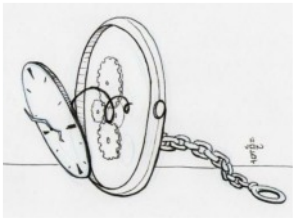
Accelerating the particles.

If you want to see what is inside a clock you can throw it to the ground and smash it to pieces.



From the debris you can find out what it was made of and how it worked.

The same method is used to find out what is inside particles.

Throw two protons at each other, smash them together and detect what they are made from.

This is what happens at the large hadron collider at the European Centre for Nuclear Research, CERN as it is called which is in Geneva Switzerland.

Question. What is meant by a large hadron collider?

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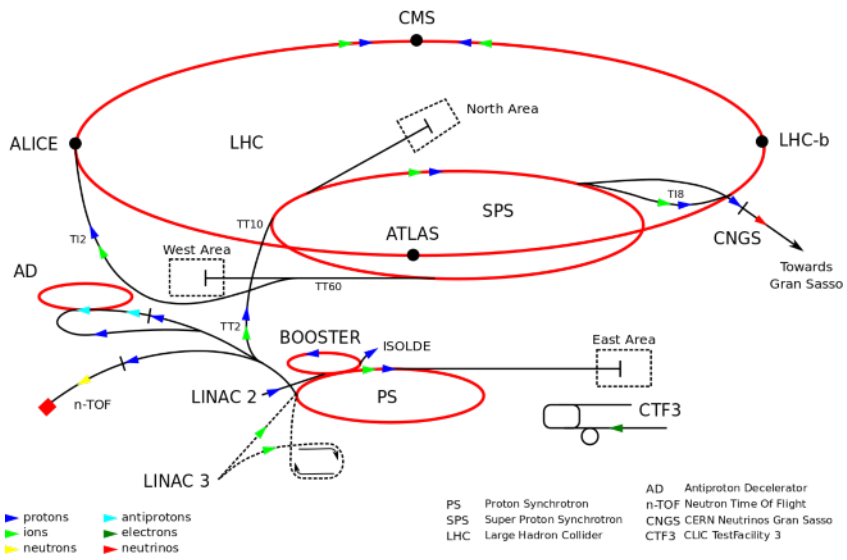
How do they make the particles move?



The particles are accelerated by

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The particles are guided by

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Force Fields in Physics

A force field in physics is where objects experience a force without being touched.
The most familiar force field we know is the **Gravitational** force field.

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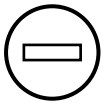
Electric Fields

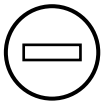
An electric field is a region of space around a charged particle, or groups of charged particles, where charged particles experience a force and thus an acceleration.

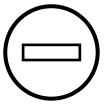
Examples of Electric Fields:
The electric field around a positive charge

The electric field around a negative charge



The electric field around two identical point charges





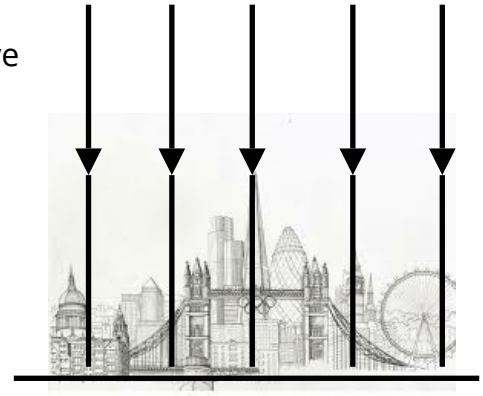
The electric field around two non- identical point charges

The electric field between two oppositely charged wires or plates

Gravitational Potential Energy

When an object of mass m is lifted up to a height h above the ground energy is needed to move it.

We say **work has to be done against** the gravitational field in moving the mass upwards.



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The mass has now gravitational **potential energy.**

The mass is said to be at a higher potential energy.

The mass will then fall to the ground which is a lower potential energy.

The gravitational field now does **work on the mass**.

The gravitational potential energy it had is transferred into energy of movement, ie, kinetic energy.

