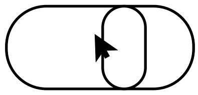
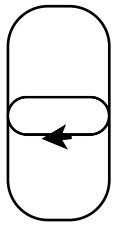
Planet Earth & Beyond

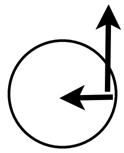
1	Orbiting satellite	To demonstrate the force that keeps satellites in orbit around the Earth

Materials needed: small-mouthed glass jar (around 300-500mls), marble
Procedure:
1.Use your hand to hold the jar horizontally with the opening facing a side
2.Place a marble inside the jar
3.Gently place the opening against the palm of your hand and move the jar so that the marble quickly spins inside the jar
4.Continue to move the jar as you slowly turn the jar and your palm upside down
5. Remove your hand, stop moving the jar, and rest the opening of the jar on the table.





What happened:
The marble remains in the jar for as long as the marble is spun. This continues for a short time after you stop moving the jar, but the marble slows down and eventually falls out of the jar.
Why did this happen:
The jar pushed the marble and provides an an inward force that keeps the marble moving in a circular path inside the jar. That forces that goes towards the centre is called the *centripetal force*. If the bottle suddenly disappeared, the marble would fly off in a straight line because of it's forward speed. Any object moving like this has a forward speed/force and a centripetal force acting on it such as our moon or artificial satellites.The earths natural and artificial satllites are pulled towards the earths surface by gravity but their own forward speed keep them from being pulled into the earth. Satellites,like the marble ,fall when their forward speed decreases.



Material World

2	The Great Escape	To demonstrate gas diffusion and osmosis

Materials needed: eyedropper, vanilla extract, balloon, shoe box or other small box with a lid
Procedure:
1. Place 15 drops of vanilla extract inside the deflated balloon. Be careful not to get any of the vanilla on the outside of the balloon.
2.Inflate the balloon to a size that will comfortably fit inside the shoe box and tie the open end. Place the balloon in a empty shoe box.
3.Leave the balloon in the closed box for one hour
4. Open the box and smell the air inside.
What happened:
The air smells like vanilla. The box is still dry.
Why did this happen:
The balloon appears to be solid but it actually has tiny holes in it that you can't see. The liquid vanilla molecules are too big to go through these holes but the vanilla gas molecules are small enough to do so. The movement of the gas through the rubber is called *osmosis.* The gas fills the whole box and this is called *diffusion*.

Physical World/Living World

3	Water drop lens	To demonstrate how a water drop can magnify print

Materials needed: 15mm 20-gauge wire (thick fuse wire or stripped thin electrical wire), pencil, bowl, newspaper

Procedure:

1. Twist one end of the wire around the pencil to make a small loop
2.Fill a bowl with water and dip the wire into the water with the pen loop facing up
3.Lift the loop carefully out of the water carefully so that a large round drop of water sits in the loop
4.Look through the water drop at the letters on the newspaper. You may have to move the loop up and down to find a position that makes the letters clear.

What happened:

The letters are enlarged. If the letters look smaller, dip the loop into the water and try again.

Why did this happen:

The water drop is curved outwards and behaves like a convex lens. This is the same sort of lens used in magnifying glasses. If the writing looks smaller it is because the water is stretched so much between the wires that it curves downwards, making a concave lens. This type of lens makes the print look smaller.

Physical World/Living World

4	Bells in my ears	To demonstrate how a sound is louder traveling through solid material

Materials needed: metal spoon, 65mm cotton string, table

Procedure:

1. Tie the handles of the spoon in the centre of the string with a knot
2.Wrap the ends of the string around both index fingers making sure that both strings are about the same length
3.Place the tip of index finger in each ear
4.Lean over so that the spoon hangs freely and then tap it against the table

What happened:

There is a sound like a bell or door chime

Why did this happen:

The metal in the spoon vibrates when it is hit and these vibrations travel up the string into the ears. All sound is called by vibrations and when these reach the ear, the ear turns that into sound when it strikes the eardrum. These vibrations travel through bones and fluids in the air and jaw until they reach a nerve that sends the message to the brain. The sound moves faster up the string than through the air which is why it sounds so loud.

