The electrostatic shoelace

The Czech Republic

An everyday example of electrostatics

You will need...

✔ a synthetic shoelace

Background

Electrostatic charges can be produced by friction. Like charges repel.

Follow these steps

Stroke a shoelace between your thumb and forefinger several times, then hold it a few centimetres from the end.

So what happened?

The shoelace becomes electrostatically charged and stands upright. Several types of shoelace may need to be tested to find one that works well.

What next?

Try charging different materials.

Repelling straws

Spain

Like charges repel whereas unlike charges attract

Background

There are two kinds of charge: positive and negative. Forces of repulsion and attraction appear with like and unlike charges. Charging by friction is useful for charging insulators: rubbing a plastic straw with fur gives the straw a negative charge; rubbing the straw with silk gives it a positive charge.

You will need...

- ✔ a wooden frame (about 20 × 30 cm)
- ✔ six screws
- ✔ some fishing line (1 m)
- ✔ three plastic straws
- ✔ different cloths (e.g. silk, fur, wool)

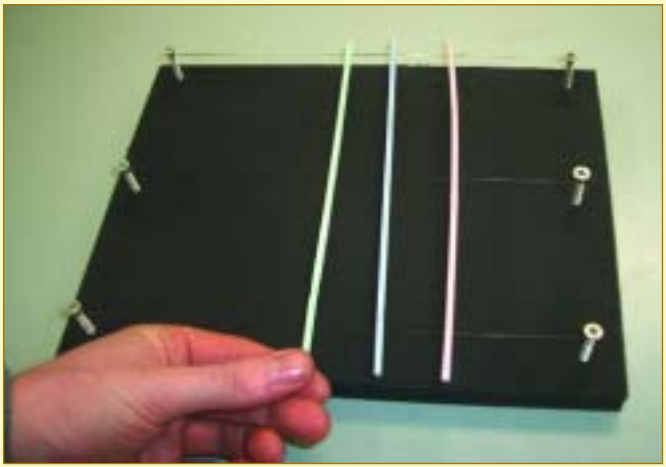
Follow these steps

1 Fix the screws near the long sides of the frame (see picture).
2 Attach the fishing line between the pairs of screws to make taut supports for the straws (preferably use three).
3 Charge the straws by friction, rubbing one with fur and one with silk.
4 Rest one of the straws across the wires.
5 Bring the second straw close to the first one and see what happens.
6 Charge a third straw by rubbing it with silk and place it between the other two.
7 Note what happens to the first two straws.

So what happened?

Rubbing one straw with fur and one with silk means that they have opposite charges so they attract each other.

Charging two straws with the same material means that they will have like charges and will therefore repel each other.



What next?

Try using different coloured straws to distinguish between positive and negative charges. Also try different types of material and then determine what type of charge is on each of the straws.

This exercise can also be extended to show charging by induction.

Seeing alternating current in a bulb

Belgium

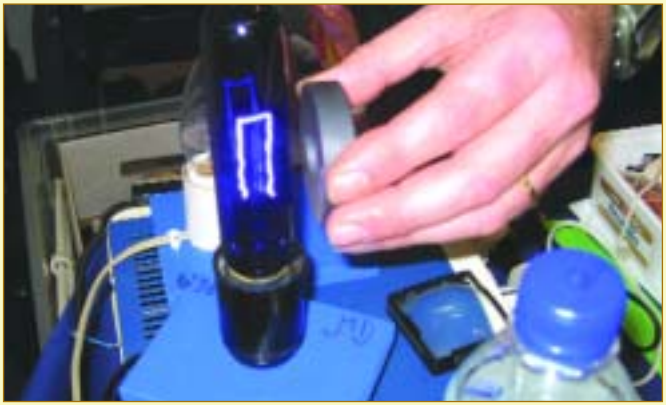
Mains current is alternating

You will need...

- ✔ a clear light bulb
- ✔ a powerful magnet
- ✔ a mains source

Background

Mains supply electricity is an alternating current with a frequency of 50 Hz.



Follow these steps

1 Connect the light bulb to the mains supply.
2 Bring the magnet close to the glowing bulb.

So what happened?

The filament vibrates when the magnetic field is present.

In the presence of the magnet, the filament of the bulb acts as a conductor in a magnetic field and therefore experiences a force.

The alternating nature of the current produces a varying force, resulting in the vibration of the filament.

The effect is best seen in a bulb that has a long filament, which can be found in certain ornamental bulbs. An ordinary candle bulb can also be used.

What next?

You can use a convex lens to project a magnified image of the filament onto a suitable screen or wall, thereby making the vibrations easier to see.

Making a simple induction motor

Hungary

How does an induction motor work?

You will need...

- ✔ wire coiled round an iron core (12,000 turns; use a demountable transformer kit)
- ✔ an aluminium can
- ✔ a 1 mm thick aluminium ring
- ✔ a 6–12 V AC power supply
- ✔ a pencil
- ✔ a piece of BluTack

Background

This is a simple induction motor that can be made if you have a demountable transformer kit.

Follow these steps

1 Mount the coil on one arm of the core.
2 Remove the top of the can.
3 Position the pencil pointing upwards with the BluTack.
4 Place the inverted can over the pencil so that it balances on the pencil tip and can rotate freely.
5 Position the can so that one end of the transformer core faces it.
6 Shield half of the core that is facing the can with the aluminium ring.
7 Connect the coil to the power supply and see what happens.