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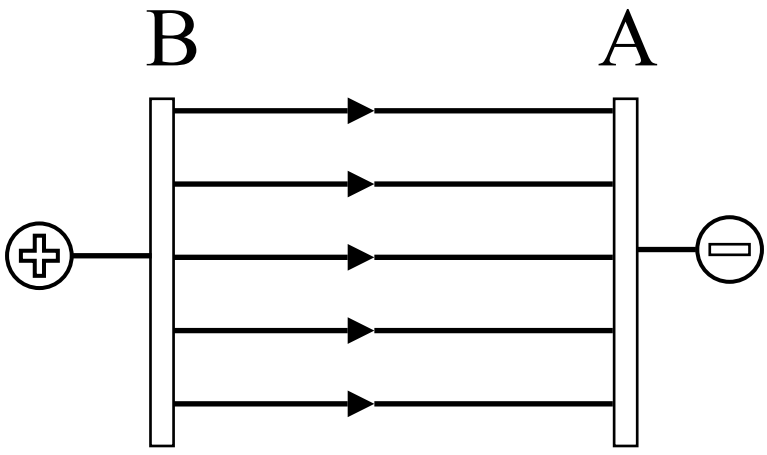
Electrical Potential Energy

The electric field arrows indicate the direction of the force acting on a positive charge.
Work has to be done in moving the positive charge from plate A to plate B against the electric field.



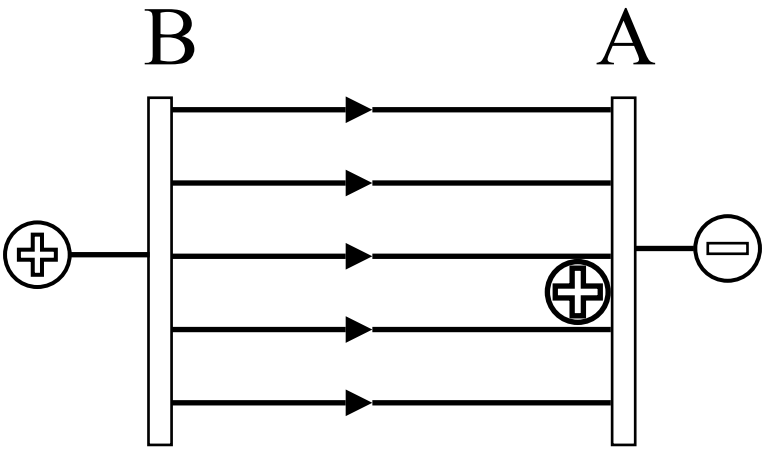
At position B the positive charge will have **electric potential energy.**

The positive charge will be at a higher electric potential at B than at position A.

The electric field will now do work on the electric charge moving it to a lower electric potential.

Definition of the volt.

We say that there is **an electric potential difference of 1 volt** between B and A if the work done moving 1 coulomb of positive charge amounts to 1 Joule.



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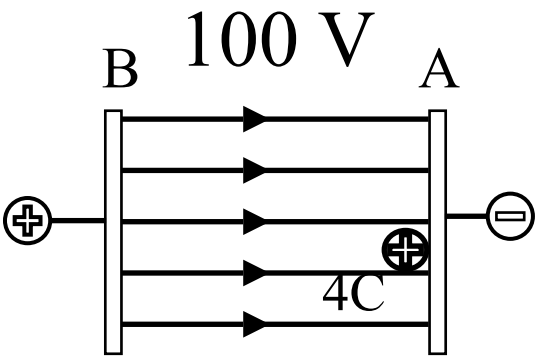
Example 1

Find the electric potential difference when it takes 12 Joules to move a 6 coulomb positive charge from position A to B

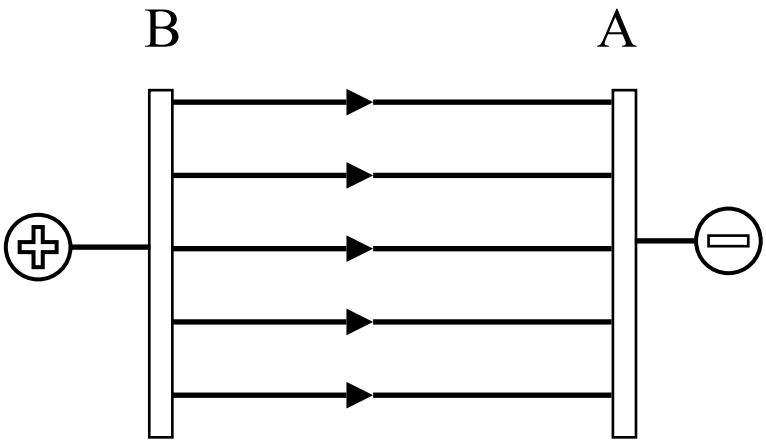
Example 2

Determine the work done in moving a 4 C positive electric charge from A to B where the potential difference is 100 V



Charged particles in electric fields

When a positive charge enters the region of the electric field at , say position B ,it will be accelerated through the field in the direction of the field lines.



The electric field will do work on the positive charge just like the gravitational field does work on a mass.

Just as the mass gains speed so will the positive charge as it swept along the electric field lines.

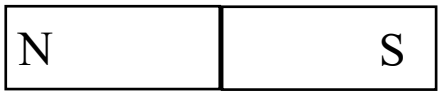
The positive charge will have gained kinetic energy going from position B to A.

