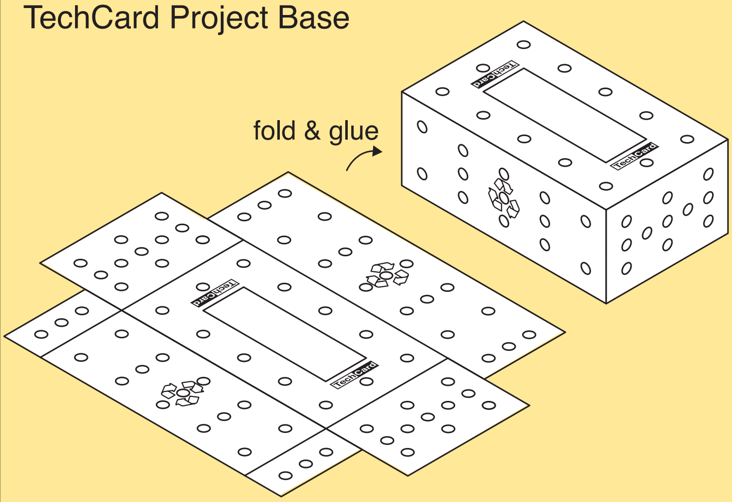
TechCard Beam



TechCard Base

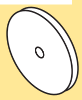


TechCard Project Base

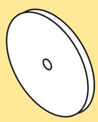


MECHANICAL PARTS

2.5cm Disc

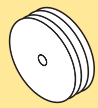


4cm Wheel

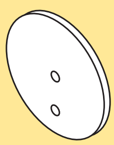


5cm Wheel

2cm Pulley



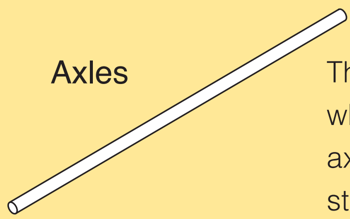
4cm Pulley



6cm Wheel

Holes are 4.5mm diameter giving a tight push-fit onto the 5mm axles.

Axles

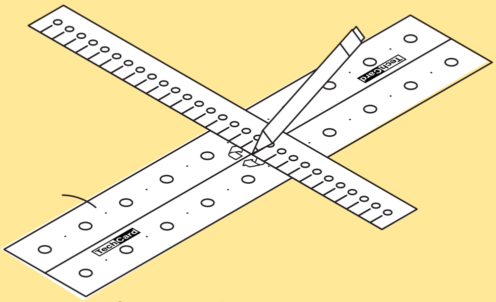


The axles push-fit into the wheels and pulleys. The axles rotate through the structural parts.

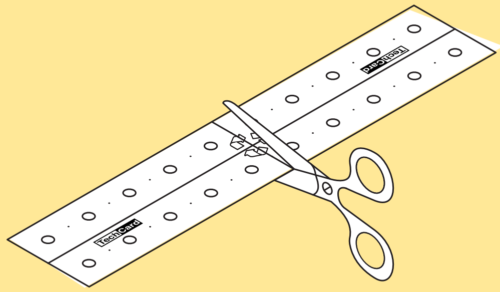
USING TECHCARD

Cutting TechCard

Use the pin holes between the holes as a guide.

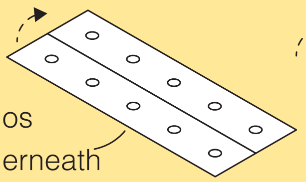


Use a ruler and pencil to mark TechCard before cutting.

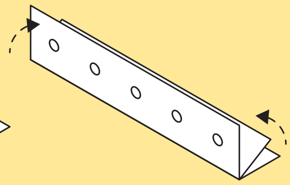


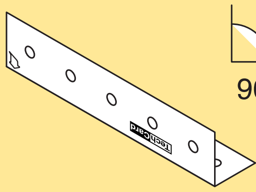
Carefully cut with scissors.

Folding TechCard



Logos underneath

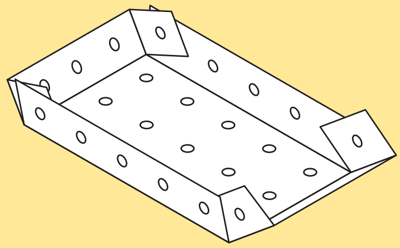




Finished folds are 90°

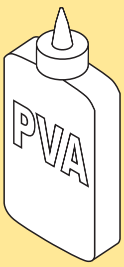
90°

Fold panels over and then back to get a neat fold.



Fold bases before gluing.

Gluing TechCard

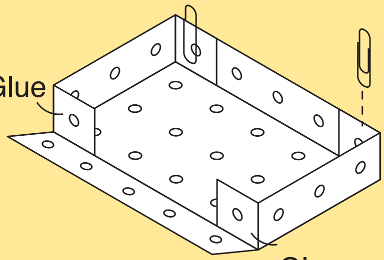


Use PVA Glue

Use scraps of card as glue spreaders.

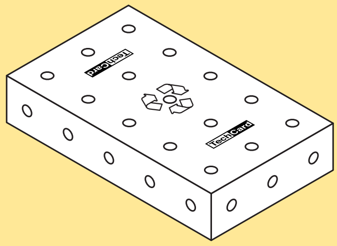
Apply glue evenly and sparingly.

Glue



Glue

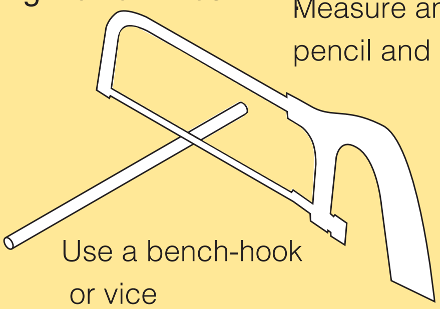
Use paper clips as clamps.



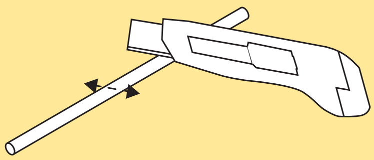
Check folds are neat.

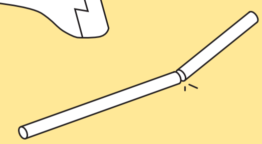
Cutting Dowel Axles

Measure and mark the dowel with a pencil and cut with a junior hacksaw



Use a bench-hook or vice

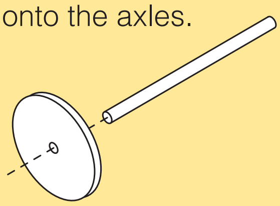




Dowel can be cut by an adult with a craft knife. Mark the dowel and roll under the blade to score the dowel and snap apart.

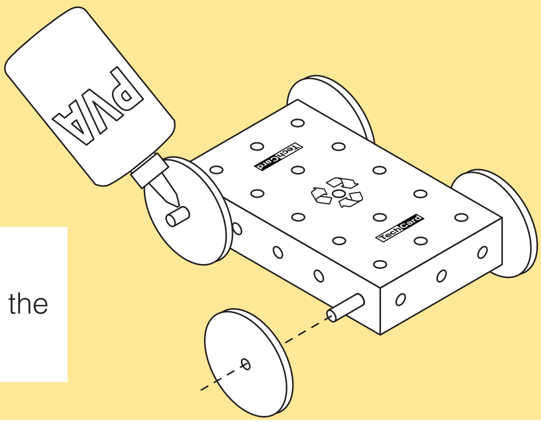
Assembling Mechanical Parts

Wheels, discs, and cams push-fit onto the axles.



Assemble carefully so as not to damage the wheel.

Wheels and cams can be glued with PVA.



Important! Check axles can turn freely where they need to. Widen the hole in the TechCard if needed.

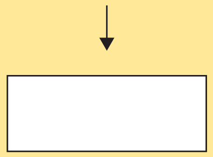
TOPIC 1: SIMPLE STRUCTURES

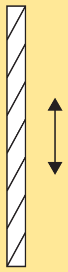
Project Notes

Investigate simple structures by building a test bench to explore how shaping materials can make them more useful.

Discover that materials have different properties that make them suitable for different jobs.

MATERIALS





Everything is made from material whether formed by nature or by us. All materials have different properties which make them good at some jobs and bad at others. When we make things we have to select materials carefully.

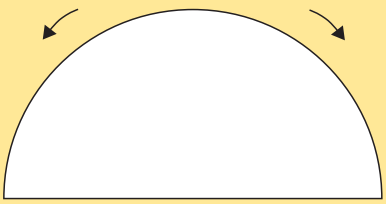
All things, and the materials they are made from, have forces acting on them. The things we build need to be able to withstand these forces.

Apart from the processes of aging, the forces acting on materials and structures are usually doing one of three things: pulling, pushing or twisting.

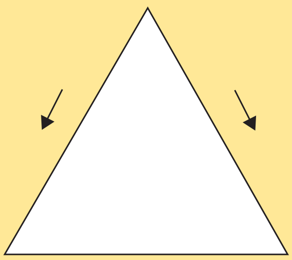
These forces occur when we use things. For example, when we sit on a chair, the chair must be able to cope with the ‘pushing force’ we create as we sit down.

Another force all objects are subjected to is the force of gravity. Gravity pushes all objects downwards toward the earth and things need to be able to withstand this constant force.

STRUCTURES



Arch



Triangle

When we build structures we combine and shape materials. We form materials to make the most of their properties. We shape and bake clay to form bricks. Bricks are good at withstanding a ‘pushing force’ so we use them to build houses where the weight of the house pushes down on layers of brick. Steel wire can be wound into cable which is good at withstanding a pulling force and is used to support huge bridges and raise heavy loads.

We have used some shapes when building structures for hundreds of years and they are still important today. Arch and triangle shapes formed some of the first bridges and buildings and are all around us.

These shapes are strong because of the way they deal with the forces acting on them.

Types of Materials

Materials have different properties that make them useful for different jobs. For example you wouldn't have a chocolate teapot or a woollen boat! Natural materials, such as wool and wood, come from living things or are mined from the ground. Synthetic materials, like plastic, are made from chemicals.

Metals

Most metals are strong, hard and shiny materials that can be hammered into different shapes without breaking. They are good conductors of heat and electricity and some are magnetic. Some examples are cutlery, saucepans, and coins.


Cutlery ©Tanya Patrikeyeva


Saucepans ©Adam Dachis

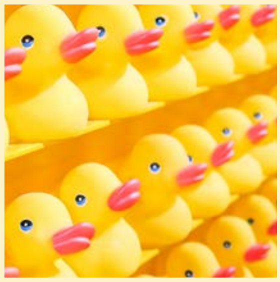

Coins ©Ibrahim Rifath

Plastics

Plastic is easy to mould into lots of shapes but only some types of plastic can be recycled into new products. In the past plastic has been made from chemicals from oil and gas. New bio plastics are being developed from plant based chemicals.


Plastic bags © Roberta Errani


Made from bio plastic
Cornstarch Clock © Lexon


Plastic toys © joshua-coleman

Glass

Glass is made by melting sand and other minerals together at very high temperatures. Thick glass can be strong, but thin glass breaks easily. It's used for objects that need to be transparent, such as windows and spectacles.


Window © micaela-parente


Stained Glass © pascal-bernardon


Glasses © zahra-amiri

Wood

Wood comes from trees. It is strong, flexible and long-lasting. It is an insulator of heat and electricity. It's used to make things such as buildings and furniture.


House © kristaps-grundsteins


Furniture © jana-sabeth


Boat © cetteup

Fabrics

Fabrics are made from thin fibres woven together. They can be stretchy (a pair of tights), insulating (a woollen coat) or absorbent (a towel). Fabrics are used to make clothes as they are flexible, warm and do not wear out easily.


Tights © kiana-bosman


Wool coat © laura-holt


Towel © dylan-alcock

Types of Structures

When making a structure some are strong and others are not. There are simple rules that can be followed to make structures strong. Ensure that the base is wider than the top. Use triangles where possible - take a look at a bridge or pylon and you may see lots of triangles there to add strength to the structure. Offset the way blocks are stacked so that gaps don't run down the whole structure - look at house bricks to get a better idea.

Arch

The **Mycenaean Arkadiko Bridge,** built around 2500 BC**,** is an arch bridge and thought to be constructed for use by Roman chariots.
The **Aqueduct of Segovia** contains 36 semi-circular arches and was built over 2000 years ago. In Roman times the aqueduct would have transported water into the city.
The **Iron Bridge** in England was the first arch bridge in the world to be made out of cast iron finished in 1779.
The **Sydney Harbour Bridge** is an Australian heritage-listed steel arch bridge opened in 1932.
It is nicknamed "The Coathanger" because of its arch-based design.

Mycenaean Arkadiko Bridge © David Gavin

Aqueduct of Segovia © Manuel González

Iron Bridge © JJ Harrison

Sydney Harbour Bridge © Roantrum

Triangular

Eleutherna Bridge is an arch bridge in the shape of an isosceles triangle. It is thought to be one of the oldest bridges still in use.
All Giza Pyramids, first built in 2630 B.C, are triangular monuments erected for worship, as a grave or as a memorial.
The Shard, London, built in 2012

Eleutherna Bridge © Petr Novak

The Great Pyramid of Giza

The Shard, London

Beam

Beams are important elements of many structures we build. In its simplest form a beam can be a solid length of wood supporting the load above a door or window. Steel beams are created in different shapes to make them more efficient. An 'I' beam is the shape of a capitol letter 'i' to make it as strong and light as possible.

Lintel above door © moran

Construction site © tolu-olubode

Steel beams supporting a bridge ©Ahmaskoski

SIMPLE STRUCTURES - Explanation of the Science Lab Models

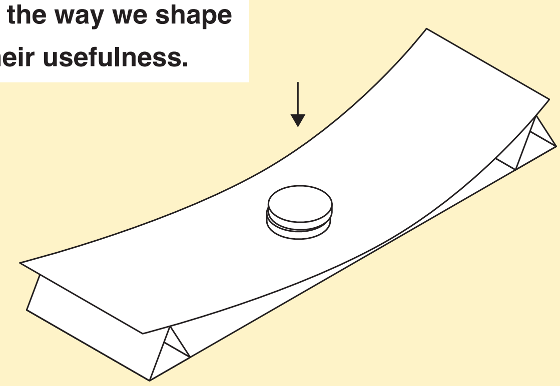
Build a Test Bench and test the strength of different shapes.