Physical World

5	Optical Illusion	To demonstrate how we overlap images in our mind to make an illusion

Materials needed: cardboard, hole punch, pen/marker, rubber band

Procedure:

1. Draw and cut out a 10cm diameter circle on a piece of cardboad.
2. Punch a hole on each side and tread a rubber band through each
3. Use a marker and draw either: a big bowl on one side and a small fish on the other; or a big birdcage on one side and a small bird on the other
4. Hold the rubber bands taunt and twirl the cardboard
5. Observe what happens in the middle of the disc.

What happened:

The fish appears inside the bowl or the bird appears inside the cage

Why did this happen:

The see each picture as it passes in front of your eyes. You retain that image for about 1/16 of a second but because the images are traveling so fast, they superimpose upon each other. This is how movie pictures were made prior to video with 50 frames passing your eyes in one second. The first movies were shot at about 12 frames a second, hence the movement was not fluid and looked jerky.

Physical World

6	Jumping paper	To demonstrate how things move with static electricity

Materials needed: 15-20 paper circles cut from refill using a hole punch, table, balloon

Procedure:

1. Place the circles separately on a table
2. Blow up a balloon
3. Rub the balloon against your hair 5-6 times (best with clean, dry hair)
4. Hold the balloon close but not touching the paper circles

What happened:

The paper circles will hop up and stick to the balloon

Why did this happen:

Everything in the universe is made up of atoms which have a positive (+) centre and negatively (-) charged electrons spinning around it. The balloon rubs off electrons from the hair and has excess negative charges (*becomes negatively charged*) and The positive part of the paper circles is attracted to the negative charges on the balloon. This attraction between positive and negative charges is strong enough to overcome the force of gravity and so the circles move to the balloon.

Physical World/Material World

7	The appearing ball	To demonstrate how matter can not occupy the same space

Materials needed: large mouthed jar (litre) with lid, uncooked rice, small ball 20-25mm or walnut

Procedure:

1. Fill the jar 1/4 full with uncooked rice
2. Put the ball or walnut inside the jar and close the lid
3.Hold the jar upright then turn it over. DO add more rice if the ball can not be covered by the rice
4.Shake the jar back and forth vigorously until the ball surfaces. DO NOT SHAKE UP AND DOWN

What happened:

The ball or walnut rises to the surface

Why did this happen:

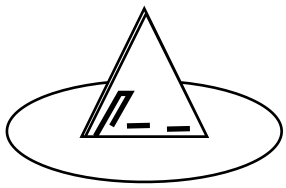
The re are spaces between the grains of rice. As the jar is shaken, the rice moves closer together. This is what is known as *settling* and happens with most loose foods found in packets such as flour, salt, cereals, and sugar due to the jostling of the foodstuffs during transportation and shelving. As the rice moves together it pushes the ball upwards. Two bits of matter can not occupy the same space at the same time, so one must make room for the other.

Material World

8	Rainbow inks	To demonstrate how inks are made of different colours

Materials needed: coffee filter paper, green and black water soluble ink (felts will do), paper clip, saucer, water

Procedure:



1. Fold a coffee filter in half and then half again
2. Make a dark green mark with the green pen about 2-3cm from the outer edge.
3. Make a black mark with the black pen about 2-3cm from the outer edge, close to but not touching the other mark
4.Secure the edge of the filter with a paper clip so that a cone is formed
5.Fill the saucer with water and place the rounded edge of the cone in it
6.Leave for an hour

What happened:

The colours will separate after an hour. A trail of blue, red and yellow will travel upwards from the black, and the green has a trail of blue and yellow.

Why did this happen:

Black and green are combinations of different colours. As the water rises in the paper due to *capillary action*, the ink dissolves with it and the different parts are seen. The colours rises differently due to the solubility of the chemicals producing that colour. The more soluble chemicals rise the most.

