Static Electricity

Static electricity is all about charges which are not free to move. This causes them to build up in one place and it often ends with a spark or a shock when they do finally move.

Build-up of **static** is caused by **friction**

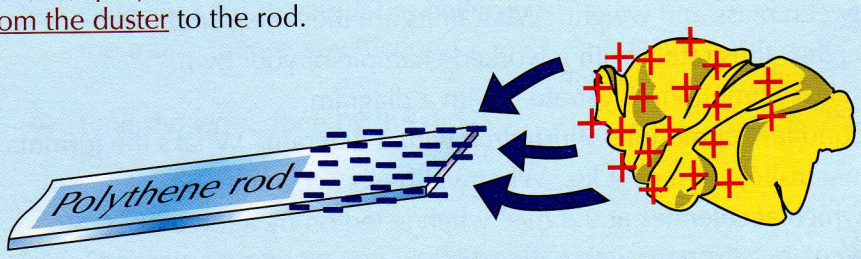
1) When two insulating materials are rubbed together, electrons will be scraped off one of them and dumped onto the other.

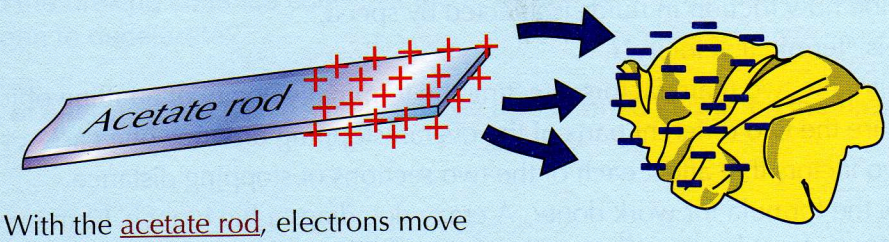
2) This will leave a positive static charge on one and a negative static charge on the other.

3) Which way the electrons are transferred depends on the two materials involved.

4) The classic examples are polythene and acetate rods being rubbed with a cloth duster, as shown in the diagrams below.

With the polythene rod, electrons move from the duster to the rod.





With the acetate rod, electrons move from the rod to the duster.

5) Electrically charged objects attract small objects placed near them. (Try this: rub a balloon with a cloth, then put the balloon near some bits of paper and watch them jump.)

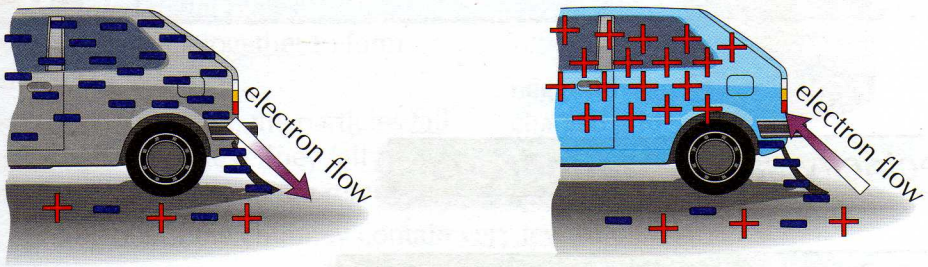
Static electricity is caused by electrons being transferred

Static electricity's great fun. You must have tried it — rubbing a balloon against your jumper and trying to get it to stick to the ceiling. It really works... well, sometimes. Bad hair days are caused by static too — it builds up on your hair, so your strands of hair repel each other. Which is nice...

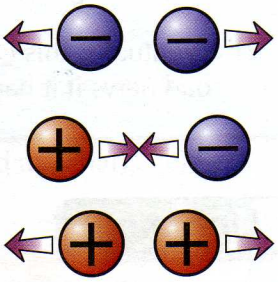
Static Electricity

Only electrons move — never the positive charges

1) Watch out for this in exams — both positive and negative electrostatic charges are only ever produced by the movement of the negative electrons. The positive charges definitely do not move.
2) A positive static charge is always caused by electrons moving away elsewhere and taking their negative charges with them, as shown on the last page.
3) A charged conductor can be discharged safely by connecting it to earth with a metal strap.
4) The electrons flow down the strap to the ground if the charge is negative and flow up the strap from the ground if the charge is positive.
5) The flow of electrical charge is called electric current (see page 91).



Like charges repel, opposite charges attract



This is easy and, I'd have thought, kind of obvious.

Two things with opposite electric charges are attracted to each other.
Two things with the same electric charge will repel each other.

These forces get weaker the further apart the two things are.

As charge builds up, so does the voltage — causing sparks

1) The greater the charge on an isolated object, the greater the voltage between it and the earth.
2) If the voltage gets big enough there's a spark which jumps across the gap.
3) High voltage cables can be dangerous for this reason. Big sparks have been known to leap from overhead cables to earth. But not often.

Static Electricity

They like asking you to give quite detailed examples in exams. Make sure you learn all these details

Static electricity is **annoying** more often than it is dangerous

Clothing clings and crackles

When synthetic clothes are dragged over each other (like in a tumble drier) or over your head, electrons get scraped off, leaving static charges on both parts. That leads to the inevitable — attraction (they stick together and cling to you) and little sparks or shocks as the charges rearrange themselves.