These experiments show that the way we shape materials can greatly effect their usefulness.

Video Link Click Here

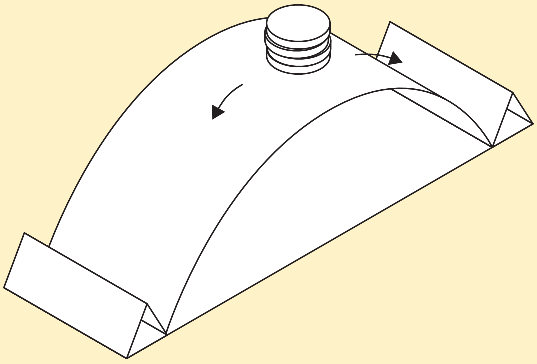
Simple Panel

A flat panel will bend with only a small load as all the force is concentrated in one place.



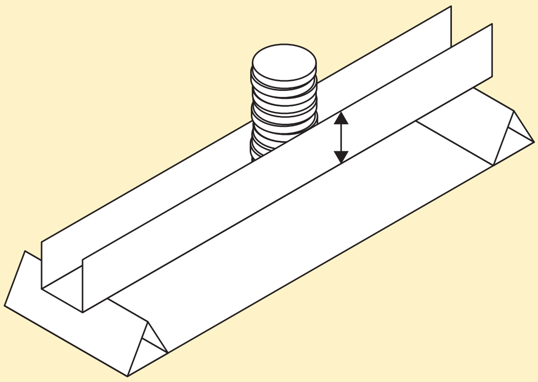
Arch

When formed into an arch a panel becomes much stronger. The forces are directed through the arch and down to the foundations.



Channel Beam

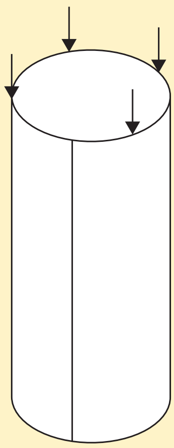
Folded into a 'channel beam' a panel gains even more strength. The vertical sides are rigid and give the panel the strength of a much thicker piece of material.

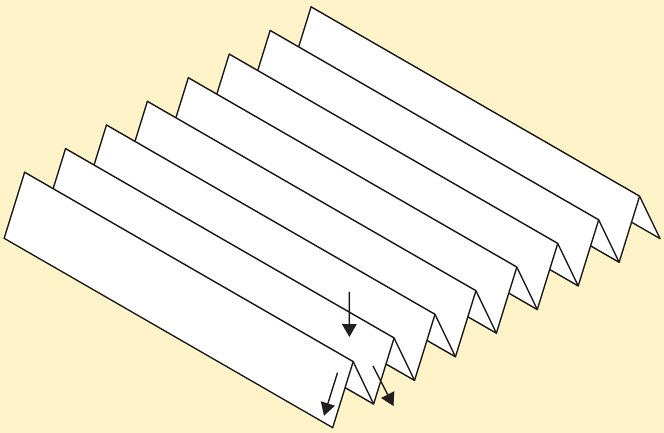


Other Shapes

The paper column can take a surprising load as the downward force is spread evenly around its circumference.

The 'corrugated' panel forms a series of triangular shapes. Triangles are strong because the force of the downward load is spread.

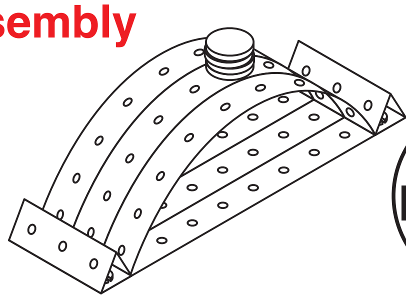




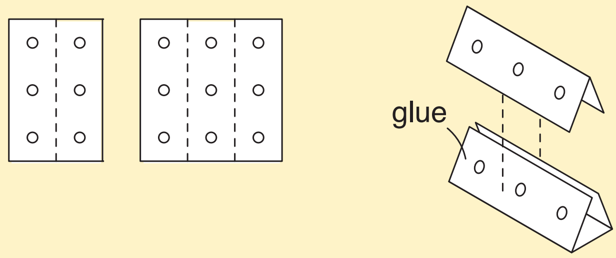
SIMPLE STRUCTURES

Test Bench Assembly

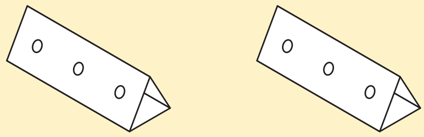
Parts:
2 x 7.5cm Girders
2 x 7.5cm Beams
4 x 25cm Beams
4 x Rivets and Collars



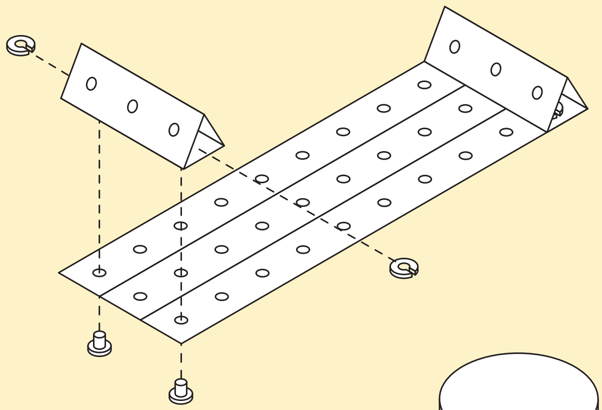
1. Fold the 7.5cm girder and 7.5cm beam. Glue together as shown.

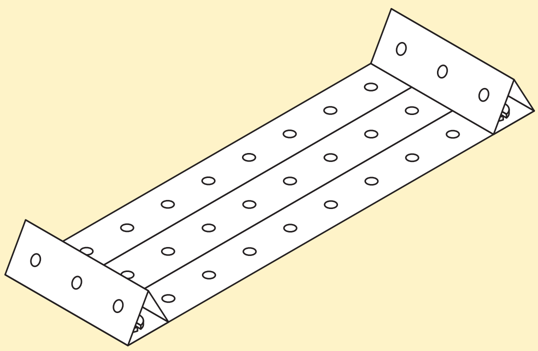


2. Make a second support in the same way.

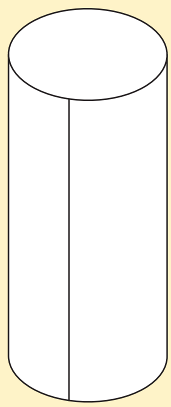


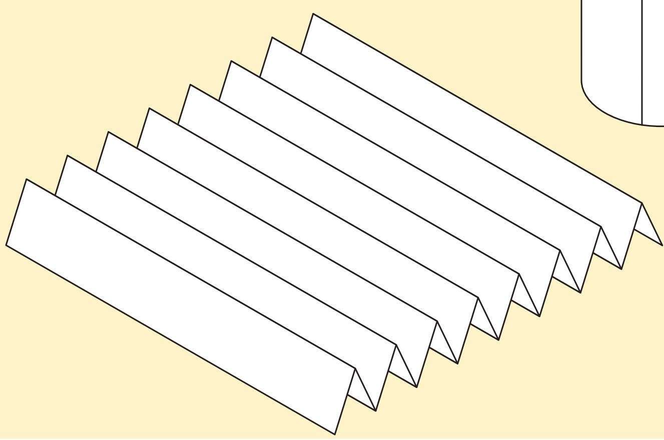
3. Rivet the two supports to the ends of a 25cm beam as shown.





4. Roll a A5 piece of paper into a tube and tape it together. Mark an A4 piece of paper with lines every 2.5cm. Fold in a zigzag to form a corrugated sheet.





TEST BENCH

Using the model

Simple Panel

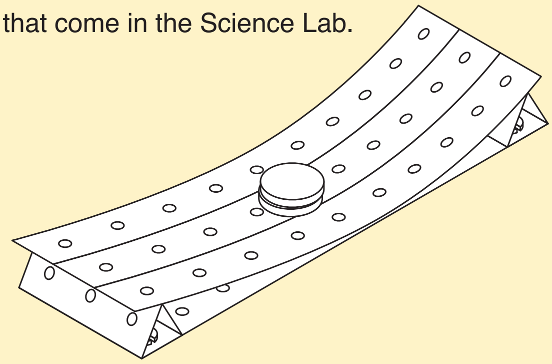
Lay the panel on the test bench.

Slowly add weights until the panel bends.

How much weight can the panel support?

Use coins for weights or use the washers and magnets that come in the Science Lab.

Why does the panel bend?

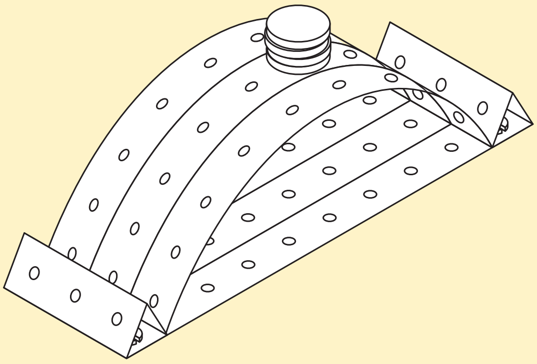


Arch

Carefully curve the panel to fit between the supports to form an arch. Slowly add weights to the centre of the arch.

Can the arch support more weight than the simple panel?

Why is the arch stronger?

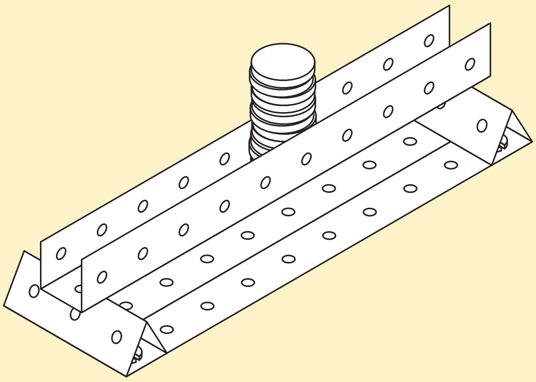


Channel Beam

Position the folded beam and slowly add weights.

How much weight can this shape support?

Why is this shape so strong?

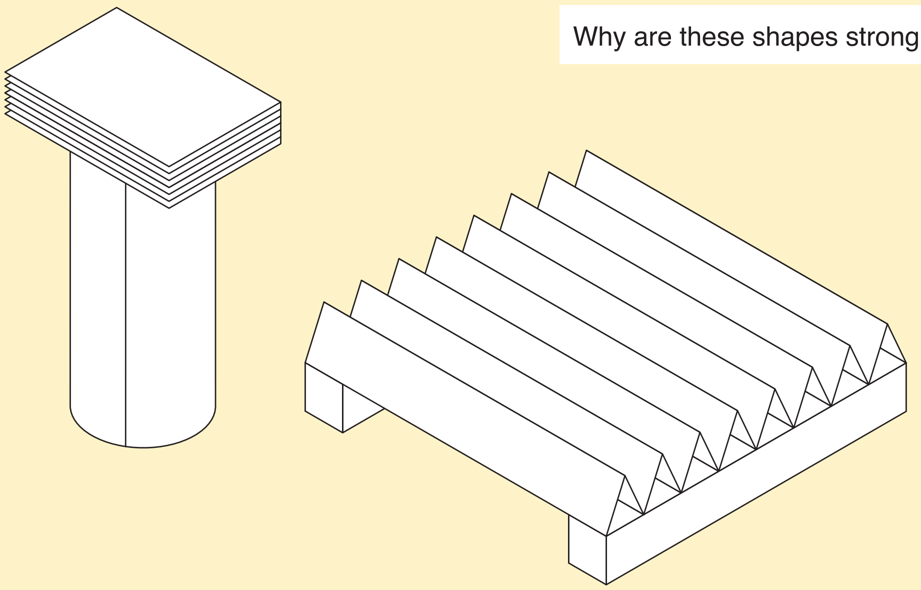


Paper Shapes

Carefully place a small book on top of the paper tube. Can it support the weight?

Place the corrugated sheet across two supports. Can it support itself?

Why are these shapes strong?



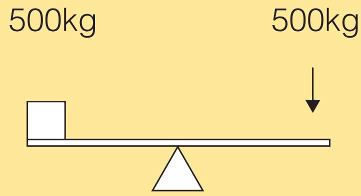
TOPIC 2: LEVERS AND FORCES

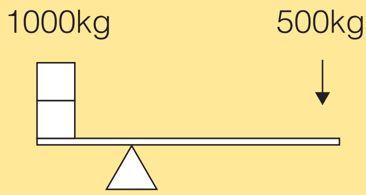
Project Notes

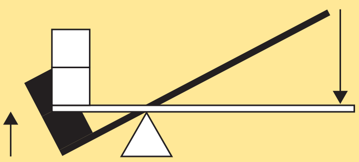
Investigate the three classes of lever and see how they can change the power and speed of a force.

Discover that levers are one of the most important inventions and form the basis of all simple machines.

LEVERS



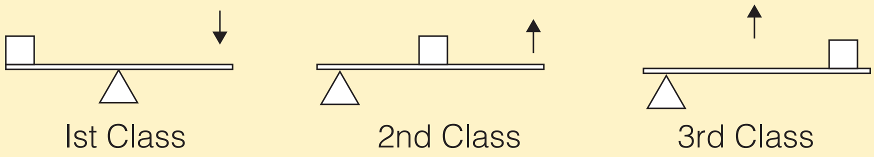




The ‘lever’ is a ‘simple machine’ and perhaps the single most important invention in our history. A lever can transform a force making it more powerful, faster or change its direction. The lever is the basis of our mechanical world as all simple mechanisms, including gears, pulleys, wheels and axles, can be described as variations of the lever.

