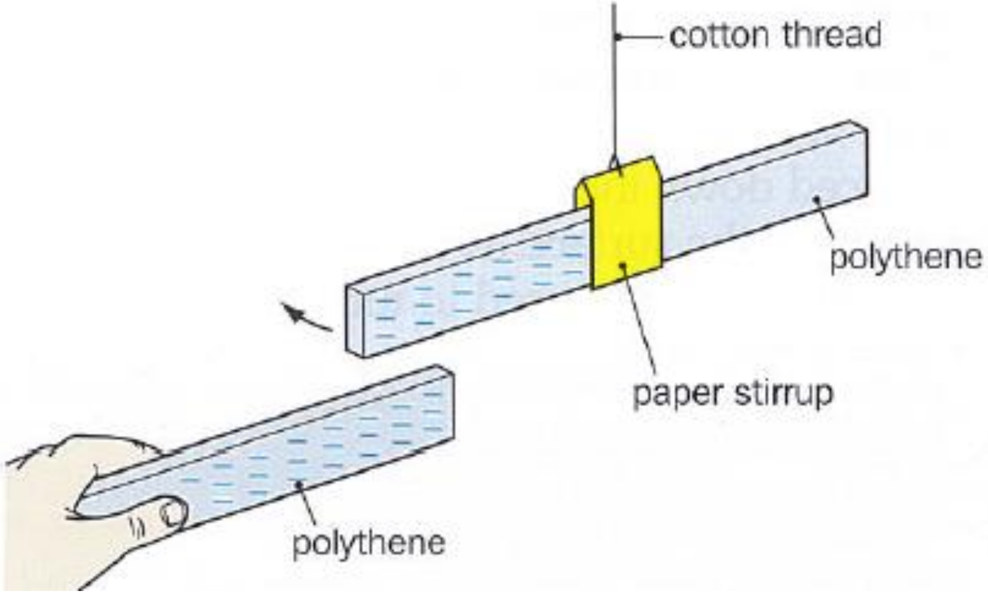
Electrostatics Term 3 Week 5

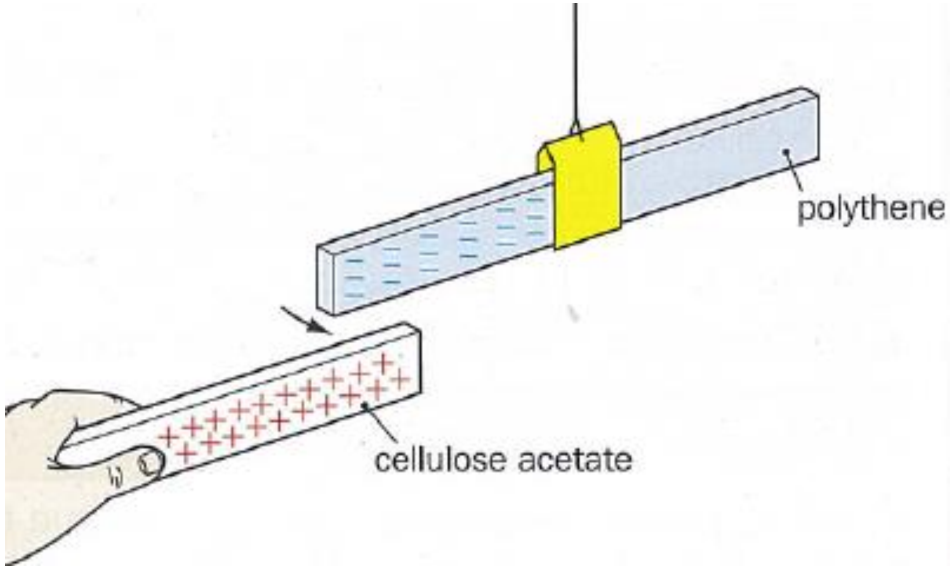
Background Notes

Objects are usually uncharged and so are electrically neutral.

Objects can become charged by friction, when one material is rubbed against another material.