<u>Material World</u>

9	Chemical heating	To demonstrate how rusting can produce heat

Materials needed: cooking, outdoor, medical or laboratory thermometer, jar with lid large enough to fit the thermometer, plain steel wool (without soap), 60mls/ ¼ cup of vinegar

Procedure:

1. Place the thermometer inside the jar and close the lid
2. Record the temperature after 5 minutes
3. Soak ½ steel wool pad in vinegar for 1-2 minutes.
4. Squeeze out excess liquid and wrap it around the bulb of the thermometer
5. Place the thermometer and the steel wool inside the jar. Close the lid
6. Record the temperature after 5 minutes

What happened:

The temperature rises

Why did this happen:

The vinegar removes any protective coating from the steel wool allowing the iron to rust. Rusting is a slow chemical reaction between the iron in the steel wool and oxygen in the air and heat is always released. This is called an *exothermic reaction*. The heat makes the liquid in the thermometer to expand and rise inside the thermometer.

<u>Planet Earth & Beyond/ Material World</u>

10	Bubbling shells	To demonstrate that shells are made of limestone

Materials needed: 3 seashells, vinegar and a jar/glass

Procedure:

1. Fill a jar/glass ¼ full of vinegar
2. Add seashells

What happened:

Bubbles start rising off the seashells

Why did this happen:

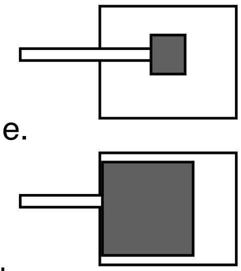
The vinegar is an acid and the seashells are made of limestone, a type of mineral often found as a rock such as the Waitomo caves region. Limestone rocks were millions of years ago the shells and bones of marine animals. Limestone reacts with acids and makes new chemicals. One of these is carbon dioxide (CO_2) which is a gas. This is the same gas found in fizzy drinks.

Planet Earth & Beyond

11	Strong Air 1	To demonstrate the strength of air pressure

Materials needed: 1 metre ruler, 1 sheet of newspaper,table

Procedure:



1. Place metre ruler ½ off a table
2.Fold a sheet of newspaper into half four times
3.Place the folded newspaper over the end of the ruler that is on the table.
4.With your index finger tap the other end of the ruler. Observe what happens to the ruler and folded newspaper
5.Unfold the sheet of newspaper and spread it over the ruler so that the paper lies flat over it and along the edge of the table. Try and smooth out any air underneath.
6.With your index finger tap the other end of the ruler. Observe what happens to the ruler and folded newspaper

What happened:

The ruler and newspaper are more difficult to move when the paper is spread out

Why did this happen:

The weight of the paper whether folded or flat are the same. It is the weight or pressure of the air that is different. There is more than 156km of air above the paper and this pushes against it (and on us too!). The force is 1 kg per square cm. On average it would mean that on the folded paper there was 263 kgs of air on top but when it is unfolded produces a surface 16 times greater, the weight is 16 times greater too.... 4,208kg.

Planet Earth & Beyond/Material World

12	Strong Air 2	To demonstrate the strength of air

Materials needed: a raw potato, 2 plastic drinking straws (not bendy ones), table

Procedure:

1. Place a raw potato on a table
2.Hold a straw at the top without covering the top
3.Raise it about 10cm above the potato and quickly and with force stick the end into the potato
4.Repeat this with the other straw but this time have your thumb firmly on the top of the straw

What happened:

The open ended straw buckles and does not enter the potato very much. The closed straw cuts deeply into the potato

Why did this happen:

The air is made up of lots of different gases we can't see but they do exert pressure. We see this pressure in action with fast moving air (wind) which if strong enough can knock down buildings. When we trap air inside of the straw with our thumb, the push of the air against the inside of the straw stops it bending and makes the whole straw strong enough to break through the skin of the potato. The pressure of the air increases as the plug of potato enters the straw and compresses the air. If you inflate a bike tyre really high it becomes very hard.