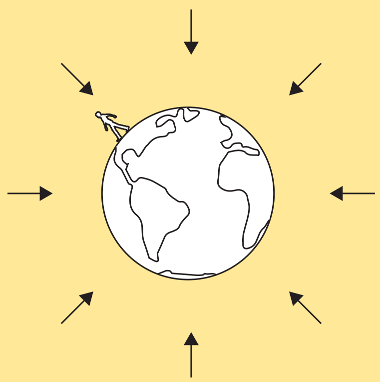
In its basic form a lever consists of a beam and a ‘fulcrum’. A lever has a different effect depending on where the fulcrum is positioned. With the fulcrum in the middle of the beam an object or ‘load’ can be raised by an equal force.

There are three types or ‘classes’ of lever defined by where the fulcrum is positioned.



Move the fulcrum of a 1st class lever nearer to the load and a much greater load can be raised. In this position, the lever has created a ‘mechanical advantage’ enabling a greater load to be raised. This has not happened by ‘magic’ but by an ‘exchange’. The smaller force can raise the larger load but has travelled further to do it.

FORCES



When we refer to an object as having ‘weight’, we are actually referring to the effect of ‘gravity’ on that object. Gravity is an invisible force pushing down on everything. Very ‘dense’ objects such as a brick, have lots of material packed closely together. This means there is lots of material for gravity to push down on making a brick very ‘heavy’.

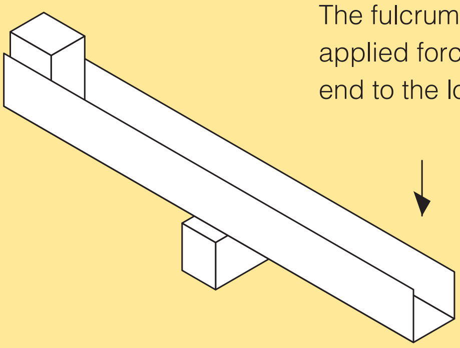
The invisible force of gravity pushes everything towards the centre of the earth and gives things their ‘weight’.

LEVERS AND FORCES - Explanation of the Science Lab Models

Build a Lever and explore how they can change force

Ist Class Lever

The fulcrum is the centre and the applied force acts at the opposite end to the load.



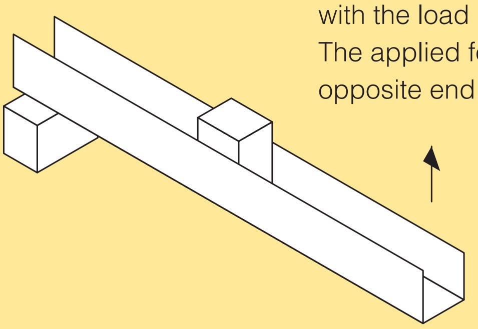
A good example of a 1st class lever is a seesaw. Another example is when you head a football. The neck muscles provide the effort, the neck is the fulcrum, and the weight of the head is the load.

Seesaw © aarchiba

Footballers heading a ball ©jeffrey-f-lin

2nd Class Lever

The fulcrum is at one end with the load in the centre. The applied force acts at the opposite end to the fulcrum.



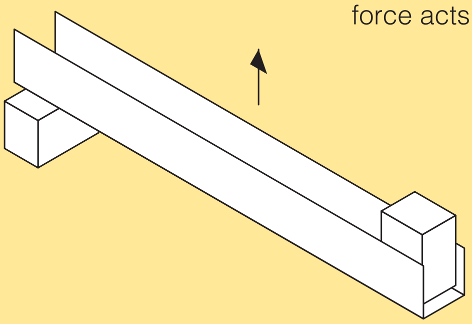
A wheelbarrow is a 2nd class lever. Another example is seen when an athlete pushes against the starting blocks before a sprint.

Wheelbarrow

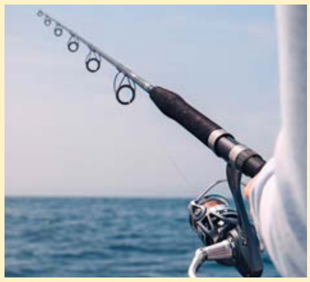
Athlete on blocks © nicolas-hoizey

3rd Class Lever

The fulcrum and the load are at opposite ends. The applied force acts between them.



A fishing rod is a good example of a 3rd class lever. A biceps curl, is also an example. The fulcrum is the elbow joint, the effort comes from the biceps contracting and the resistance is the weight of the forearm and any weight that it may be holding.

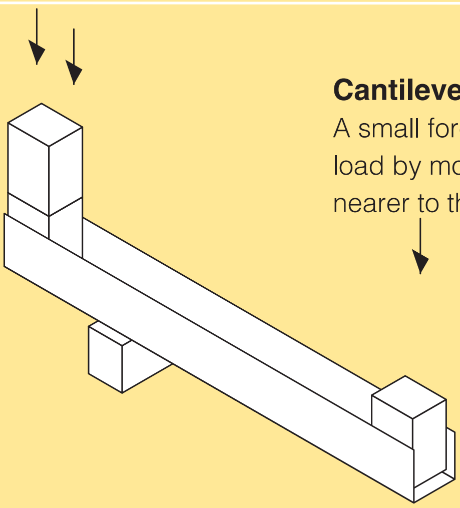


Fishing rod © mathieu-le-roux

Arm lifting weight

Cantilever

A small force can raise a large load by moving the fulcrum nearer to the large load.



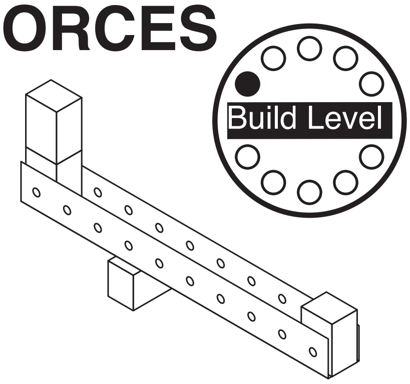
A good example of a cantilever beam is a balcony. A balcony is supported where its connected to the building but extends over open space where there is nothing supporting it. Another example is a diving board.

Fallingwater cantilever

Diving board

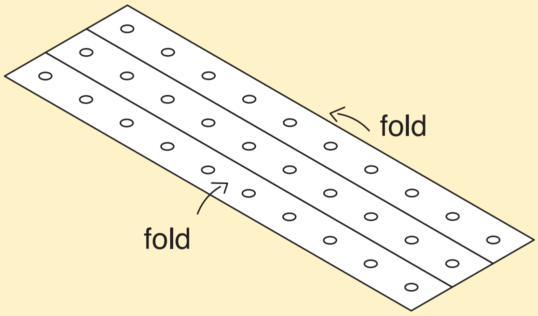
LEVERS AND FORCES

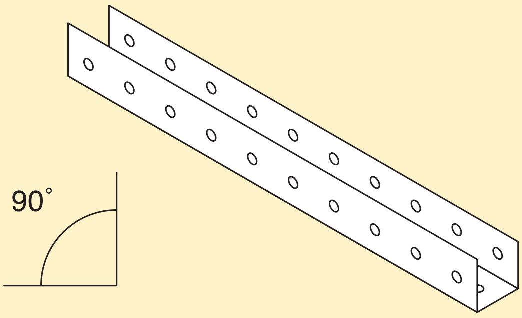
Levers Assembly



Parts:
1 x Beam
4 x Wood Blocks

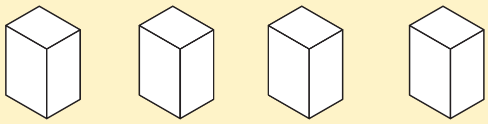
① Fold the beam to shape

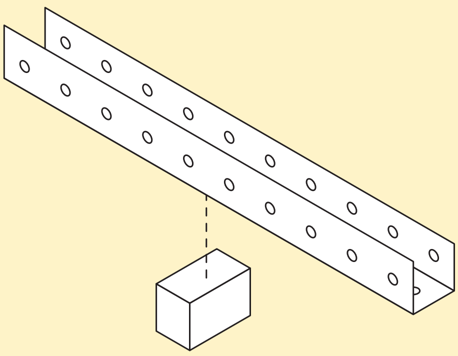




② Check the sides are 90˚

③ The four wood blocks are used as weights and as the fulcrum.





④ The beam is positioned on top of the fulcrum.

LEVERS AND FORCES

Using the model

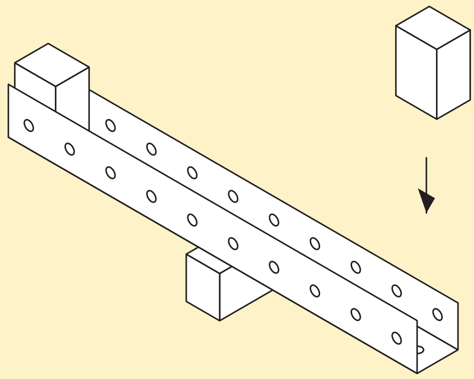
Ist Class Lever

Position a block under the middle of the beam. Place a block at one end.

What happens when you place the same size block at the other end?

What is the block under the beam called?

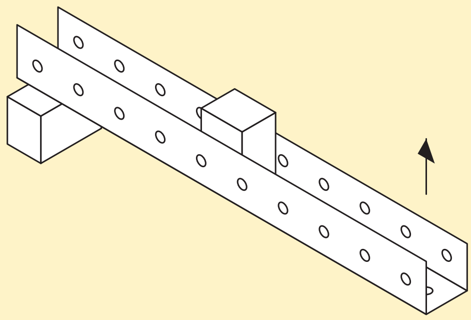
Use the wood blocks for the weights and fulcrum.



2nd Class Lever

Position the fulcrum and weight. Lift the end of the beam to raise the load.

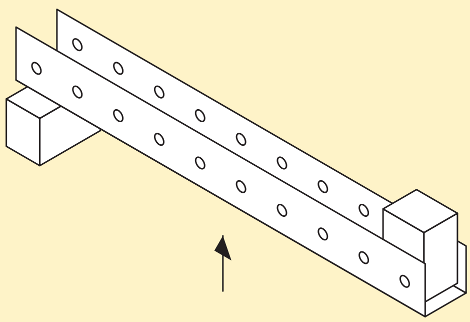
Can you think of an example of this kind of lever in the real world?



3nd Class Lever

Position the fulcrum and weight. Lift the centre of the beam to raise the load.

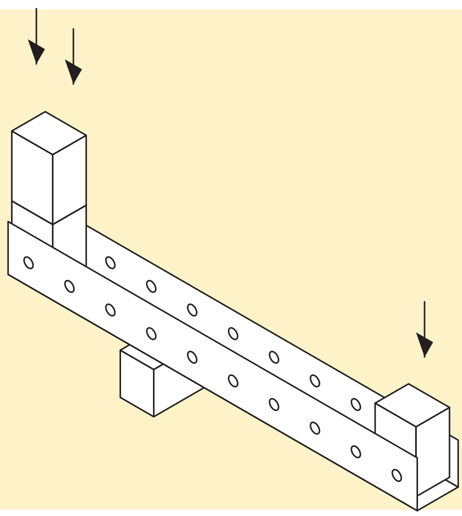
Can you think of an example of this kind of lever in the real world?



Cantilever

Position the weights as shown. Move the beam along the fulcrum until it balances.

How is the single weight able to balance the two weights at the other end?



TOPIC 3: MAGNETIC FORCE

Project Notes

Build three exciting models that explore the science of magnetism and understand how magnets work.

Discover the role of the earths magnetic field in guiding us and protecting us from harmful radiation.

MAGNETS

History

Around **2000 BC** a shepherd from Greece was the first to discover lodestone when his crook, which had an iron tip, was pulled towards a stone when he passed over it. The shepherd's name was Magnes. The **Vikings**, in about **1000 BC**, are said to have used a compass-like tool made of lodestone and iron which when floated in a bowl of water would point to the north helping to navigate.

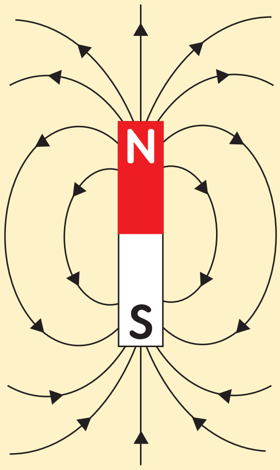
Moragsoorm, Viking boat

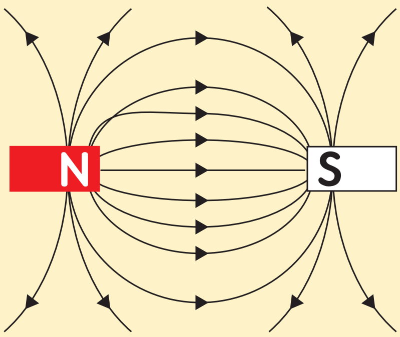
In **1600 William Gilbert,** discovered not only that the Earth itself was a magnet, but also that magnets could be forged out of iron and that their magnetic properties could be lost when that iron was heated. In **1820, Hans Christian Oersted** began to explore the relationship between electricity and magnetism. He demonstrated his theory by setting a magnetic compass near an electrical wire, derailing the compass's accuracy.

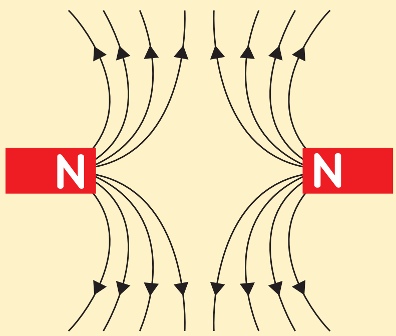
Magnets are objects that produce magnetic fields. Magnetic fields are an invisible force that attract metals like iron and attract or repel other magnets.

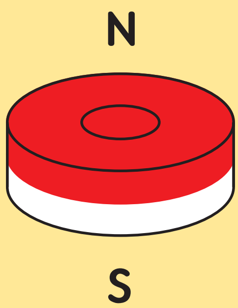
The magnetic fields lines of force exit the magnet from its north pole and enter its south pole. The north pole of one magnet will attract the south pole of a second magnet but repel the north pole of a second magnet.

Magnetism is a fundamental force of nature caused by the movement of electrons around atoms which cause tiny magnetic fields. The electrons in most materials move randomly but in magnetic materials they move in the same direction.