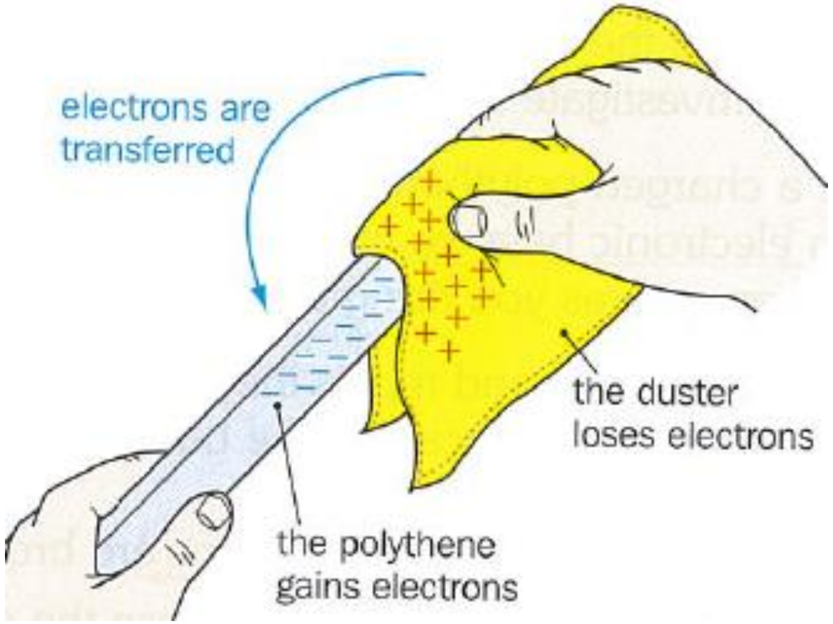
A charged object can attract an uncharged object, for example, small pieces of paper.





Charging occurs when ***electrons are transferred*** from one material to another.

Friction can transfer electrons

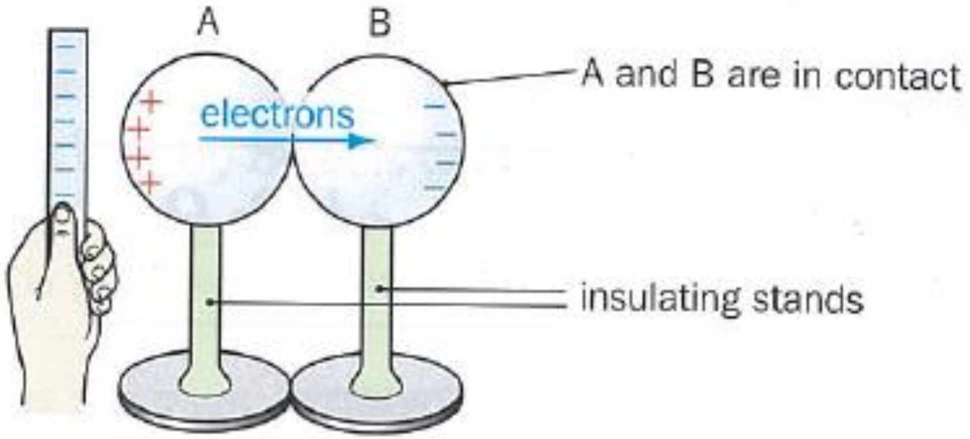


A conductor can only be charged if it is insulated from Earth.

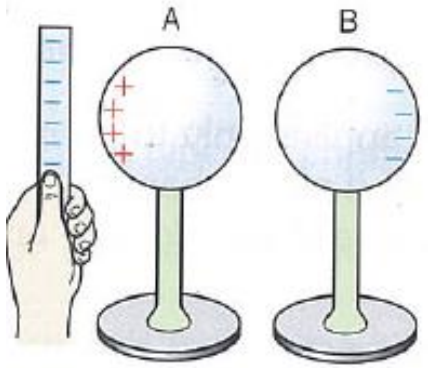
Charging by electrostatic induction

A charged conductor will share its charge with an uncharged conductor that is placed in contact with it. Electrons can flow between the two conductors because they are touching.

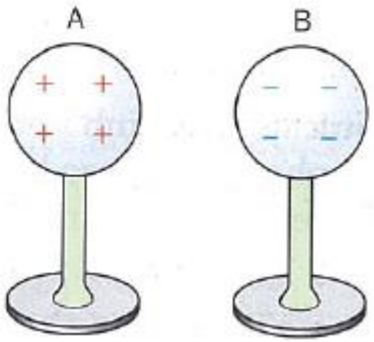
A charged strip can also be used to ***induce*** a charge in an uncharged conductor ***without*** touching it.



When a negative strip is brought close to 2 metal spheres, electrons from sphere A are repelled to sphere B.



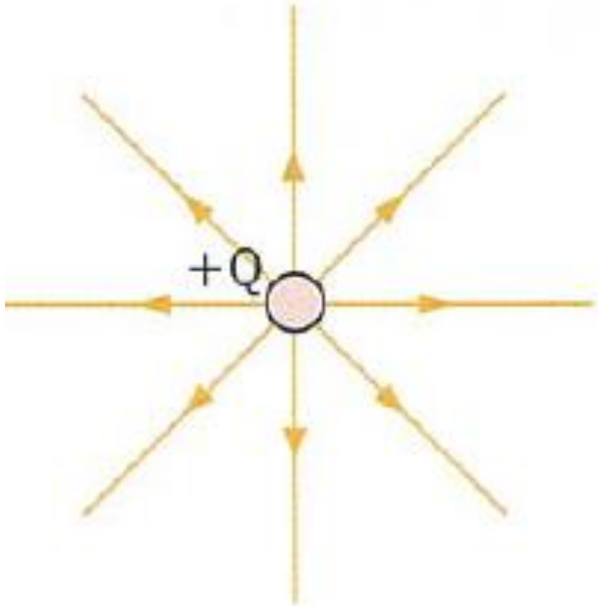
The spheres are separated with the strip still held nearby.