Physical World

13	Static sounds	To demonstrate how static electricity produces sound

Materials needed: plastic ruler, blu tac, large metal (not covered in plastic nor painted) paperclip, woolen cloth/piece of clothing

Procedure:

1. Use the blu tac to stand the paper clip upright on a table
2.Rub the ruler with the woolen cloth quickly (3-5 times)
3.Immediately hold the ruler near the top of the paper clip

What happened:

A snapping sound can be heard. If the room is darker you may also see a blue spark

Why did this happen:

Electrons are rubbed off the wool and onto the ruler. They clump together until there is sufficient energy to move them across the gap of air between the ruler and paperclip. The movement is so fast that it produces sound waves which we hear as the “snap” .

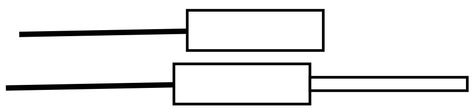
Physical World

14	Kite tail	To demonstrate how a kite’s tail works

Materials needed: string, refill paper, scissors, cellotape, ruler

Procedure:

1. Measure and cut 5cm X 30cm strip from refill
2.Tape a 45cm piece of string to one end
3.Hold the free end of the string and whip the paper back and forth in front of you. Observe what happens
4.Measure and cut 0.5cm X 30cm strip from refill and attach it to to the free end of the wider strip
5.Again hold the free end of the string and whip the paper back and forth in front of you. Observe what happens



What happened:

The first paper twirls but the second the movement is much smoother

Why did this happen:

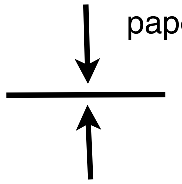
The paper moves through the air at an angle with the air flowing faster on the top than the bottom of the paper. Fast moving air has less air pressure so there is more air pressure pushing up, this is called *lift*. But, the angle of the paper is not consistent like an airplane wing and this causes turbulent air flow across the strip. These changes in air flow cause the strip to rotate and twist just like in a bumpy ride in a small aeroplane. The paper tail makes the angle of the of the big piece of paper more constant and therefore there is smoother airflow across the paper and less twisting.

Physical World

15	Bending paper	To demonstrate the effect of air speed on air pressure

Materials needed: 2 thick books of equal size, drinking straw, sheet of refill, ruer
Procedure:
1. Position the books 10cm apart on a table
2. Lay the refill paper across the space between the books
3.Place the end of the straw just under the front edge of the paper and blow as hard as you can through the straw
  1. Observe what happens

(1)



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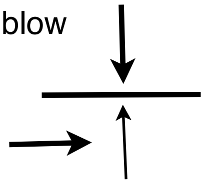
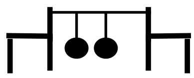


What happened:
The paper bends down towards the table
Why did this happen:
Before you blow, air is pushing equally on all sides of the paper.(1) As the speed of the air increases, the sideways pressure of the air decreases. So forcing air under the paper makes the upward air pressure decrease which means the downward air pressure on top of the paper is now greater (2) and the paper moves down.

Physical World

16	Pendulum	To demonstrate how energy can be transfered between 2 pendulums

Materials needed: 2 chairs, metre ruler, string, 2 washers, scissors
Procedure:
1. Stand 2 chairs 1 metre apart, back to back
2.Attach a string to the tops of the chair backs to make a taut line between them
3.Measure and cut 2 x 60cm pieces of string and attach a washer to the end of each
4.Tie the free ends of the strings about 30cm apart in the middle of the string attached to the chairs
5.Lift one washer up so that the string (A) is taut and release the string



What happened:
String (A) will swing backwards and forwards and soon after string (B) will also start to swing. As one string slows, the other speeds up. This cycle continues until both strings are stationary.
Why did this happen:
The hanging strings with weights (the washers) are pendulums. When string (A) moves, the central lines moves and then string (B) moves. The moving energy is transfered between the strings through the central string. During this transfer, one pendulum slows down whilst the other speeds up. At one point/instance in time in the cycle; one pendulum has all of the energy and the other has none; and they have equal amounts of energy when their swings are at the same height. because of air resistance (friction), both pendulums slow down and eventually stop.

