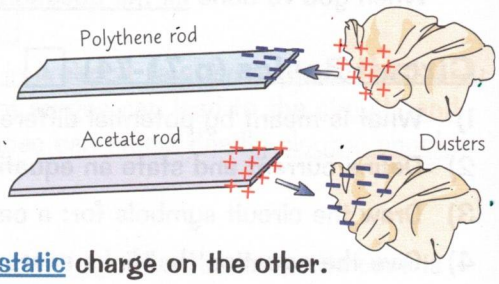
Static Electricity

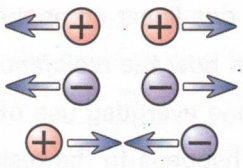
Static electricity builds up on insulating materials and often ends with a spark or a shock.

Build-up of Static is Caused by Friction



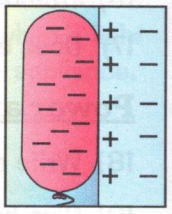
1) When certain insulating materials are rubbed together, negatively charged electrons will be scraped off one and dumped on the other.
2) As the materials are insulators, these electrons are not free to move — this build up of charge is static electricity. The materials become electrically charged, with a positive static charge on the one that has lost electrons and an equal negative static charge on the other.
3) Which way the electrons are transferred depends on the two materials involved. But whether an object has a positive or negative charge, it's always the negative electrons that have moved.
4) The classic examples are polythene and acetate rods being rubbed with a cloth duster (shown above).

Like Charges Repel, Opposite Charges Attract



1) Electrically charged objects exert a force on one another.
2) Two things with opposite electric charges are attracted to each other, while two things with the same electric charge will repel each other.
3) These forces get weaker the further apart the two things are.
4) One way to see these forces is to suspend a rod with a known charge from a piece of string (so it is free to move). Placing an object with the same charge nearby will repel the rod — the rod will move away from the object. An oppositely-charged object will attract the rod, causing it to move towards the object.

Electrically Charged Objects can Attract Uncharged Objects



1) Rubbing a balloon against your hair or clothes transfers electrons to the balloon, leaving it with a negative charge. If you then hold the balloon against a wall it will stick, even though the wall isn't charged.
2) That's because the charges on the surface of the wall can move a little — the negative charges on the balloon repel the negative charges on the surface of the wall.
3) This leaves a positive charge on the surface, which attracts the negatively charged balloon. This is called attraction by induction. And there are plenty more examples of it, too...
4) If you run a comb through your hair, electrons will be transferred to the comb making it negatively charged. It can then be used to pick up little pieces of uncharged paper — holding it near the little pieces of paper causes induction in the paper, which means they jump up and stick to the comb.

Too Much Static Causes Sparks

For more on how sparks actually jump across gaps, see page 84.

1) As electric charge builds on an object, the potential difference between the object and the earth (which is at 0 V) increases.
2) If the potential difference gets large enough, electrons can jump across the gap between the charged object and the earth — this is the spark.
3) They can also jump to any earthed conductor that is nearby — which is why you can get static shocks from clothes, or getting out of a car.
4) This usually happens when the gap is fairly small. (But not always — lightning is just a really big spark.)

Stay away from electrons — they're a negative influence...

Electrons jumping about the place and giving us all shocks, the cheeky so-and-sos.

Q1 Jake removes his jumper in a dark room. As he does so, he hears a crackling noise and sees tiny sparks of light between his jumper and his shirt. Explain the cause of this. [3 marks]

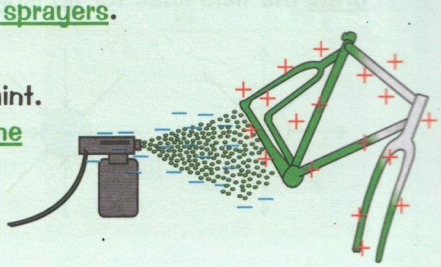
Uses and Dangers of Static Electricity

Static electricity can be a bit of a nuisance sometimes, but it also has some good uses, e.g. in industry. But don't get too happy clappy about how wonderful static electricity is — it can be pretty dangerous too.

Static Electricity Is Used in Electrostatic Sprayers

1) Photocopiers use static electricity to copy images onto a charged plate before printing them.
2) Static electricity can be used to reduce the dust and smoke that rises out of industrial chimneys.
3) Another use of static electricity is electrostatic sprayers:

- Electrostatic sprayers are used in various industries to give a fine, even coat of whatever's being sprayed. The classic examples are insecticide sprayers and paint sprayers.
- Bikes and cars are painted using electrostatic paint sprayers.
- The spray gun is charged, which charges up the small drops of paint. Each paint drop repels all the others, since they've all got the same charge, so you get a very fine, even spray.
- The object to be painted is given an opposite charge to the gun. This attracts the fine spray of paint.

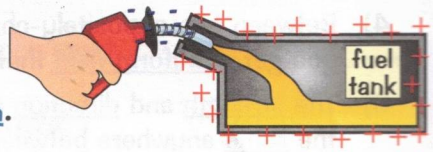


- This method gives an even coat and hardly any paint is wasted. In addition, parts of the bicycle or car pointing away from the spray gun still receive paint, i.e. there are no paint shadows.
- Insecticide sprayers work in a similar way, except the crops to be sprayed aren't given an opposite charge — the plants charge by induction as the insecticide droplets come near them (see p.82).

Static Electricity Can be Dangerous

Whilst there are some uses of static electricity, it can be inconvenient and sometimes even dangerous.

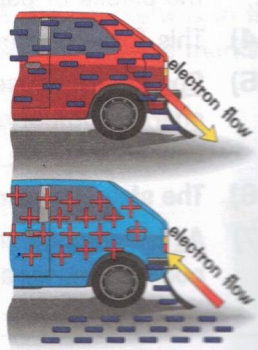
1) Refueling cars — as fuel flows out of a filler pipe, e.g. into an aircraft or tanker, then static can build up. This can easily lead to a spark (p.82) which might cause an explosion in dusty or fumey places — like when filling up a car with fuel at a petrol station.



2) Static on airplanes — as planes fly through the air, friction between the air and the plane causes the plane to become charged. This build up of static charge can interfere with communication equipment.
3) Lightning — raindrops and ice bump together inside storm clouds, leaving the top of the cloud positively charged and the bottom of the cloud negative. This creates a huge voltage and a big spark, which can damage homes or start fires when it strikes the ground.
4) You can reduce some of these dangers by earthing charged objects (see below).

Objects Can be Earthed to Stop Electrostatic Charge Building Up

1) Dangerous sparks can be prevented by connecting a charged object to the ground using a conductor (e.g. a copper wire) — this is called earthing.
2) Earthing provides an easy route for the static charges to travel into the ground. This means no charge can build up to give you a shock or make a spark.
3) The electrons flow down the conductor to the ground if the charge is negative and flow up the conductor from the ground if the charge is positive.
4) Fuel tankers must be earthed to prevent any sparks that might cause the fuel to explode.



I know, I know — yet another shocking joke...

As useful as static electricity can be, you've got to be aware of the dangers — and how to prevent them.

Q1 Give two uses of static electricity. [2 marks]