Static electricity can be **dangerous**:

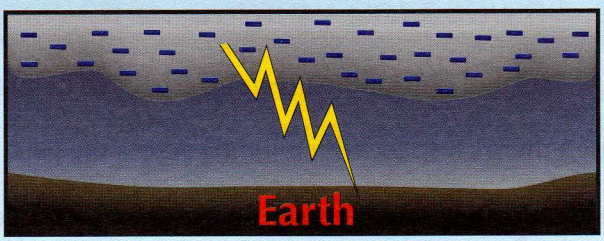
1) A lot of **charge** can build up on **clothes**

1) A lot of static charge can build up on clothes made out of synthetic materials if they rub against other synthetic fabrics — like when wriggling about on a car seat.

2) Eventually, this charge can become large enough to make a spark — which is really bad news if it happens near any inflammable gases or fuel fumes... KABOOM!

2) Lightning

Raindrops and ice bump together inside storm clouds, knocking off electrons and leaving the top of the cloud positively charged and the bottom of the cloud negative. This creates a huge voltage and a big spark.



So it's not just bad hair days and fun with balloons then

Lightning always chooses the easiest path between the sky and the ground — even if that means goi through tall buildings, trees or you. That's why it's never a good idea to fly a kite in a thunderstorm.

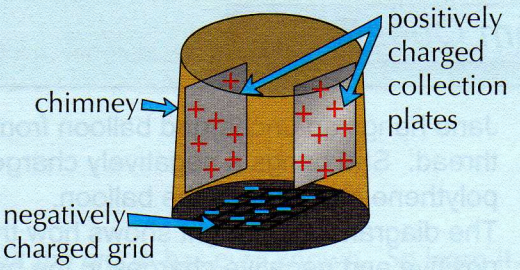
Uses of Static Electricity

Static electricity isn't always a nuisance. It's actually got loads of applications. Read on for some examples...

1) Dust precipitators — cleaning up emissions

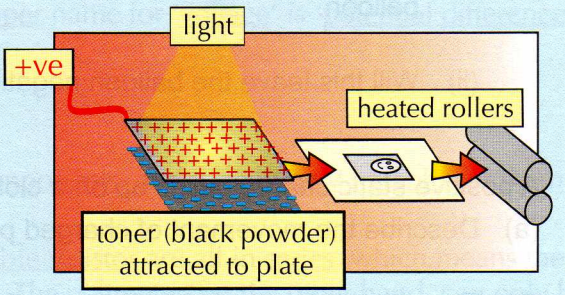
Smoke is made up of tiny particles which can be removed with a precipitator. There are several different designs of precipitator — here's a very simple one:

1) As smoke particles reach the bottom of the chimney, they meet a wire grid with a high negative charge, which charges the particles negatively.
2) The charged smoke particles are attracted to positively charged metal plates. The smoke particles stick together to form larger particles.
3) When they're heavy enough, the particles fall or are knocked off the plates. They fall to the bottom of the chimney and are removed.
4) The gases coming out of the chimney contain very few smoke particles.



2) Photocopiers — er... copying stuff

1) The image plate is positively charged. An image of what you're copying is projected onto this image plate.
2) Whiter bits of the thing you're copying make light fall on the plate and the charge leaks away in those places.
3) The charged bits attract negatively charged black powder, which is transferred onto positively charged paper.
4) The paper is heated so the powder sticks.
5) Voilà, a photocopy of your piece of paper (or whatever else you've shoved in there).
6) Laserjet printers work in a similar way. Instead of an image plate, the printer has a rotating image drum. And the light comes from a controlled laser beam.



Dust precipitators are important for the environment

Most power stations (see page 33) that burn fossil fuels have dust precipitators in their chimneys. Removing smoke particles means that the amount of pollution they give out is greatly reduced.

Warm-up and Exam Questions

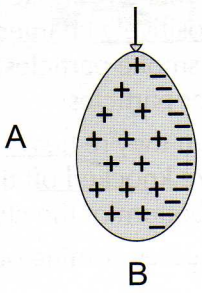
By this point you'll probably have worked out that static electricity isn't the most exciting of topics. Don't worry — there's just these few questions before you get on to much more interesting stuff.

Warm-Up Questions

1) What are the two types of electric charge?
2) Do similar charges attract or repel one another?
3) Suggest how a charged conductor might be safely discharged.
4) Describe a situation where static electricity can be dangerous.
5) What particles move when an electrically charged object is brought near another object?

Exam Questions

1 Jane hangs an uncharged balloon from a thread. She brings a negatively charged polythene rod towards the balloon. The diagram on the right shows how the positive and negative charges in the balloon rearrange themselves when she does this.



(a) In which of the positions labelled A, B and C on the diagram did Jane hold the polythene rod? Explain your answer.

(2 mark

(b) Why are the positive charges still spread evenly over the balloon?

(1 ma

(c) Jane brings the rod closer to the balloon. Why does the balloon swing towards it?

(2 mark

(d) Jane keeps the rod close to the balloon, then touches the negatively charged side of the balloon with her finger.

(i) Describe what happens to the negative charges when she touches the balloon.

(1 ma

(ii) Will this leave the balloon negatively charged, positively charged or neutral?

(1 ma

2 A positive static charge builds up on a cloth when it is used to wipe a surface.

(a) Describe the movement of charged particles that gives the cloth its charge.

(1 ma

(b) The cloth's charge makes it more effective at dusting. Why?

(1 ma

3 Lightning is one of the dangerous effects of static electricity.

(a) What causes the build-up of static electricity before lightning occurs?

(1 ma

(b) Describe the distribution of charge within a cloud before a lightning strike.

(1 ma

(c) A lightning rod is a metal spike fixed to the top of a tall building and connected to Earth by a conducting wire. Explain how lightning rods can protect a building.

(2 mar