Material World

17	Hot rubber band	To demonstrate how energy changes

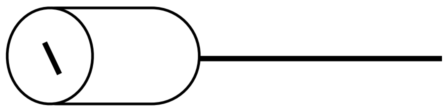
Materials needed: thick rubber band
Procedure:
1. Place the rubber band on your forehead and note the rubber band's temperature (Your forehead is sensitive to enough to heat that it can measure this)
2. Hold the rubber band between your thumbs and index fingers with your thumbs touching
3.Stretch the rubber band as far as you can with the band touching your forehead

What happened:
The stretched rubber feels warm
Why did this happen:
The rubber band is made up of molecules coiled like a spring. When you stretch the band they uncoil and when you let go the recoil. You are using *mechanical energy* (the energy of moving things) to uncoil the molecules and the rubber band uses energy to coil them back. But, some of this mechanical energy was changed into *heat energy*. So energy was needed to change the shape of the molecules and energy was needed to restore the original shape.

Physical World

18	Clucking bird	To demonstrate how a vibrating string produces noise

Materials needed: sharp pencil or nail, paper drinking cup, 60cm cotton string, matchstick, kitchen sponge (cut approx 2.5cm x 1.5cm),water



Procedure:
1. Use the sharp pencil/nail to make a hole in the bottom of the cup
2.Push one end of the string into the cup and tie the end outside the bottom of the cup around a matchstick (secures string to cup). The free end of the string comes out of the front of the cup
3.Wet the sponge and wrap it around the string

What happened:
A sound is produced like a clucking bird
Why did this happen:
The water in the sponge allows it to move down the string, but there is enough friction to cause the string to vibrate and sound is produced. The sponge does not grip the string all of the time and it skips and pulls on the string. This irregular touching on the string produces tiny vibrations that forces the strings molecules to move. The vibrating string strikes the bottom of the cup and in turn the cups molecules strike the air molecules cause them to also move back and forth in the same rhythm as the string and cup molecules. The sound is made louder as the inside the cup acts like a sound amplifier and concentrates the sound waves and sends them out in one direction.

<u>Physical World</u>

19	Flounder fishing	To demonstrate how the depth of water affects how light is bent

Materials needed: 2lt ice-cream (white best) container, jug, water, black permanent marker. (Needs to be done with a partner)

Procedure:

1. Place a large round mark in the middle of the bottom of the icecream container (about the size of a $2 coin)
2. Place ice-cream container on edge of a table and you move back to a position where you can just see the black dot over the edge of the container.
3. Keep your eyes on the dot and move your head back until the dot completely disappears and DON'T MOVE.
4. Get your partner to slowly fill the container with water

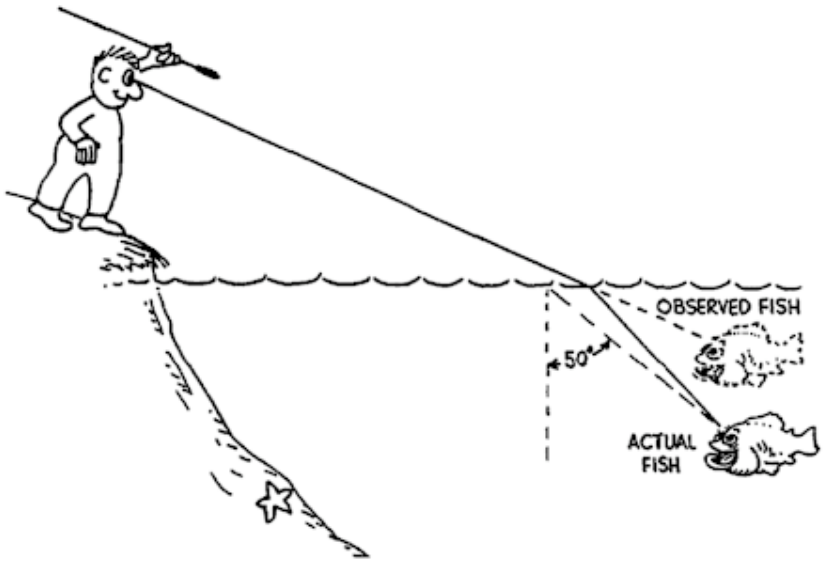
What happened:

