Scientist Badge
Pack Holiday 1997

Topics

Electricity and Magnets

Movement and Mechanics
The Natural World
Light
Floating and Sinking

Electricity and Magnets

Materials needed for Electricity and Magnets.

Glass jar.	Large Needle.	Saucer.
Plastic comb.	Woollen jumper/felt.	Tissue paper.
Balloons.	Thread.	Plastic pen.
Table tennis ball.	Plastic straws.	Salt
Finely ground pepper.	Iron or steel nail.	Wires.
Tape.	Copper coins.	4 Pieces of zinc.
Blotting paper.	Lemon.	Bulbs.
Steel wool.	Magnets.	Paper Clips.
Corks.	Bowl.	

Static Electricity

Electricity was first discovered by the Greeks in about 600BC. A man called Thales found that when he rubbed a piece of amber with some cloth, the amber attracted small objects. (Amber is hardened sap from trees) In about 1570AD an Englishman called William Gilbert carried out similar investigations. He called the effects he saw '***electricity***', after the Greek word for amber, which is *elektron*. The type of electricity with which Thales and Gilbert experimented is called static electricity, which means it does not move.

Making Static

Equipment: A plastic comb, woollen jumper, tiny bits of tissue paper.

Method: Rub the comb several times on the woollen jumper. Then hold the comb close to the pieces of tissue paper. What happens to the paper?

Expected Result: The paper should be attracted to the comb.

Explanation: When the comb is rubbed on the jumper, it becomes charged with static electricity and attracts the pieces of paper.

Static charges can be positive or negative. An object with one kind of static charge will attract an object, with the opposite charge. In this experiment the comb has a negative charge and it attracts the paper, which has a positive charge.

Bending Water Trick

Equipment: Comb, running tap.

Method: Rub a plastic comb to charge it with static electricity and then turn on a tap so the water runs in a thin stream. Hold you charged comb close to the water and watch what happens to the water.

Expected Result: The water will bend towards the comb.

Explanation: The water bends towards the comb because it is attracted by the static electricity in the comb.

Sticky Balloons

Equipment: Balloons.

Method: This trick shows you how to stick a balloon to the wall without using any glue. Rub a balloon several times on a woollen jumper and then hold it against a wall. The strong static charge on the plastic skin of the balloon will make it cling to the wall as if it is glued there.

Explanation: There is a difference between the charge on the balloon and the charge on the wall, so the balloon is pulled towards the wall. It will stay there until the static charge wears off.

The Unfriendly Balloons

Equipment: Balloons, thread. thin stick.

Method: Tie two balloons together with a piece of thread. Ask a friend to hold a thin stick in front of him. Hang the thread over the stick so the balloons are next to each other. Then rub each balloon long and hard with a woollen jumper. Let go of the balloons and see what happens.

Expected Result: When you let the balloons go, they will try to push each other away.

Explanation: When you rub the balloons, you are giving them the same kind of static charge. Things that have the same charge try to push away (repel) each other.

Rolling Tricks

Equipment: A plastic pen, felt or woollen material, table tennis ball, plastic straws.

Method: Rub the plastic pen very hard with the felt or wool. Put the table tennis ball on a smooth table top and hold the pen close to the ball. The ball will seem to move at the command of your 'magic wand'. Which way does it roll, towards the pen or away from it? Now put two straws parallel to each other, with a third laying across them. Rub the pen with the felt or wool and hold the side of the pen close to the straw which is on top of the others. Can you work out why some things move towards the pen and others move away?

Explanation: They will repel if they have the same charge, and attract each other if they have the same charge.

Separate Salt from Pepper

Equipment: Salt, pepper (finely ground), plastic comb or pen, felt or wool.

Method: Sprinkle a little salt and pepper on to a plate. Rub the pen or comb very hard with the felt or wool. Hold the pen or comb very close to the plate and move it slowly over the salt and pepper mixture. What happens?

Expected Result: The pepper will jump up to the pen or comb but the salt will stay behind.

Explanation: Both the salt and pepper are attracted by the static charges on the pen or comb, but the pepper rises first because it is lighter than the salt. If you hold the pen or comb too close to the plate you will pick up the salt as well.

Electricity in the Sky

Although you may not realise it, you will already have come across one kind of static electricity. This is the powerful ‘electricity in the sky’ which we call ***lightning***. In a storm cloud, the moving air makes tiny water droplets and ice particles rub together so they become charged with static electricity. The positively-charged particles rise to the top of the cloud and the negatively-charged particles sink to the bottom of the cloud.