Magnets can be made in different shapes. The round magnets in our Lab have a north and south pole like all magnets. The hole makes the magnet easier to use in our experiments but does not effect the way the magnet works.

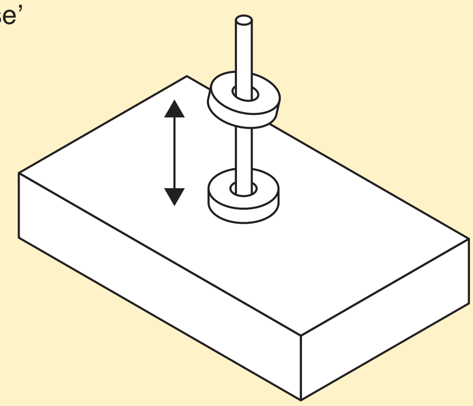
MAGNETIC FORCE - Explanation of the Science Lab Models

Build a Floating Magnet, Magnetic Car and Magnetic Pendulum to explore magnetic force.

Floating Magnet

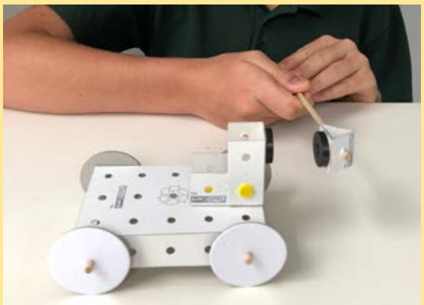
With the magnetic poles of the two magnets opposing each other the upper magnet will appear to float in the air.

Arrange the magnets so they 'oppose' each other. If the magnets don't oppose each other then turn the upper magnet over.

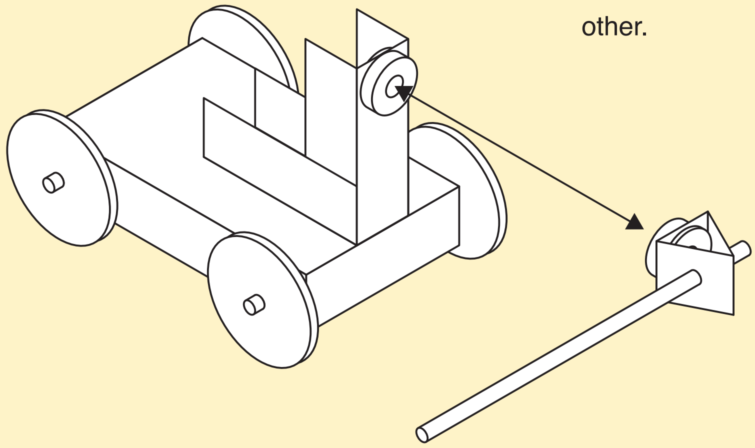


Magnetic Car

With the magnetic poles of the two magnets opposing each other the vehicle can be propelled forward without any physical contact from the wand.

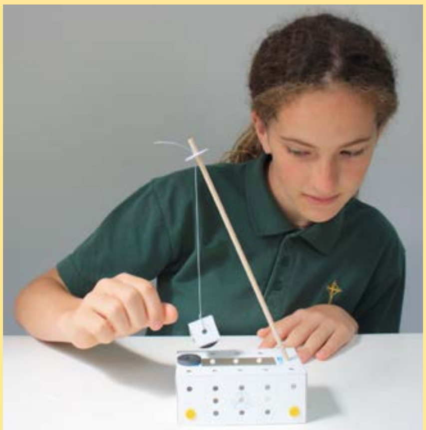


Arrange the magnets so they 'oppose' each other.

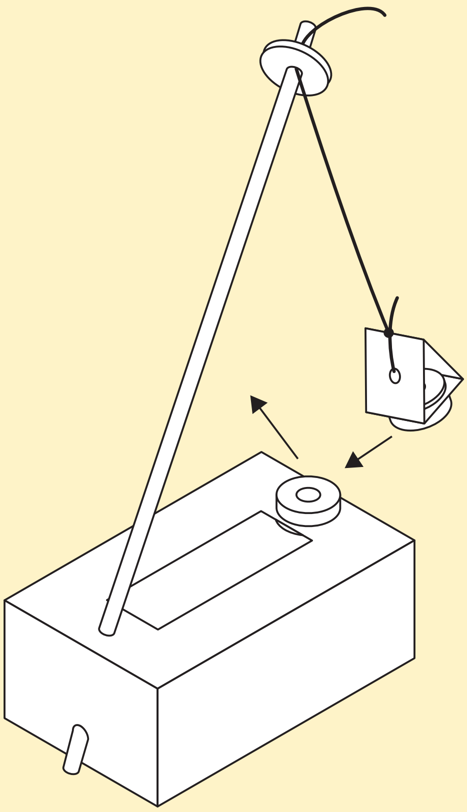


Magnetic Pendulum

With the magnetic poles of the two magnets opposing each other, swing the suspended magnet towards the fixed magnet. The suspended magnet will continuously 'bounce' away.



Arrange the magnets so they 'oppose' each other.

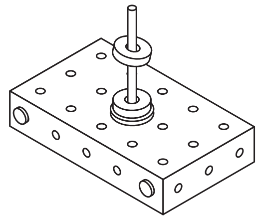


MAGNETIC FORCE

Floating Magnet Assembly

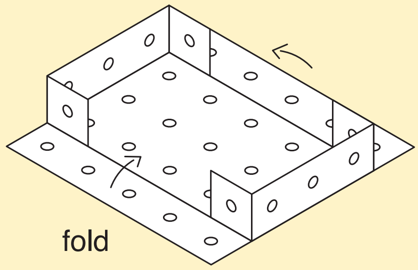
Parts:

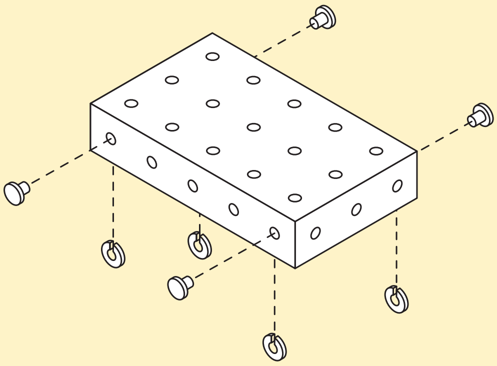
1 x Base
4 x Rivets and Collars
2 x 2.5cm Discs
1 x 8cm Axle
2 x Magnets



Build Level

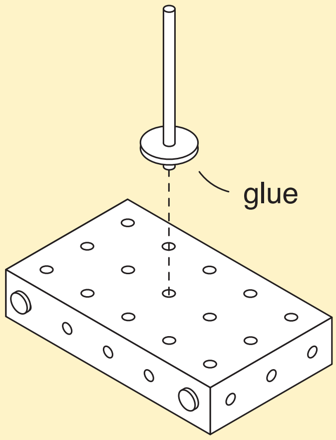
1 Fold the base to shape.

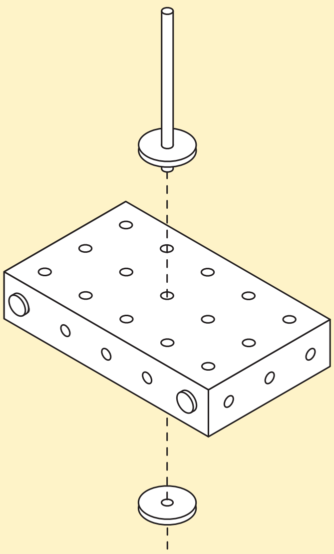




2 Rivet the base together.

3 Fit a 2.5cm disc near the end of the 8cm axle and glue to the base.





4 Glue a second 2.5cm disc to the axle and base underneath. Allow to dry.

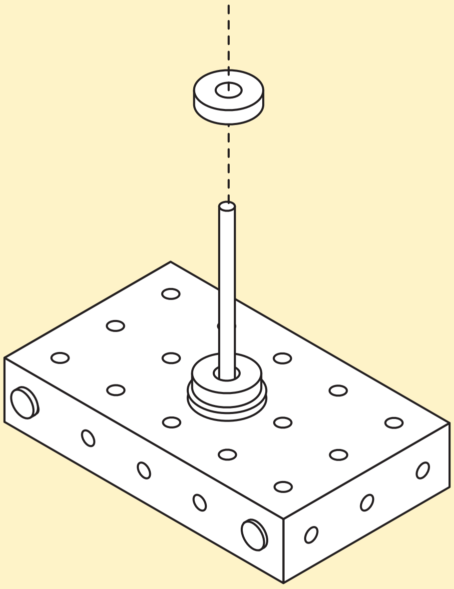
MAGNETIC FORCE
Using the model

Floating Magnet

Fit a magnet over the dowel so it sits on the base.

Fit a second magnet over the dowel and let it go.

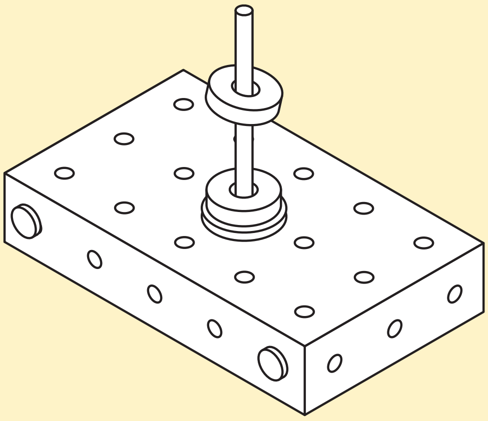
What happen to the second magnet?



When you fit the second magnet one of two things happened.

If the magnets 'snapped' together, why did this happen?

If the second magnet floated above the first magnet, why did this happen?



More about magnets in everyday use.

Magnets are used in many everyday things from microphones and speakers to simple toys. Fridges and freezers use magnets to keep their doors closed and sealed.

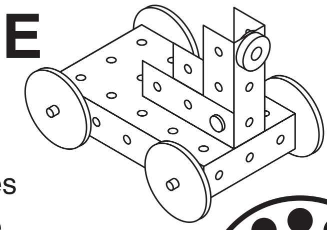
Using a microphone © obie-fernandez

Magnetic children's toy

Fridge ©Latrach Med Jami

MAGNETIC FORCE

Magnetic Car Assembly

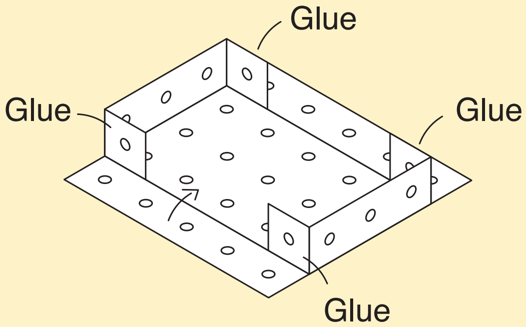


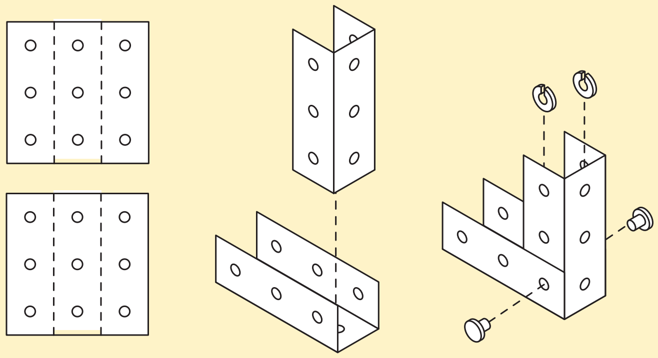
Parts:

- 1 x Base
- 2 x 7.5cm Beams
- 1 x 2.5cm Beam
- 1 x 2.5cm Girder
- 6 x Rivets and Collars
- 2 x 10cm Axles
- 1 x 15cm Axle
- 4 x 5cm Wheels
- 2 x Washers
- 2 x Magnets

Build Level

1 Fold the base to shape and glue together.

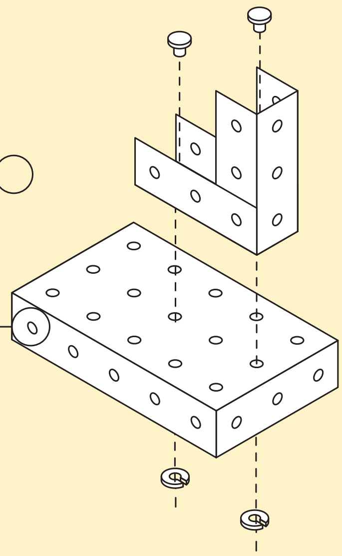


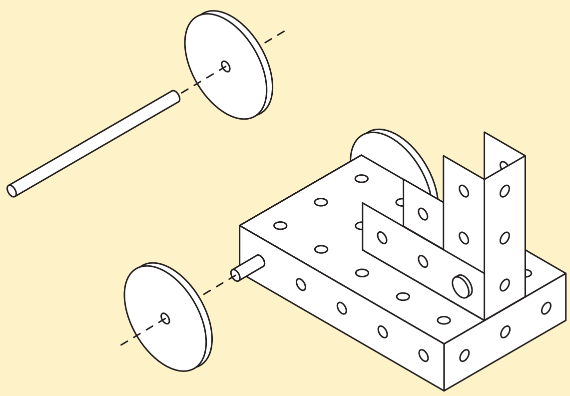


2 Fold the two 7.5cm beams and rivet together.

3 Rivet the tower to the base where shown.

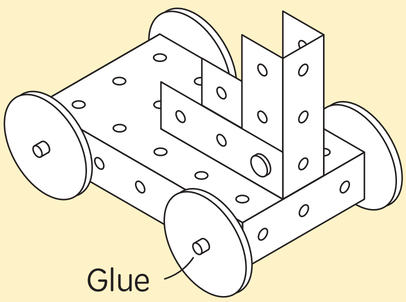
4 Check axles will turn freely in the four axle holes. Widen the holes if needed.