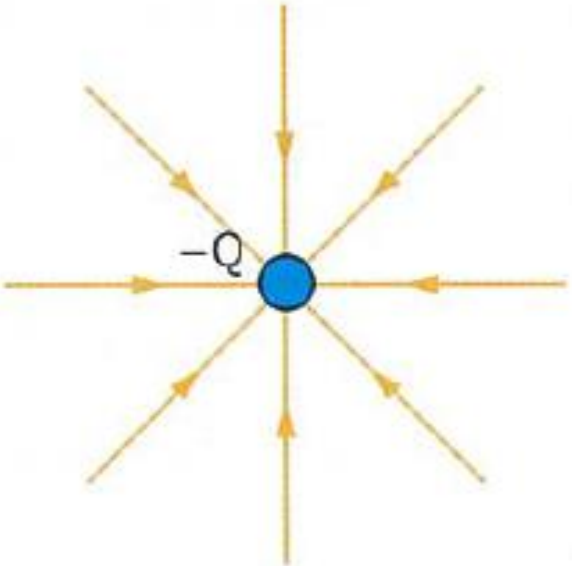
Then the strip is removed. The free electrons in each sphere now spread out, so that the charge is distributed evenly over the surface of each sphere.

Electric field strength E

The electric field strength at a point is the force per coulomb exerted on a positive charge placed at that point in the field.



This radial field is repulsive



This radial field is attractive

Electric Fields

The arrows on the field lines tell us the ***direction*** of the field.

This is defined as the direction of the force on a ***positive*** charge

The spacing of the lines tells us about the ***strength*** of the field.

Field Strength

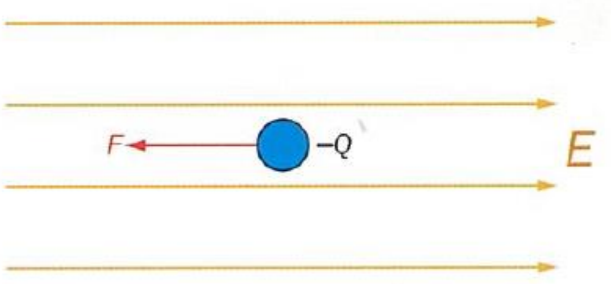
Electric field strength, *E* (N C^{-1}) $=$ $\dfrac{\textbf{Force, } F \text{ (N)}}{\textbf{charge, } Q \text{ (C)}}$

$$E = \frac{F}{Q}$$

$$F = Q\,E$$

Electric field strength *E* is a vector quantity. The direction of the field is the direction of the force on a positive charge.

The unit here for *E* is the N C^{-1}, but an alternative unit is the volt per metre (V m^{-1}).