The negative charges in the cloud are strongly attracted to the ground. They leap from cloud to cloud or from the cloud to the ground as giant flashes of lightning. The lightning makes the air so hot that it explodes with loud booms of thunder.

In 1753, an American scientist, Benjamin Franklin, decided to investigate the charge in storm clouds. He did this in an experiment that was so dangerous he was lucky not to have been killed. On a stormy day he flew a large kite on a very long line up into a black, mountainous storm cloud. He tied a large iron key to the bottom of his line and when the electrical charge ran down the wet kite line and hit the key, sparks flashed. Luckily he was not hurt and his investigations led to the invention of lightning conductors.

Lightning often strikes the first point it reaches on its journey to the ground, so tall buildings are most likely to be hit. If you look up at church spires and tall buildings, you can sometimes see a metal strip going down the side of the building. This is called a ***lightning conductor*** and it is usually made of copper. If lightning strikes the top of the building, electricity will flow safely down the copper strip to the earth instead of damaging the building.

How far is the Storm?

Light travels so quickly (about 300 000 kilometres -186,416 miles- in one **second**!) that we see a bright flash of lightning instantly. But we have to wait a few moments before we hear the thunder. This is because sound travels much more slowly than light - at only 330 metres in one second (750 miles an hour).

During a storm, wait until you see a flash of lightning, then start to count slowly. For every count of three, the storm is roughly one kilometre away (a count of five means the storm is about one mile away)

<u>Electricity on the Move</u>

The electricity we use in our homes and schools is different from static electricity because it moves from place to place. It flows through wires in the same way that water flows through a hose. We call this flow an electric ***current***.

Making Electricity

An electric current was first generated in 1831 by Micheal Faraday. He moved a magnet in and out of a coil of wire and found that this made an electric current flow through the wire.

This was a very important discovery which led to the invention of the ***dynamo***. Nowadays, we still use dynamos to make almost all our electricity and much of our present way of life is based on Faraday's discovery.

Power Stations

Most of the electricity we use in our homes, schools, shops and factories is made (***generated***) in power stations. In a power station, fuel such as coal or oil is burned to heat water and turn it into steam. The steam pushes a huge wheel, called a ***turbine***, round at very high speeds. The turbine turns a massive dynamo called a ***generator***, which makes electricity.

From the power station, the electricity is carried along thick wires called cables until it reaches our homes or other buildings. The wires may be buried under the ground or they may be hung from tall towers called ***pylons***.

To send the electricity over long distances, it first goes through a device called a ***transformer***. This increases the voltage of the electricity, (voltage is the pressure which pushes electricity along a wire) and makes it cheaper to move. When the electricity reaches towns or cities, the power is reduced back to the right level for the machines we use by another transformer.

Battery Power

The first battery was made in 1800 by an Italian scientist, Alessandro Volta. Volta discovered that some metals and a liquid could work together to produce electricity. he made a sandwich of paper soaked in salt water between a piece of silver and a piece of zinc. When he joined the two metals with a wire, he found that a current flowed through the wire. As the current was very weak, he make a pile of these ‘sandwiches’ and then he got sparks of electricity. Voltas battery came to be known as the ***Voltaic Pile.***

Make your own Battery

Equipment: Two piece of wire, sticky tape, 4 copper coins, 4 pieces of zinc, blotting paper soaked in salty water.

Method: Sandwich a piece of the salty paper between a coin and piece of zinc. Tape the bare end of one wire to the coin and lay your sandwich down with the wire on the bottom. Now make three more and put them on top. Finally tape the bare end of the other wire to the piece of zinc on top of your Voltaic pile. Now take the free end of each wire and touch both ends lightly on to your tongue. Can you feel a tingle of electricity?

Explanation: In your voltaic pile, chemical reactions cause a tiny electric current. The current flows from one wire, through your tongue and into the other wire. The current is just enough to make your tongue tingle.

Can you get Electricity from a Lemon?

Equipment: Lemon, copper coin, zinc piece.

Method: Make two slits in the skin of a lemon and push a copper coin into one slit and a piece of zinc into the other slit. Make sure the two metals are not touching each other inside the lemon. If you hold the coin and the zinc gently against your tongue, you should be able to feel a tingle of electricity.

Explanation: The current flows because a chemical reaction takes place between the metals and an acid in the lemon juice. The lemon juice acts in the same way as Volta’s salt water or the chemical paste in a battery.