So what happened?

The can rotates owing to electric currents in the can induced by the magnet.

What next?

For an explanation of the principle behind this type of induction motor, see any text on shaded-pole induction motors. These motors are common – they are used to drive washing-machine pumps and the cooling fan of overhead projectors.

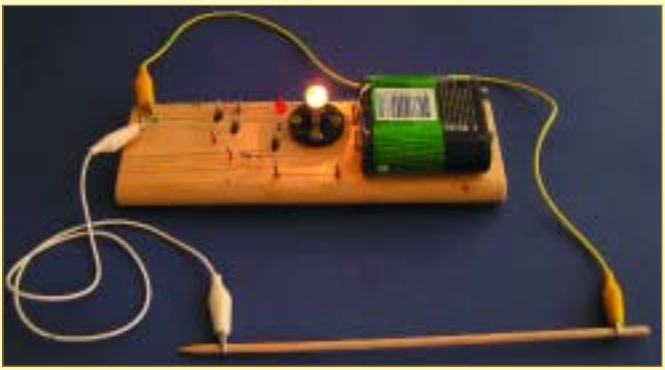
The Darlington trio

The Czech Republic

A simple circuit demonstrates several electrical phenomena

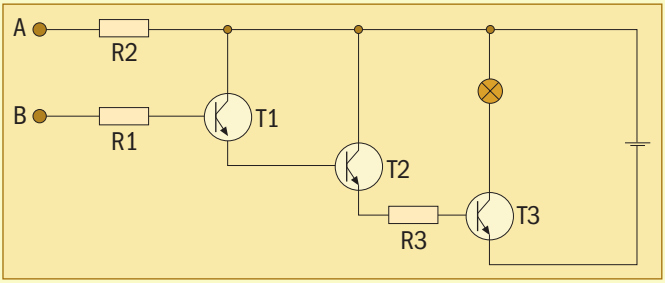
Background

The configuration of the circuit is known as a Darlington trio.



Follow these steps

1 Set up the circuit shown in the diagram.
2 Place the leads of A and B across the wooden skewer.
3 Hold lead A (let lead B hang in air) then rub your foot on the ground.
4 Move a charged object close to lead A.



So what happened?

The amplified output of the first transistor is fed onto the base of the second transistor, so there is a cascade effect. The circuit can detect currents in the order of nanoamperes.

When the leads are placed on the wood, the bulb lights up, showing that wood is not a perfect insulator.

When you hold lead A, let lead B dangle and rub your foot on the ground, the bulb lights because the circuit is able to detect the static electricity generated.

When you move a charged object close to lead A, the bulb lights only when the charge moves.

You will need...

- ✔ three transistors (BC337 or BC547)
- ✔ resistors (R1 = 10 MΩ, R2 = 1 MΩ and R3 = 15 kΩ, but their values aren't critical)
- ✔ a 35 V/0.2 A light bulb
- ✔ a 4.5 V battery
- ✔ a wooden skewer

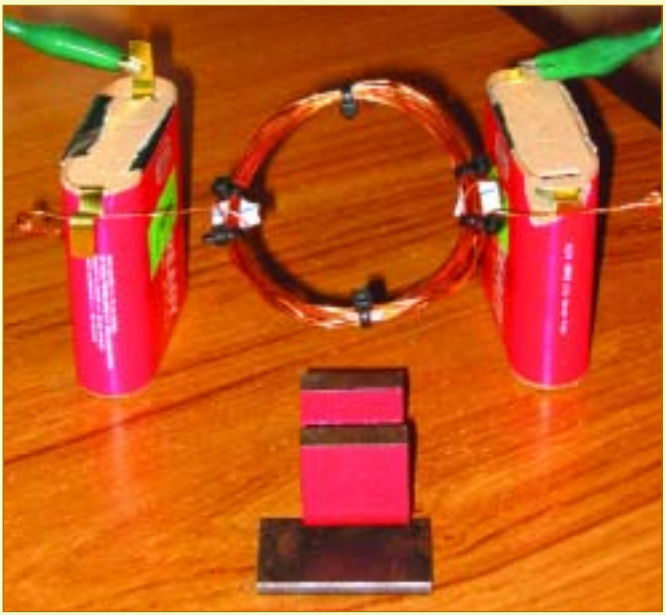
What next?

Sockets can be added to the circuit so that it can be connected to a digital voltmeter and a cathode-ray oscilloscope to measure currents and view signals.

Making a simple electric motor

Slovakia

How does an electric motor work?



You will need...

- ✔ some lacquered copper wire
- ✔ two bicycle/head torch batteries (4.5 V)
- ✔ a strong magnet
- ✔ some sandpaper
- ✔ a piece of cable

Background

Using a few inexpensive components, it is easy to construct a simple electric motor.

So what happened?

The coil receives torque for only half of each rotation and its angular momentum is enough to keep it turning.

Follow these steps

1 Using the lacquered copper wire, make a coil of about 10 turns (the ends of the wire will form the axles of the coil).
2 Remove all of the lacquer coating from one of the axles using the sandpaper.
3 Remove the lacquer from only one side of the other axle.
4 Bend the battery terminals so that they can support the ends of the coil.
5 Place the coil so that one axle sits in the positive terminal of one battery and the other sits in the negative terminal of the other battery.
6 Complete the circuit by connecting the two batteries with a piece of cable.
7 Place the magnet near the coil and give the coil a single turn by hand.