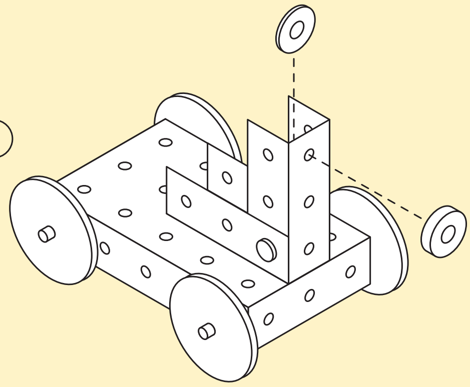


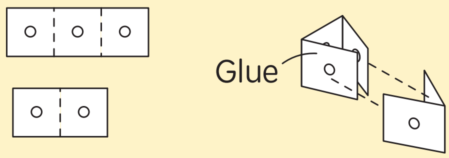
5 Fit a wheel to the end of a 10cm axle. Pass the axle through the base and fit a second wheel.

6 Fit the second axle and wheels. Check the axles turn easily through the base. Glue the wheels to the axles.



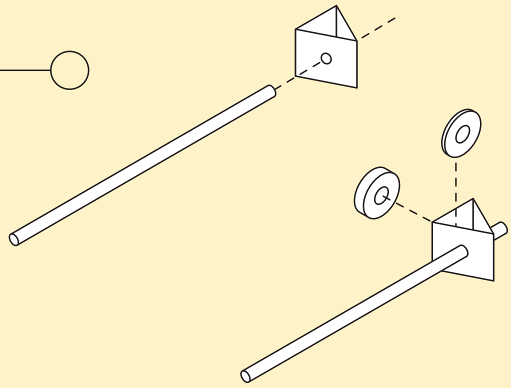
7 Fit a washer inside the tower and position the magnet.





8 Fold and glue together a 2.5cm beam and girder.

9 Fit the 15cm axle into the beam. Fit a washer into the beam and position the second magnet in front.



MAGNETIC FORCE

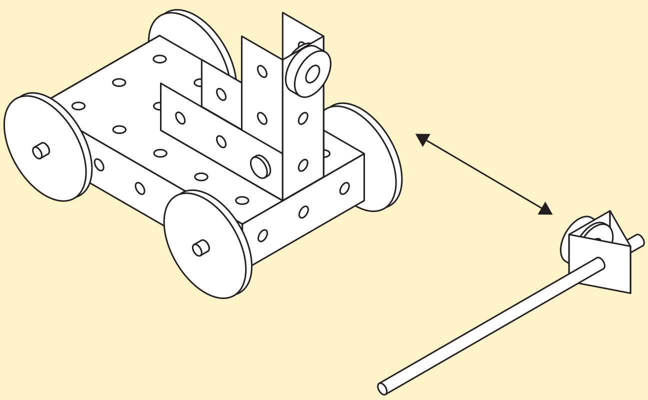
Using the model

Magnetic Car

Move the magnet on the wand towards the magnet on the car.

If the magnets move towards each other then reverse the magnet on the car.

Can you make the car roll forward without touching it!



Technology

The SCMaglev is a new type of train that uses magnets along a track to pull trains at up to 300 miles per hour.

Maglev train on the Yamanashi Test Track
© Saruno Hirobano

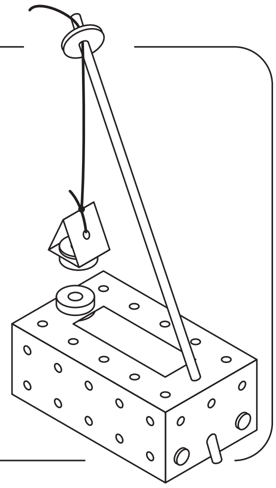
MAGNETIC FORCE

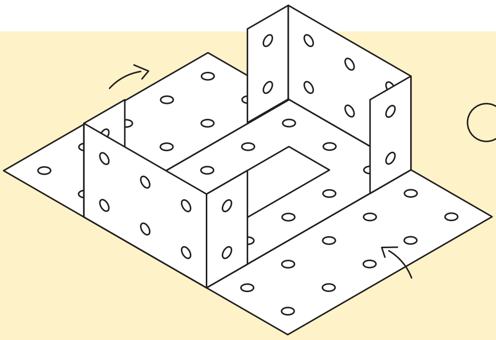
Magnetic Pendulum Assembly

Parts:

1 x Project Base
1 x 2.5cm Beam
1 x 30cm Axle
4 x Rivets and Collars
1 x 25cm String, 2 x Magnets, 2 x Washers

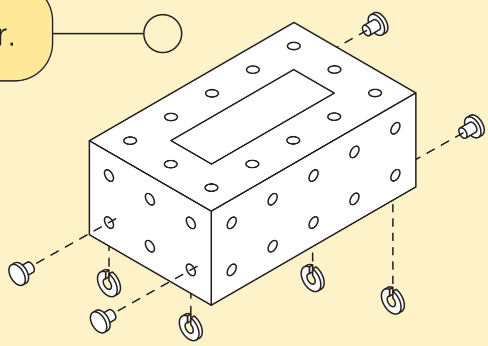
Build Level



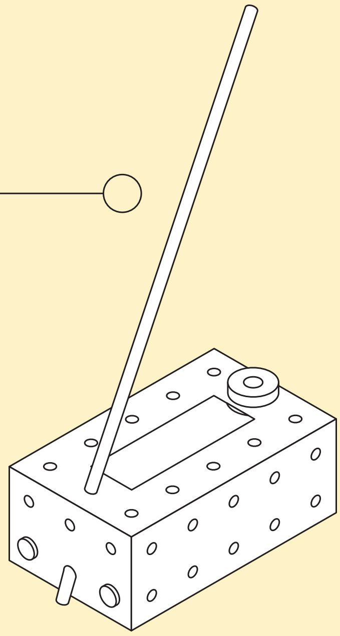


1. Fold the base to shape.

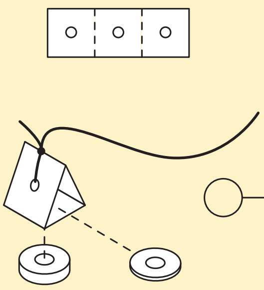
2. Rivet the base together.



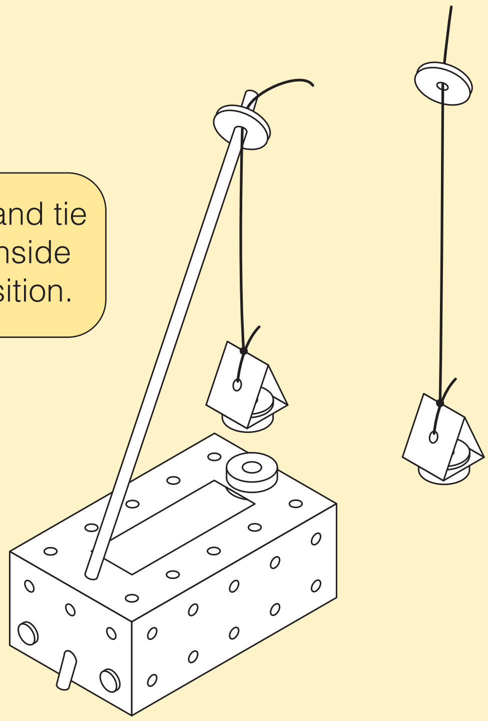
3. Fit the 30cm axle into the base.



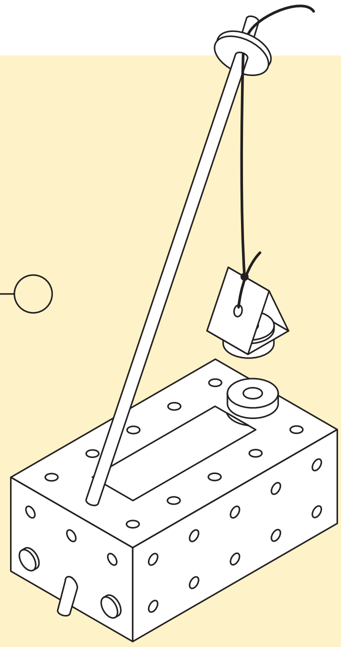
4. Fit a washer inside the base to hold the magnet in position.



5. Fold the beam to shape and tie with string. Fit a washer inside to hold the magnet in position.



6. Pass the string through the 2.5cm disc and slide the disc onto the axle.



7 Set the magnets up so they oppose each other and are about 2.5cm apart.

MAGNETIC FORCE

Using the model

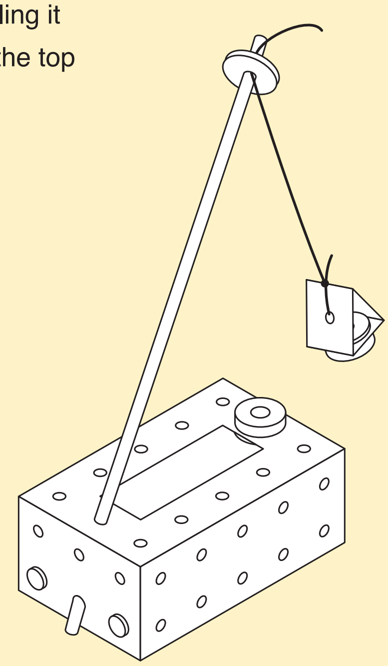
Magnetic Pendulum

Carefully move the magnet on the string away and let it go.

What happens and why?

Can you adjust the string to make the magnet keep moving for longer?

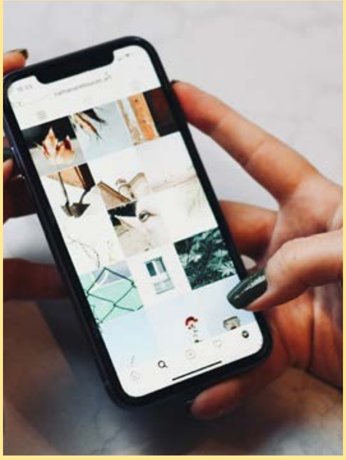
Adjust the string by pulling it through the washer at the top of the axle.



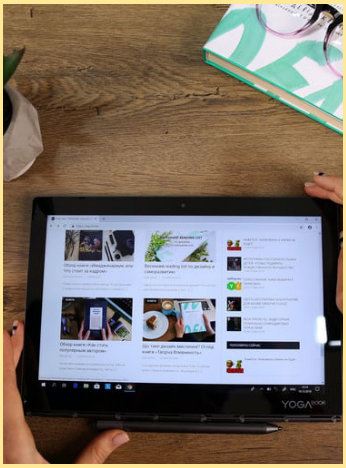
Computers

Most computers use tiny magnets to store information. The hard disk inside a computer is made up of metal plates. Tiny areas on these plates can be made magnetic or non-magnetic, creating a code that the computer can turn into data such as pictures, sounds, and videos.

Computers © obie-fernandez



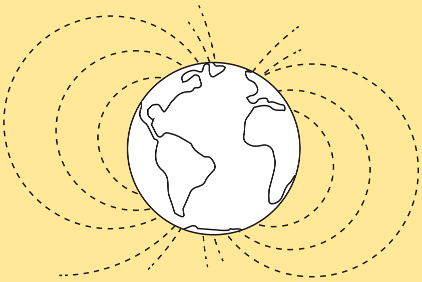
Mobile phone © nathana-reboucas



Ipad © Yura Fresh

MORE ABOUT MAGNETISM...

EARTH'S MAGNETIC FIELD



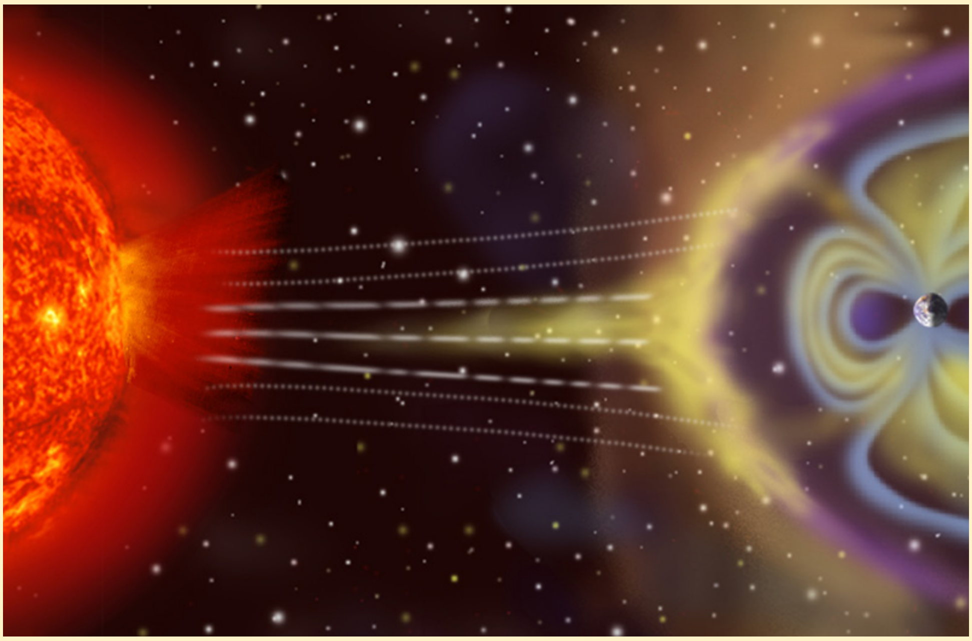
Generated by the motion of molten iron in earths core, the magnetic field protects our planet from cosmic radiation and from the charged particles emitted by our sun. It also provides the basis for navigation with a compass.

Compass © Christopher-Rusev

The rotation of earth causes electric currents to flow through the molten iron in the earths outer core. These form a magnetic field like a giant magnet which extends from the earths interior out into space.

The magnetic field is extremely important to sustaining life on earth. Without it, we would be exposed to high amounts of radiation from the sun and our atmosphere would be free to leak into space.

Magnetic North, which follows the earths magnetic field, is slightly different from 'True North' which is at the geographic North Pole. This is a fixed point on the earths globe.



Artist's rendition of Earth's magnetosphere © Nasa

The earths magnetic field serves to deflect most of the solar wind, whose charged particles would otherwise strip away the ozone layer that protects the earth from harmful ultraviolet radiation.

Biology

Some animals use the earths magnetic field to navigate their journeys. For example, 'homing pigeons' have this ability and were used to carry important messages where normal communication was not possible. Flights as long as 1,800 km (1,100 miles) have been recorded in competitive pigeon racing.