Investigating Circuits

To make electricity come out of a battery, you need to give it a path, such as a wire, to move along. Electricity can only move in one direction, so you need to attach a wire from one end (***terminal***) of the battery to the other end. This loop of wire is called a ***circuit***. As long as the circuit is complete, electricity will flow. If there is a gap in the circuit, electricity will not be able to flow.

Make a Simple Circuit

Equipment: Batteries, some wire, small torch bulb.

Method: See if you can make the bulb light up. Inside the bulb you can see a tiny coiled wire. This is called the filament. See if you can make the bulb light up. Inside the bulb you can see a tiny coiled wire. This is called the ***filament***. Electricity can flow through the filament if you touch one wire to the side of the bulb and the other wire to the bottom of the bulb. What happens if you link two batteries into your circuit? What happens if you put the two negative or the two positive battery ends together?

Glowing Wool Trick

Equipment: A battery, two wires, some steel wool (the kind used for cleaning pots and pans)

Method: Pull out one long strand of steel wool and pin it to a board. Attach one wire to one end of the battery and the other wire to the other end. With the free ends of both wires, touch the strand of steel wool. What happens?

Expected Result: The steel should heat up and glow.

Explanation: The electrical current flows easily through the wires but has more difficulty passing through the thin strand of steel wool. This makes the steel heat up and glow red hot. With a powerful battery, it may even melt and break.

There are very thin wires in the ***fuses***, which are fitted into the electrical machines, circuits and plugs in our homes. If something goes wrong with the wiring, the thin fuse wire quickly melts and makes a gap in the circuit. This cuts off the electricity supply and prevents a fire.

Circuit Challenge

Can you link three bulbs to one battery so that all three bulbs light up at the same time? When you have done this, try taking one of the bulbs out of the circuit. Do the other bulbs go out as well?

There are two different ways of wiring several bulbs into a circuit. One way is to wire up all the bulbs on one circuit. This is called a ***series*** circuit. The bulbs give out only a dim light because they are all sharing the same power. If you take out one bulb, it breaks the circuit, and the other bulbs go out as well.

The other way of wiring up the bulbs is to give each bulb a separate circuit. These are called ***parallel*** circuits. If you wire up your three bulbs like this, each bulb will look almost as bright as one bulb in a circuit on its own. If you take out one bulb, the other bulbs will all stay on.

Conductors and Insulators

Some materials let electricity flow through them. They are called conductors. Other materials stop electricity passing through them. They are called insulators. We use conductors to carry electricity to where it is needed and we use insulators to stop it leaking into places where we do not want it to be.

Conductor or Insulator?

Equipment: Battery, bulb, wires, various objects (coin, paper clip, plastic pen top, glass, fork, wooden spoon, tin foil, cardboard, key, eraser, stone, pencil etc.)

Method: Join the bulb to one end of the battery. Join the wires to the bulb, and one to the other pole of the battery. Touch the wires together to make sure the bulb lights up and there is no loose connections. Now touch the ends of both wires to the objects in your collection. Does the bulb light up?

Put all the things which made the bulb light up in one pile. These are the conductors. What are they made from?

Put all the things that did not make the bulb light up into another pile. They are the insulators. What are they made from?

Steady Hand Game

Equipment: Block of wood about 16 by 8 inches, wire coat hanger pair of pliers, hammer, wire staples, battery, bulb in bulb holder, wire, tape.

Method: Use the pliers to cut a short piece of wire from the coat hanger. Bend the wire into a loop but leave the end open. Join a short length of wire to the open loop and join the other end of this wire to the bulb holder. With another piece of wire, join the other side of the bulb holder to the battery. Bend the rest of the coat hanger into a long, wavy line. Wind tap around both ends of this wavy line of wire. Join one end of the wavy wire to the battery with some wire. Put the wavy wire on to the wooden board and hammer a wire staple over each end of the wire to hold it upright. Bend the end of the open loop around the wavy wire and join up the loop with the pliers. Decorate the board. Try replacing the bulb with a small buzzer.

Can you or your friends move the loop all the way along the wavy line without making the bulb flash? If your hand shakes, the loop will touch the wire and complete the circuit. Electricity will flow along the wire and the bulb will flash.

Magnets

More than 2000 years ago, the ancient Greeks discovered a strange rock which could attract pieces of iron. Nearly 1000 years later, Chinese sailors used a piece of the same kind of rock to make a simple compass for their ships. If they hung the rock from a thread, they found that it always pointed North and South.

Nowadays, one name for this rock is ***lodestone*** which means 'the stone that leads'. Another name is ***magnetite*** which comes from the area of Magnesia, where the rock was first discovered. Material with the same properties as magnetite can be made into magnets.