The force on the negative charge −Q is in the opposite direction to E

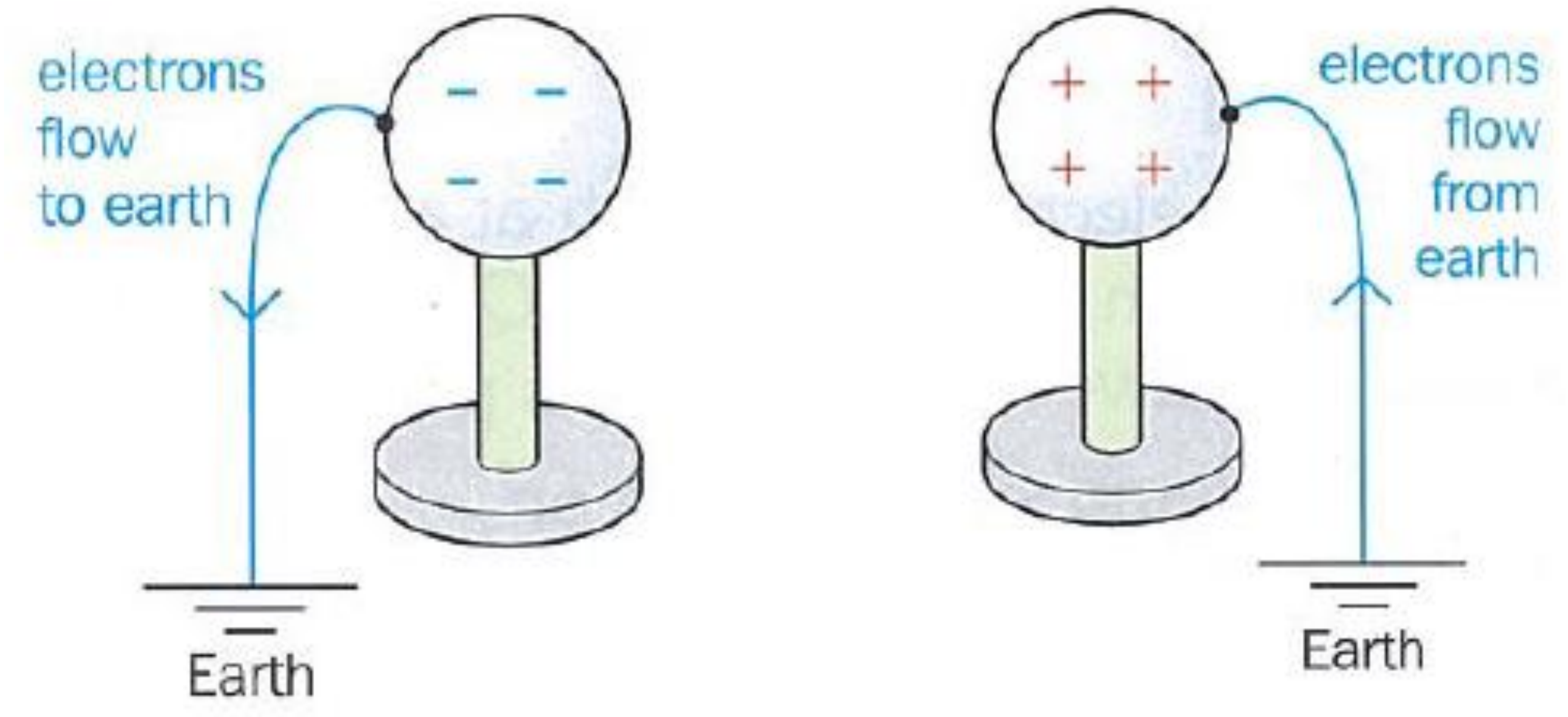
Electric Potential

When you move a charge in an electric field its potential energy changes. This is like moving a mass in a gravitational field.

The **electric potential *V*** at any point in an electric field is the ***potential energy that each coulomb of positive charge would have if placed at that point in the field.***

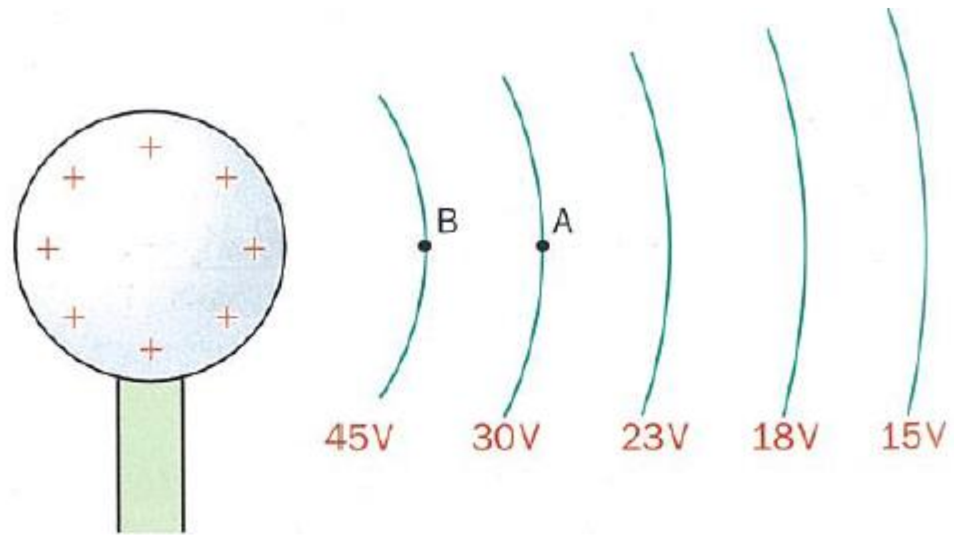
The unit for electric potential is the joule per coulomb ($J\ C^{-1}$), **volt** (V)

Earthing


electrons flow to earth
Earth
electrons flow from earth
Earth

Potential Difference

The potential difference or p.d. is the energy transferred when one coulomb of charge passes from one point to the other point.



What is the p.d. between points A and B in the diagram?

When one coulomb moves from A to B it gains 15 J of energy.

If 2 C move from A to B then 30 J of energy are transferred.

Energy transferred, *W* = **charge, *Q*** × **p.d., *V***
(joules) (coulombs) (volts)

$$W = Q \times V$$