Carrier Pigeon ©Lincoln Riddle

Avro Lancaster pigeons WWII

TOPIC 4: SIMPLE MACHINES

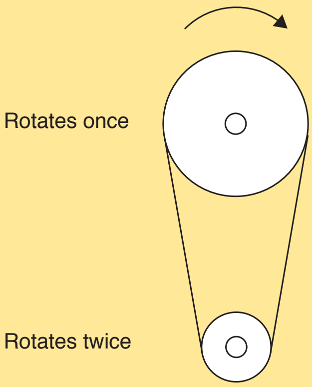
Project Notes

Build three models that show simple machines in action and explore how they change the forces applied to them.

Explore the forces of gravity and friction and see how they effect the way machines work.

MAGNETS

Applied Force



Resulting Force

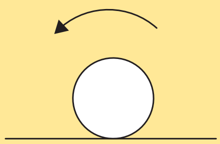
Machines are all around us in various sizes and complexities. From pencil sharpeners to food mixers, from bicycles to motor cars. It is hard to imagine life without them! The purpose of machines is to help us do work, to make it easier to do things - from washing our clothes to digging a deep hole in the ground.

Many of the most complex machines are actually combinations of what we can think of as simple mechanisms. Understanding simple mechanisms such as wheels and axles, gears, pulleys and cams is fundamental to understanding how the mechanical world around us works. When we look closely at how these simple mechanisms work we find that they are all different forms of lever.

A machine does not ‘create’ force to do work, it converts the force applied to it. For example, a simple pulley system can be used to increase the speed of a force. When a large pulley rotates once, a small pulley, which is half the size, will turn twice. However, the large pulley is travelling twice as far so the pulley system has converted increased distance into increased speed.

The power of the ‘resulting force’ is halved by this pulley system. However, if the force is applied to the smaller pulley then the larger pulley will travel at half the speed but with twice the power!

FRICTION



A ball rolls easily as there is little friction between it and the ground.

Shoes increase friction.

Friction is an invisible force that occurs between moving surfaces. When friction occurs it slows things down so we try to reduce friction in machines and sometimes add oil to lubricate moving parts and reduce friction. Ball bearings reduce friction by reducing the contact between moving parts. Friction also generates heat which can be experienced when you rub your hands together.

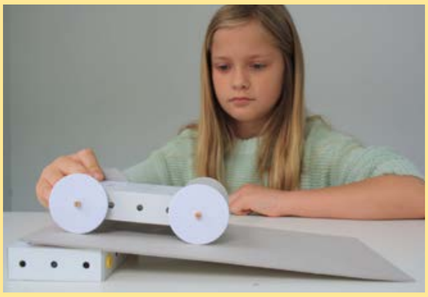
We try to keep friction to a minimum when designing machines but there are times when the force of friction is a good thing and we even try to increase it. For example, without the force of friction between our feet and the ground we wouldn’t be able to walk without slipping. Most of our shoes are designed to increase friction giving us more grip with the ground.

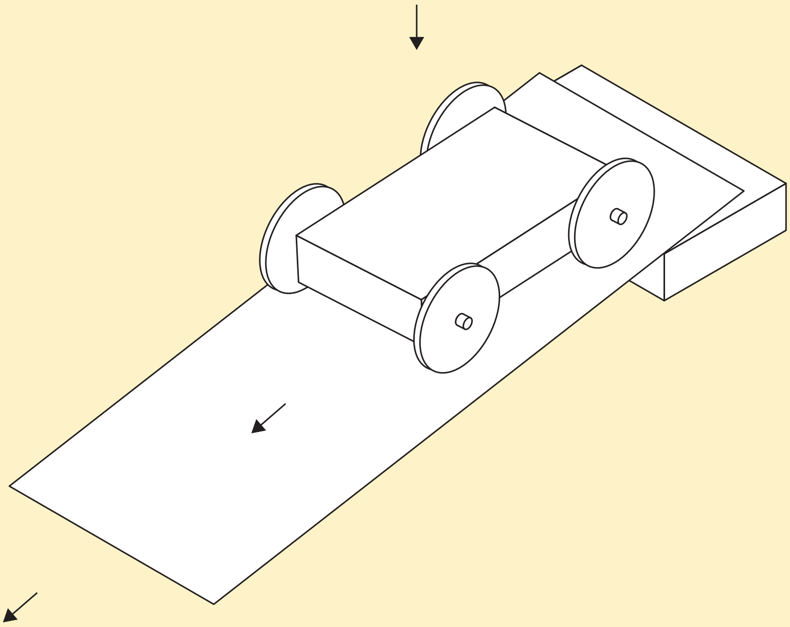
SIMPLE MACHINES - Explanation of the Science Lab Models

Build a Gravity Car, Pneumatic Jaw and Pulley System to explore how machines convert force to do work.

Gravity Car

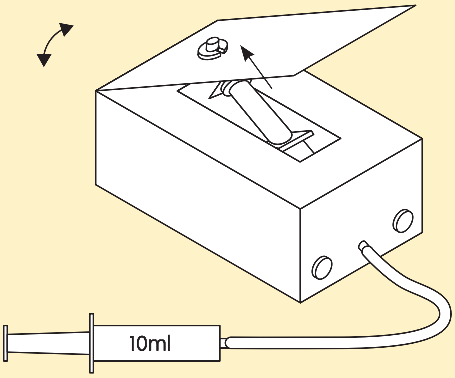
The vehicle is propelled down the ramp by the force of gravity. The wheels reduce friction by reducing the area of surfaces in contact at any time. The vehicle continues beyond the end of the ramp due to a type of force called 'momentum'.





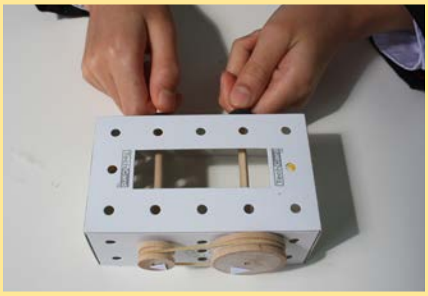
Pneumatic Jaw

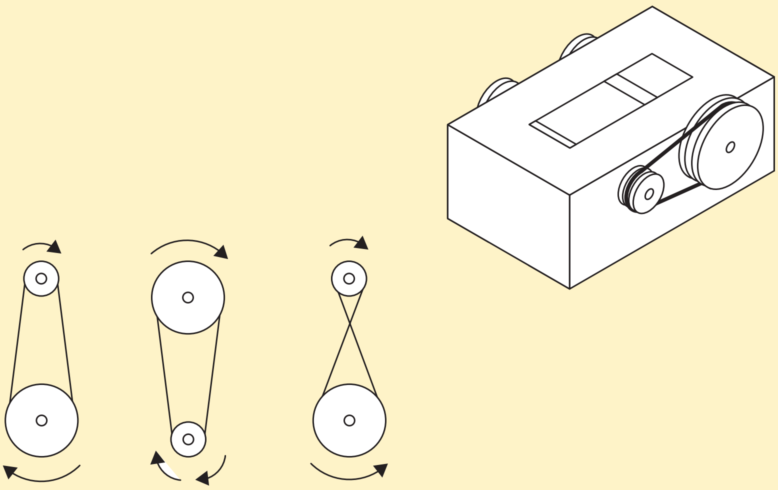
Closing the control piston forces air along the tube to open the piston inside the model. This demonstrates that air is a substance, takes up space, and can transfer a force. The opening of the upper panel is governed by a hinge.



Pulley System

In various arrangements the pulleys can change the power of a force, change the speed of a force and change the direction of a force.



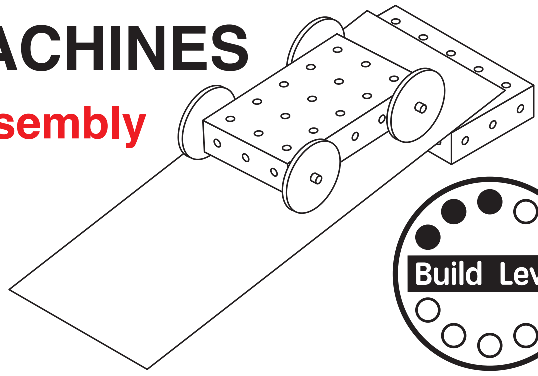


SIMPLE MACHINES

Gravity Car Assembly

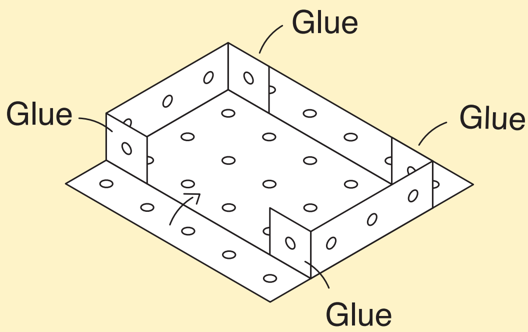
Parts:

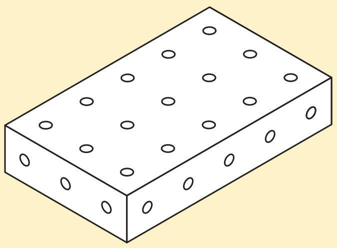
2 x Bases
2 x 10cm Axles
4 x 5cm Wheels
1 x Ramp Board



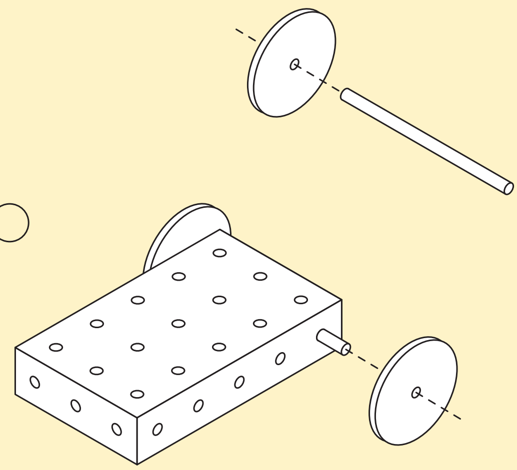
Build Level

1. Fold fold the base to shape and glue together. Assemble a second base in the same way.

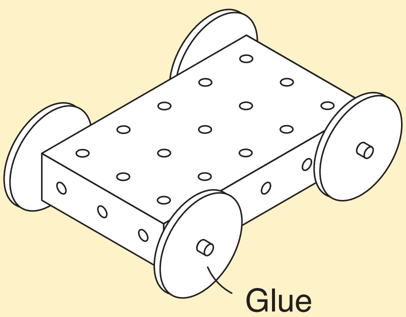




2. Check axles will turn freely in the four axle holes. Widen the holes if needed.



3. Fit a wheel to the end of a 10cm axle. Pass the axle through one of the bases and fit a second wheel.



4. Fit the second axle and wheels. Check the axles turn easily through the base. Glue the wheels to the axles.

SIMPLE MACHINES

Using the model

Gravity Car

Position the ramp on the base.

Place the car at the top of the ramp and let go.

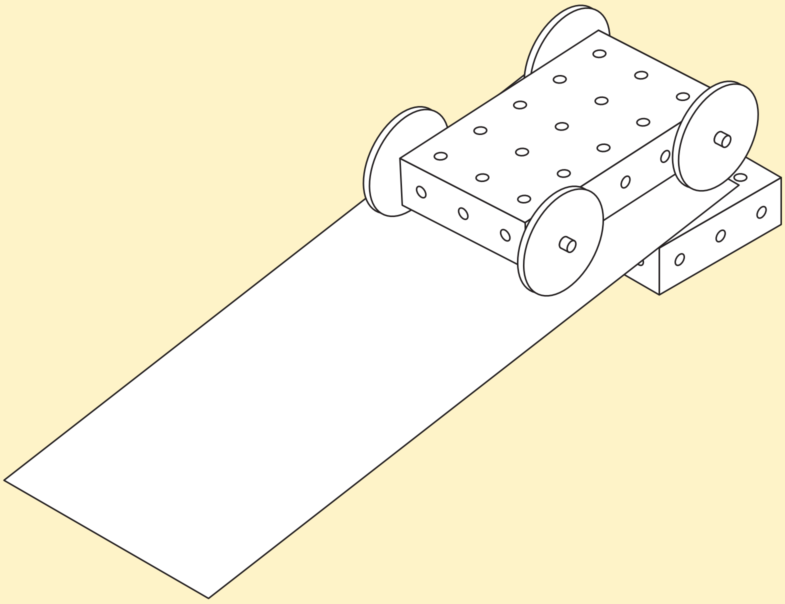
What happens when you let go of the car?

What makes the car move?

What job do the wheels do?

Why does the car keep going after it leaves the ramp?

How can you make the car go faster?



Science

A **helter skelter** is an amusement ride with a slide built in a spiral around a high tower. Users climb up inside the tower and slide down on a mat which reduces friction like the wheels of the gravity car.

Skateboarder © jorge-gonzalez

Child on helter skelter © feipeng-yi

Helter skelter

Science

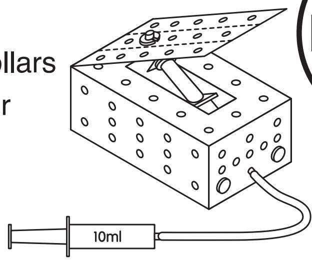
The **skateboarder** moves by pushing with one foot with the other foot on the board. A skateboard can also be used on a ramp allowing gravity to propel the board and rider.