Magnetic Attraction

Equipment: Magnet, collection of things to test.

Method: Touch the end of the magnet to each of the objects in your collection. Some of them will seem to stick to the end of the magnet as if they are glued there. Now try moving the magnet slowly towards each object and watch carefully. Small things will seem to leap towards the magnet.

Put all the things that stick to the magnet in a separate pile. What are they made from?

Does a magnet attract objects along its whole length or just at the ends?

Magnetic Fishing and Boating

Equipment: Magnetic fishing rods (thin stick with magnet on the end), card fishes, paper clips, pins, corks, paper, bowl.

Method: Draw and colour fish shapes on thin card and cut them out. Write a different number of each fish and stick a paper clip on the back of each fish. Put them in a large box. To play the game, take it in turns to use the magnetic rod to pull a fish out of the box. Keep the score by counting the numbers on the fish you catch.

Make little boats from pieces of cork, with a pin as a mast. Draw and colour paper triangles to make the masts. Float the boats in a bowl of water. Use the magnetic rods to steer the boats around the bowl and have a boat race with your friends.

Paper Clip Trick

Equipment: Glass jar, paper clip, magnet.

Method: Fill the jar almost to the top with water. Drop a paper clip into the bottom of the jar. Can you get the paper clip out of the jar without getting your fingers wet?

Expected Result: If you hold a magnet outside the jar next to the paper clip and slowly slide the magnet up the jar, the paper clip will come up with it. At the top of the jar the paper clip will stick to the magnet and you can lift it out of the jar.

<u>Magnetic Forces</u>

The strange invisible force that surrounds a magnet can be seen if iron filings are sprinkled onto a piece of paper with a magnet on it. The filings cluster together in places where the force is strongest. A lot of filings stick to the ends of the magnet.

The ends of a magnet are called ***poles*** and every magnet has a North Pole and a South Pole. The north pole is sometimes red. Tie a thread around a magnet so it balances horizontally when you let it swing freely. The magnet will turn so the north poles faces north and the south pole faces south. This is because the Earth acts as if it has a gigantic bar magnet through the earth from one pole to the other.

A compass needle does not point to the true north pole. Instead it points to a spot somewhere in Canada which is a long way to the west of the true north pole.

Make a Compass

Equipment: A large needle, small cork, magnet, saucer of water.

Method: First you need to turn the needle into a magnet.

This is called ***magnetising*** the needle. To do this, stroke one pole of the magnet gently along the whole length of the needle in the same direction 20 times. Inside the needle, the little particles (***domains***) which make up the metal are usually pointing in different directions. As you stroke the needle with the magnet, the particles all line up and point in the same direction. As long as the particles stay in line, the needle will act like a magnet.

Lay the magnetised needle on the cork and float it in a saucer of water.

Expected Result: The needle will swing round to point in a North-South direction.

Explanation: The ends of the needle are attracted by the poles of the earth’s magnetic field.

<u>Making Magnets with Electricity</u>

In about 1820, a Danish scientist, Hans Christian Ørsted, discovered that electricity flowing through a wire close to a compass needle made the needle swing away from the North-South direction. Scientists have since found many links between electricity and magnetism. For example, when electricity flows through a coil of wire which is wrapped around an iron or steel bar, the bar turns into a magnet. It is called an ***electro-magnet***.

Make an Electro-magnet

Equipment: Battery, switch, iron or steel nail about 6 inches long, some covered wire about 2 to 3 feet long, a box of pins or paper clips.

Method: Join the wire to the battery and the switch. Wind the wire around the nail about ten times. Join the other end of the wire to the battery terminal to complete the circuit. Switch on the electric current and dip the end of the nail into the box of pins or paper clips. What happens? Are there any pins or clips attracted to you electro-magnet? Switch off the current. What happens now?

Now wind the wire around the nail ten more times and repeat. Can you pick up any pins this time?

Finally wind the wire in tight coils along most of the nail. Repeat the experiment to see if the extra wire makes the magnet weaker or stronger.

Explanation: The electricity flowing through the tight coils of wire creates a strong magnetic force from one end of the coil to the other. The force lines up all the magnetic particles in the nail and turns it into a magnet. With more coils the magnetic force is stronger.

If your nail is made from iron, you will find that when you switch off the electricity, the pins or clips fall off the nail. Iron is only magnetic as long as electricity is flowing in the wire. It is a ***temporary*** magnet. But if your nail is made from steel, it stays magnetic even when the electricity is switched off. It is a ***permanent*** magnet.