The dot suddenly appears and gets larger

Why did this happen:

You see the dot because light from the room bounces off the dot into your eye. The water in the container however bends (*refracts)* the light. Light travels in a straight line. When light travels through more dense material it slows down, and in less dense it speeds up. Light travels as a wavelength and the part of the wavelength that hits the more dense material first, slows down first, and the part that hits the less dense material first, speeds up first.

An analogy: when you run along a beach and then veer off into the surf, your feet hits the water (more dense than air) first, and it is the first part of your body that slows down. Your upper body is still traveling fast so your body bends.



Planet Earth & Beyond

20	Moon vs Earth heavy	To demonstrate how the Moon's gravity affects weight

Materials needed: 60 cm cotton string, rubber band, bucket, water, rock (about size of a small apple

Procedure:

1. Tie one end of the string to the rock and attach the other end to a rubber band
2. Place an empty bucket on the floor
3.Lower the rock into the bucket holding everything by the free end of the runner band and observe the rubber band
4.Fill the bucket ¾ with water
5. Again lower the rock into the bucket holding everything by the free end of the runner band and observe the rubber band

What happened:

The rubber band stretches less when the rock was sitting in the water

Why did this happen:

Gravity the force that pulls stuff towards the center of the Earth, pulls the rock down and makes the attached rubber band stretch. When the water is added, the water pushes up the rock and cancels some of the downward pull of gravity. This simulates the affects of the Moon's gravity on weight. The Moon's gravity is 1/6 of Earth's. Astronauts train to do space work here on Earth inside huge swimming pools so that they get used to working outside in space.

Planet Earth & Beyond/Living World

20	Cooling off/ drying off	To demonstrate how the wind dries things faster but can cause hypothermia

Materials needed: paper towel, water, 7.5cm x 12.5cm (approx) card, water

Procedure:

1. Wet the paper towel with water
2.Rub the wet towel over both of your arms
3.Hold the card above ONE wet arm (about 10cm) and quickly fan the card.
4.Observe what happens to the water and how your arm feels. Compare arms

What happened:

The fanned wet skin feels cooler but rapidly dries compared to the unfanned arm

Why did this happen:

The cooling effect is due to evaporation of the water from the skin. It only occurs when the liquid absorbs enough heat energy to turn into a gas. The water takes energy away from the skin when it evaporates, causing the skin to cool. When the air moves quickly across the skin speeds up the evaporation of the water, thus aiding in the cooling of the skin.This will mean that the skin will dry faster too which is why washing dries faster on windy days. However, if the skin stays wet or even on dry days (but this is slower) and you are exposed to wind, you could loose too much heat and get hyperthermia.

Living World

21	Walking hairpins	To demonstrate how muscles move at rest

Materials needed: dinner knife, hairpin, table
Procedure:
1. Hold a dinner knife tightly in your hand with the blade facing up
2.Place a hairpin astride the blade and lift it just enough for the legs of the hairpin to rest lightly on the table with the pins in a slanting position.
3.Observe what happens

What happened:
The hairpins walk along the knife blade.
Why did this happen:
The tightly gripped muscles in the arm have slight movements which are trasfered down the arm, through the hand and fingers and along the blade. Although we can't see them, this causes the blade to slightly vibrate. Our muscles never rest and even when we are asleep they are constantly moving even if we don't notice it.