SIMPLE MACHINES

Pneumatic Jaw Assembly

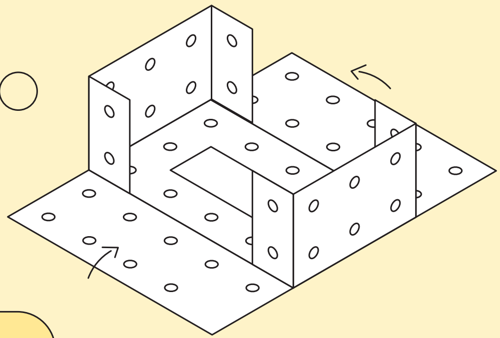
Parts:

1 x Project Base, 7 x Rivets & Collars
1 x 7.5cm Girder,1 x 2.5cm Girder
1 x 12.5cm Beam
1 x 20cm Tube, 1 x Foam Pad
1 x 5ml and 10ml pistons

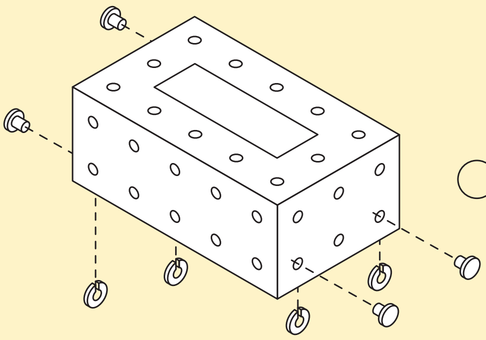


Build Level

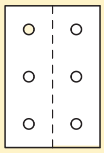
1. Fold the base to shape.

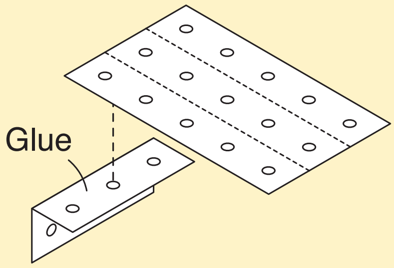


2. Rivet the base together.

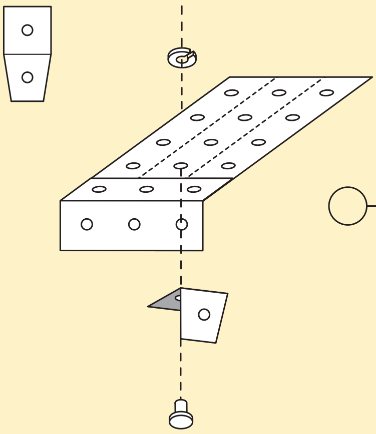


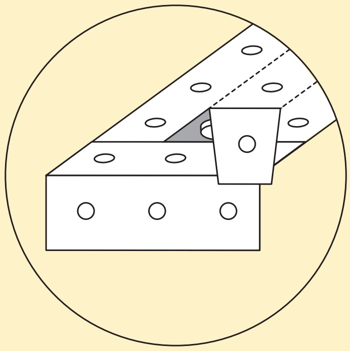
3. Fold the 7.5cm girder and glue under the end of the 12.5 beam.



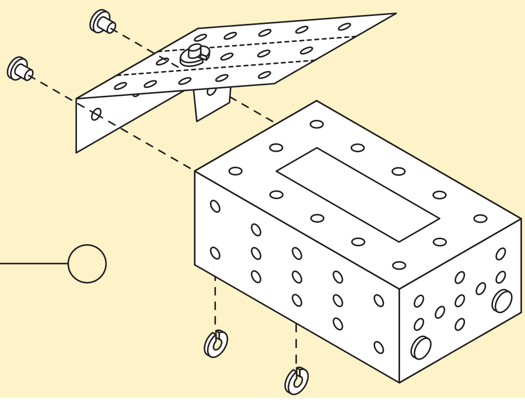


4. Trim the 2.5cm girder as shown. Rivet the girder under the beam where shown.

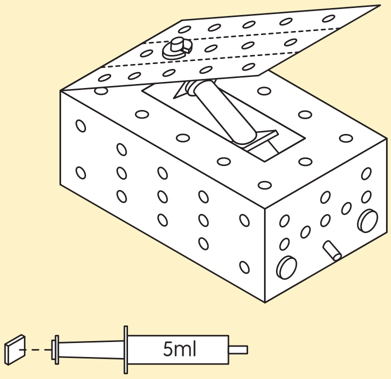


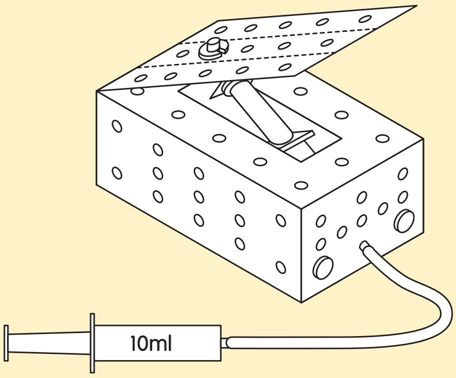


5. Rivet the girder to the back of the base.



6 Extend the 5ml piston. Fix a pad tape to the end of the 5ml piston and stick to the girder hinge. Pass the nozzle of the piston through the base where shown.





7 Fit the tube to the end of the 5ml piston. Close the 10ml piston. Fit the 10ml piston to the end of the tube.

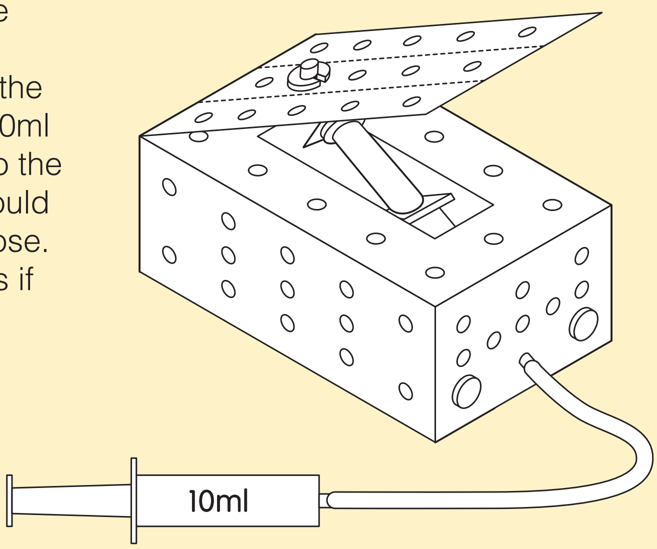
Simple Machines
Using the model

Pneumatic jaw
Why does the jaw open when you push the control piston?

What happens to the air in the tube when you pull the control piston?

Can you name the simple mechanism that guides the movement of the jaw?

To adjust, remove the 10ml control piston and close the jaw. Extend the 10ml piston and fit onto the tube. The jaw should fully open and close. Adjust the pistons if needed.



Pneumatic Machines

Can you think of machines in the real world that work like the pneumatic jaw?


Pneumatic production line robot © Lenny Kuhne


Hydraulic digger © Gerold Hinzen

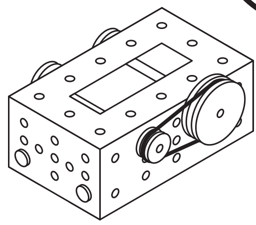
SIMPLE MACHINES

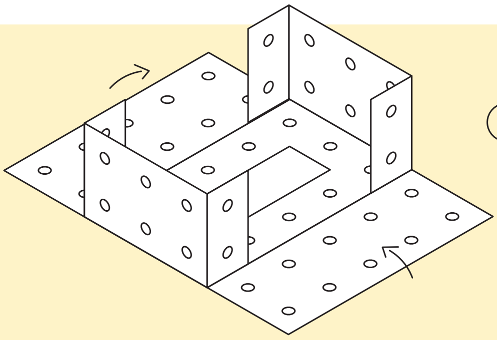
Pulley System Assembly

Build Level

Parts:

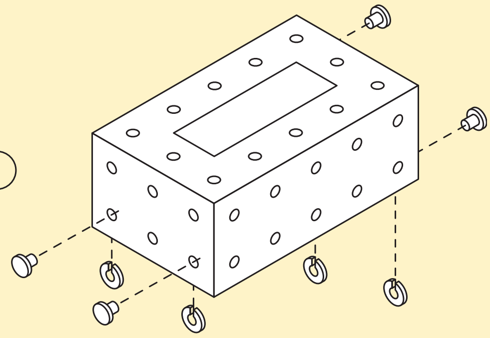
1 x Project Base
4 x Rivets and Collars
2 x 10cm Axles
2 x 2.5cm Discs, 1 x 4cm Pulley
1 x 2cm Pulley, 1 x Rubber Band

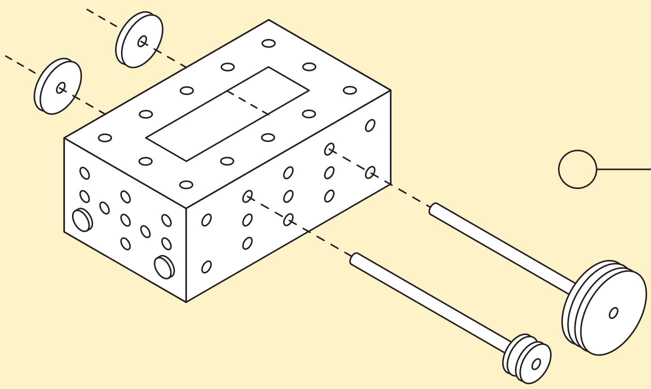




1. Fold the base to shape.

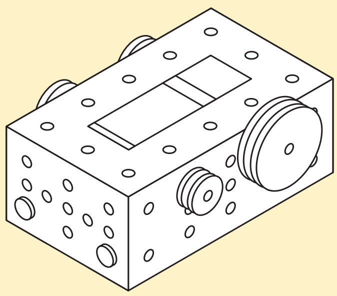
2. Rivet the base together.

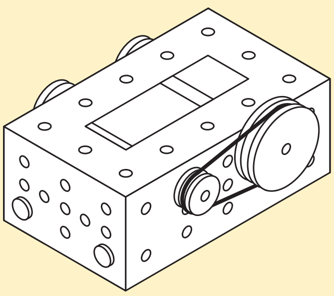




3. Fit the pulleys to the ends of each axle. Pass the axles through the base where shown. Fit the 2.5cm discs to the ends of the axles.

4. Check the axles turn easily.





5. Fit the rubber band over the two pulleys.

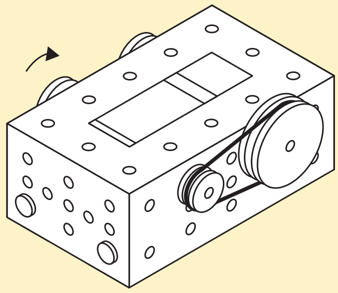
SIMPLE MACHINES

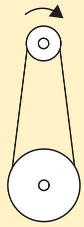
Using the model

Pulley System

With the 'pulley belt' positioned as shown, what happens when you turn the axle with the small pulley wheel?

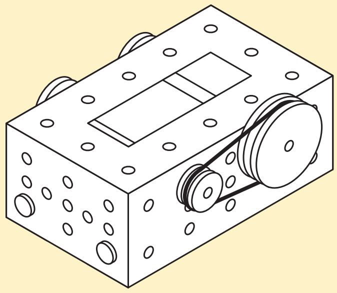
What happens to the large pulley when you turn the small pulley once all the way around?

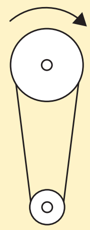




Now turn the axle connected to the large pulley. What happens to the small pulley?

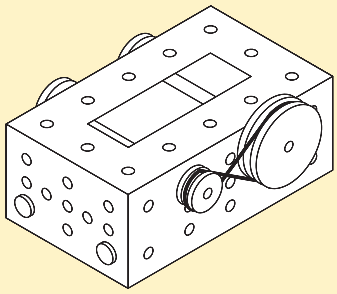
Turn the large pulley once all the way around. Does the small pulley go faster or slower?

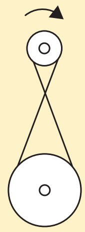




Adjust the drive belt so that it crosses over in a figure '8'.

Turn the axle with the small pulley. What happens to the large pulley?





Pulleys and Gears

Pulleys and gears can both change the power, direction and speed of the force applied to them.

Pulley © Brett Jordan.

Pulleys are often used to help lift heavy loads. The more pulleys in the 'system' the easier the work is to do.

Bicycle chain © Jeremias Radny

Gears on a bicycle are connected with a chain which means it cannot slip even when pushing hard.

Gears © Bill Oxford

Pulleys can work over long distances. Gears are used close together so their teeth 'mesh' and don't slip.

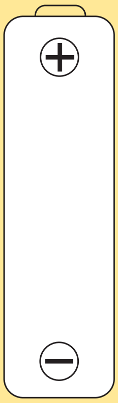
TOPIC 5: SIMPLE CIRCUITS

Project Notes

Build a buzzer circuit incorporating a buzzer, batteries and switch to see that electricity flows in a circuit.

Build a switch to control the circuit and investigate the effect of increasing voltage.

ELECTRICITY



A battery is a small power station. When the battery is connected in a circuit, a chemical reaction takes place inside which generates electrical energy. As the battery is used the chemicals are depleted.

Electricity is a form of energy that can be carried by wires and is used for heating and lighting, and to provide power for machines. Metal wires, and other materials through which electricity can flow, are called conductors or conductive materials.

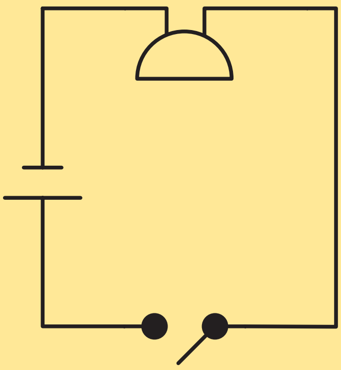
Electricity must flow in a circuit from the power source and back again in order to create electrical energy. The circuit must pass through components such as a light bulb or buzzer in order to use the energy in the circuit.

If there are no components in the circuit then a ‘short circuit’ occurs. Short circuits, even with small batteries, can be dangerous because the energy is not being used in the circuit so it returns to the battery and generates heat.

The electricity in the circuit powers an electro-magnet in the buzzer which causes a metal plate to vibrate and makes the buzzer sound.

The electricity in a traditional light bulb passes through a wire, or filament, that is so thin the filament glows white hot. It is because so much energy is wasted generating heat that traditional filament bulbs are ‘inefficient’ and being replaced by less ‘wasteful’ LED bulbs.

CIRCUIT DIAGRAM



When designing electric circuits, or communicating them to others, we use circuit diagrams. These consist of a series of symbols arranged and connected as they would be in the actual circuit.

The diagram shown is the circuit diagram for the buzzer circuit. The symbol at the top represents the buzzer. The symbol on the left is the battery or ‘cell’. The symbol at the bottom represents the switch.

The diagram shows the switch ‘open’. When the switch is open no electricity can flow through the circuit and the buzzer will not sound. When the switch is closed, the electricity can flow from the battery, through the switch and through the buzzer switching the circuit ‘on’.

IT IS VERY IMPORTANT TO READ THE BATTERY SAFETY INSTRUCTIONS OVERLEAF

IMPORTANT! FOLLOW THE INSTRUCTIONS BELOW TO INSTALL BATTERIES.

1 Your teacher or supervising adult must check your model before fitting the battery. 2 Fit the battery under adult supervision. 3 Operate the model under adult supervision. 4 The model must be assembled as shown in the instructions. 5 Do not insert the battery until the model is complete. 6 Make sure the model is switched off before inserting the battery. 7 Requires 1.5V AA batteries. 8 Make sure you insert the battery correctly checking the polarity of the battery is correct. The '+' symbol on the battery must align with the '+' symbol in the battery holder. 9 Make sure the supply terminals in the battery holder are not short circuited. 10 Remove the battery from the model when not in use. 11 Replace exhausted batteries right away to avoid damage. 12 Rechargeable batteries must be removed from the model before recharging. 13 Rechargeable batteries must be recharged under adult supervision. 14 Do not attempt to recharge non-chargeable batteries. 15 Do not mix old and new batteries. 16 Do not mix alkaline, standard (carbon-zinc) and rechargeable (ni-Cd) batteries.

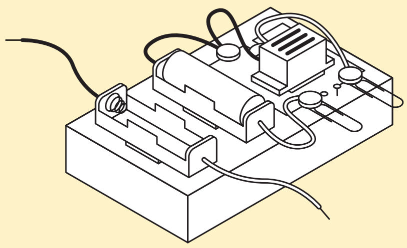
SIMPLE CIRCUITS - Explanation of the Science Lab Model

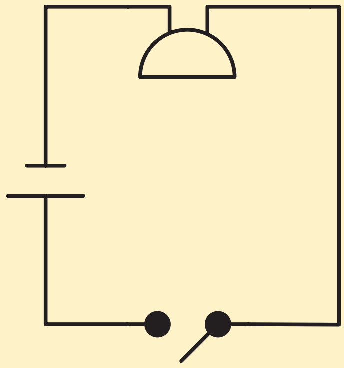
Build a buzzer circuit to see how electricity flows in a circuit and can be converted by devices to create sound and movement.

1.5 Volt Circuit

When the switch is 'closed' electricity flows in a 'circuit' from the battery, through the buzzer making it sound and returning to the battery. As it flows through the buzzer energy is used.

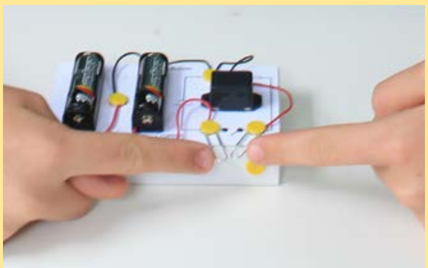
The circuit diagram uses symbols to illustrate the circuit.

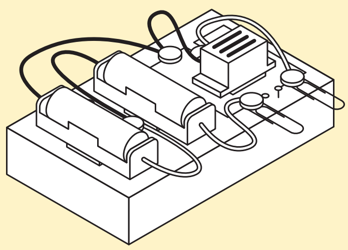


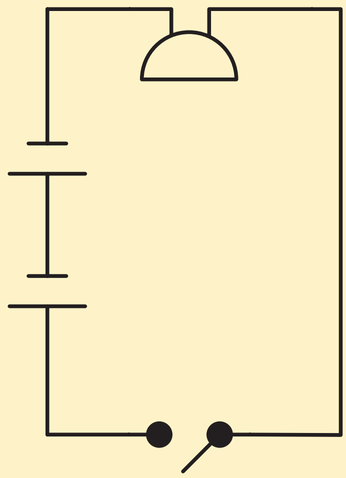


3 Volt Circuit

In this circuit two batteries are used. The batteries are arranged 'in series' one after the other so the voltages are combined to total 3 volts. This will make the buzzer sound louder as there is more energy available to operate it.







SIMPLE CIRCUITS

Buzzer Circuit Assembly

Parts:

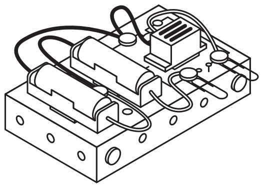
1 x Base

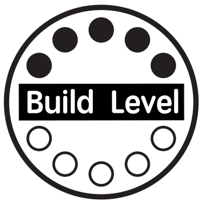
8 x Rivets and Collars

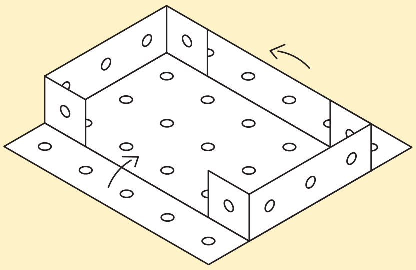
1 x Circuit Sticker

3 x Foam Pads, 2 x Battery Holders

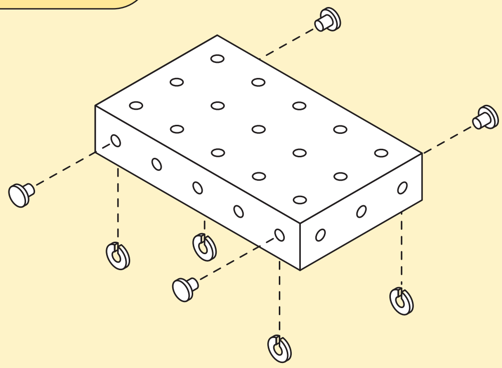
1 x Buzzer, 2 x Paperclips, 2 x AA 1.5v batteries (not included)



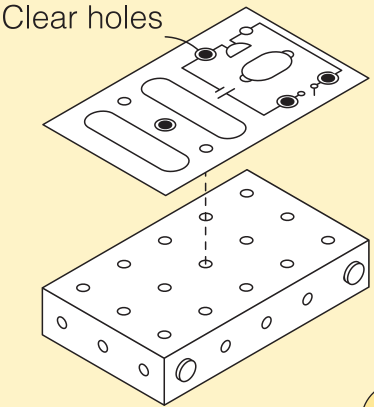




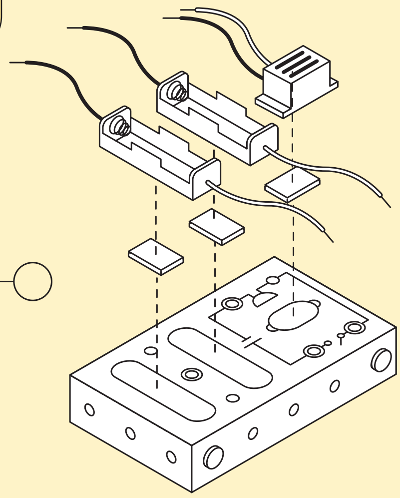
1. Fold the base to shape.



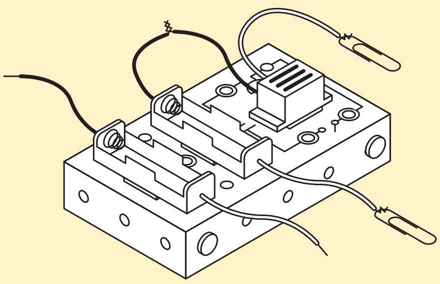
2. Rivet the base together.



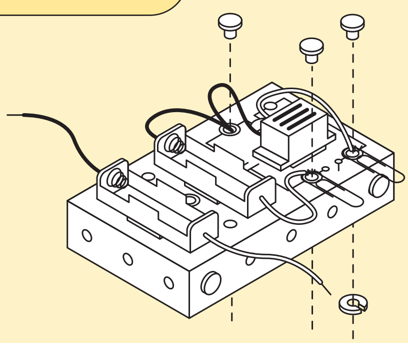
3. Tape the circuit diagram in place. Clear the four holes.



4. Fix the battery holders and buzzer with foam pads as shown. Check the position of the red wires.

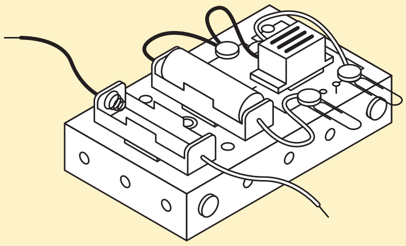


5. Twist the ends of the two black wires shown. Twist the two wires shown onto the paperclips.



6. Secure the two paperclips and the black wires with rivets and collars.

6 Ask an adult to insert a battery following the battery safety guidelines on page 33.



SIMPLE CIRCUITS
Using the model.

Buzzer Circuit

With the circuit set up with one battery, close the paperclip switch.

Why does the buzzer sound?

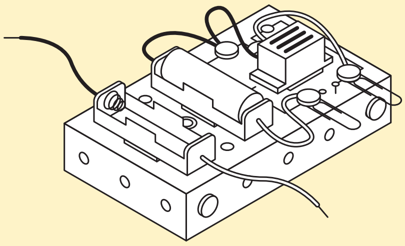
Now, remove the battery. Disconnect the black battery holder wire and connect the second battery holder as shown.

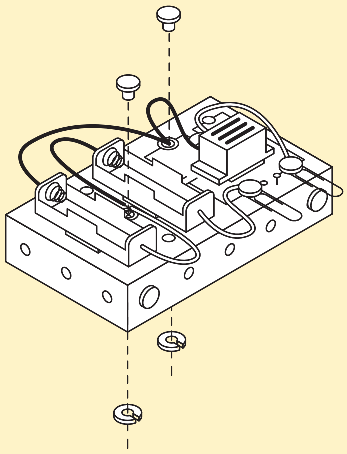
Ask an adult to fit both batteries making sure the polarities are correct.

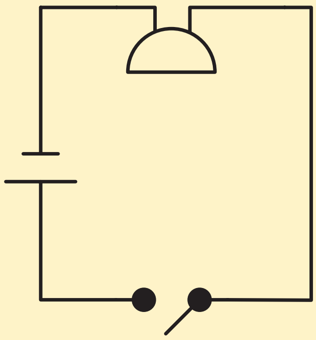
Close the paperclip switch. What do you notice about the buzzer sound with two batteries.

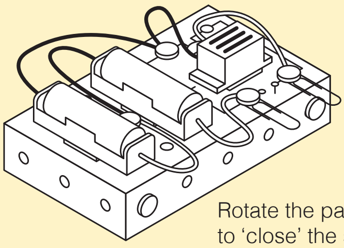
Why is it different?

Can you identify the parts in the circuit on the circuit diagram?



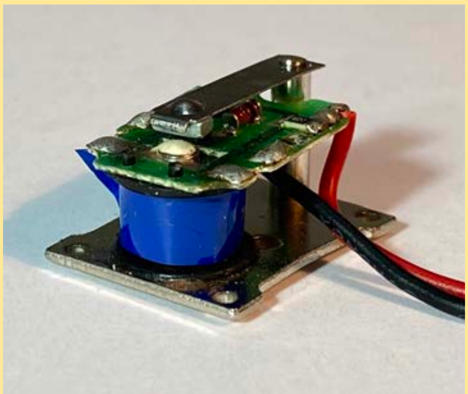






Rotate the paperclips to 'close' the switch.

Circuits
Electricity flows through a coil of wire inside the buzzer. This creates a magnetic field which makes a metal arm vibrate which makes the buzzing sound. The doorbell shown works in the same way. The coil in the buzzer is protected by blue tape.



Buzzer

Doorbell

Electricity

Making Electricity

In the past burning coal and oil have powered generators to make electricity. Now we are looking for cleaner ways to create the electricity we need such as solar panels and wind turbines. Electricity is difficult to store in large quantities. We have small batteries to power small devices but it is not feasible to have batteries big enough to power a house yet!

Power Station © Nicolas Hippert

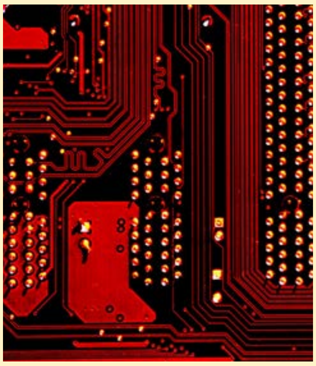
Solar Panels © Andreas Gucklhorn

Batteries © Claudio Schwarz Purzlbaum

Moving Electricity

Electricity flows from the power stations to our homes by wires and cables. In small devices 'circuit boards' are used to mount all the electronic components and the electricity flows between them on conductive tracks. New technologies are being developed that allow small amounts of electricity to flow through the air between devices!

Pylons © Fre Sonneveld



Circuit Board © Michael Dziedzic

Wireless © Limor Zellermayer

Using Electricity

Electricity is hugely important in all our lives and it is difficult to imagine life without it. Electricity flows through almost everything from the computers and electronic devices that we use every day to our powering our homes and huge cities. Even now we are finding new ways to use electricity. It is likely that in the future all our transport will be electrically powered!

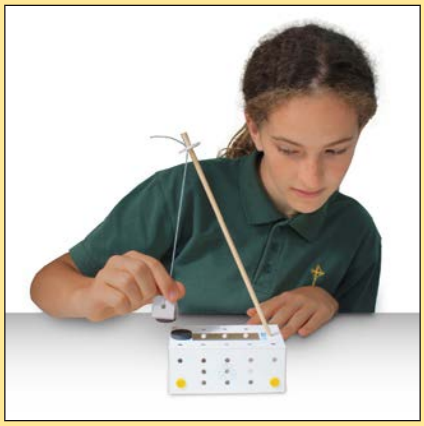
Desktop Computer © Dhru J

City Light © Pawel Nolbert

Electric Car © Marc Heckner

Thank you for using the TechCard Science Lab

We hope your class enjoyed using the Science Lab and that it helped to make learning fun and memorable.



Please let us have you feedback so we can make things better.