Living World/Material World

22	Hot or cold hands?	To demonstrate how hot and cold sensations can be deceiving

Materials needed: 3 large mixing bowls or buckets, a tray of ice cubes, tap water, boiling water
Procedure:
1. Fill the three bowls with tap water and place in a row
2.Add ice cubes to the right hand bowl and boiling water to the left hand bowl (check that it won't burn)
3.Put your right hand in the cold water and your left hand in the hot water. After 30 seconds remove your hands from these bowls and quickly put both hands in the middle bowls (room temperature tap water)
4.Observe what happens

What happened:
The same water feels warm to your right hand but cold to your left hand.
Why did this happen:
Heat generally flows from an object that is hotter to something that is cooler. The tap water feels warm to your right hand because the heat energy is flowing from the tap water into your cold hand. Your left hand has more heat energy than the tap water so the energy is leaving your hand to go into the water. This energy leaving your skin makes the water feel cold to your left hand.

<u>Planet Earth & Beyond/Material World</u>

23	Updraft and downdraft	To demonstrate how hot and cold air moves

Materials needed: tinfoil (baking foil), a tray of ice cubes, boiling water in a cup, 5cm cotton , scissors, cellotape

Procedure:

1. Draw a 10cm circle onto tin foil and cut the circle into a spiral with a round centre piece.
2.Tape one end of the cotton to the centre of the spiral
3. Holding the free end of the cotton, dangle the spiral over the tray of ice
4.Observe what happens
5.Holding the free end of the cotton, dangle the spiral over the cup of boiling water
6.Observe what happens

What happened:

The spiral twirls over the ice and does so too over the cup of boiling water but in the opposite direction

Why did this happen:

Cold air is heavier than warm air and tends to sink in the air. This is called a *downdraft* and rising air is called an *updraft*. As it sinks and passes through the spiral, it turns the spiral. Over the boiling water the air is warmer than the surrounding air, it is lighter and therefore is rising. As it rises and passes through the spiral, it turns the spiral but in the opposite direction as the cold air. This type of air movement can be seen when you watch gliders and big birds use the air's *thermals* to lift them in the air as they glide in spirals in this hot air upwards.

<u>Physical World</u>

24	Sticky static	To demonstrate how static charges repel things

Materials needed: 2 strips of 20cm cellotape

Procedure:

1. Press two pieces of cellotape onto a table leaving a small piece hanging over the edge
2.Hold the ends tight and quickly pull both pieces off the table
3.bring the two pieces near each other but don't let them touch
4.Observe what happens

What happened:

The pieces of cellotape move away from each other

Why did this happen:

Everything in the universe is made up of atoms which have a positive (+) centre and negatively (-) charged electrons spinning around it. Pulling the tape off the table causes both tapes to pick up negative static electricity charges (electrons) from the atoms in the table. Both pieces of tape are now negatively charged. Materials with the same charge repel each other

Physical World

25	Cup telephones	To demonstrate how sound travels

Materials needed: 2 paper/plastic cups, 10 m string, 2 match sticks, partner
Procedure:
5.Use a sharp pencil or nail to make a small hole in the bottom of each cup
6.Thread the ends of the string through the holes and time each end around a match stick inside the cup so that the string does not pull back through the hole
7.Have your partner hold one cup while you hold the other and move apart so that the string becomes taut. be careful you don’t damage the cups or string.
8.Hold your cup to your ear while your partner talks into their cup. Reverse roles.
9.Observe what happens
What happened:
Your partner’s words are loud and clear inside your cup
Why did this happen:
Sound is made by vibrating objects and can travel through solid objects like paper cups and string. Our vocal cords make sounds by vibrating the air in our mouths which then travel into the cup and makes the base vibrate, that in turn makes the string vibrate and when that reaches the other cup, that cup vibrates and the air inside the cup vibrates. The listeners cup amplifies the sound which goes into our ears. When these reach the ear, the ear turns that into sound when it strikes the eardrum. These vibrations travel through bones and fluids in the air and jaw until they reach a nerve that sends the message to the brain.