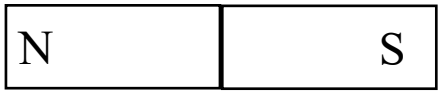
Energy gained by the positive charge is equal to the work done by the electric field.

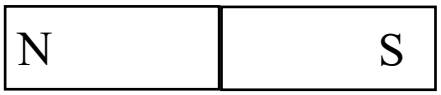
Magnetic Fields

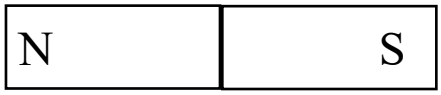
We are familiar with the patterns of iron filings around bar magnets.

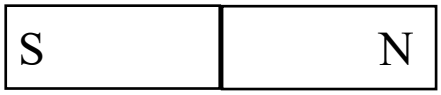
These patterns show the direction where the north pole of a compass points.



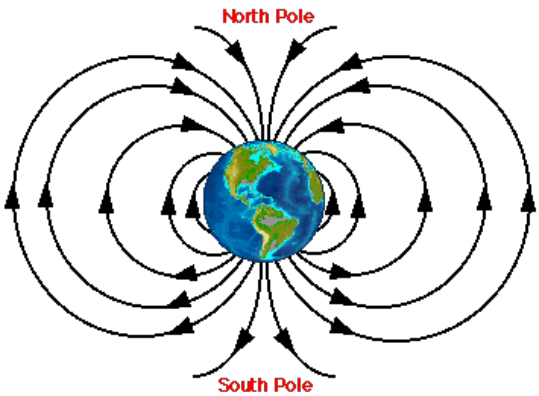




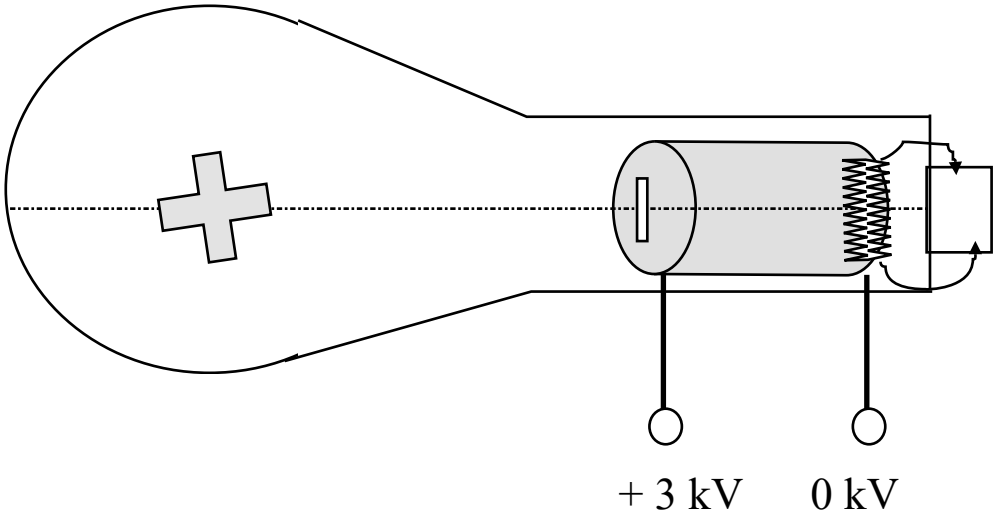




Earth`s Magnetic Field



Maltese Cross Experiment.

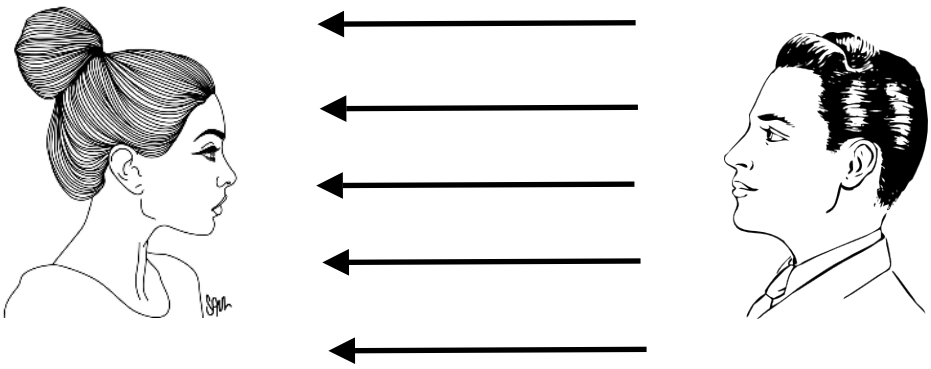


Shadow of Cross with light torch:

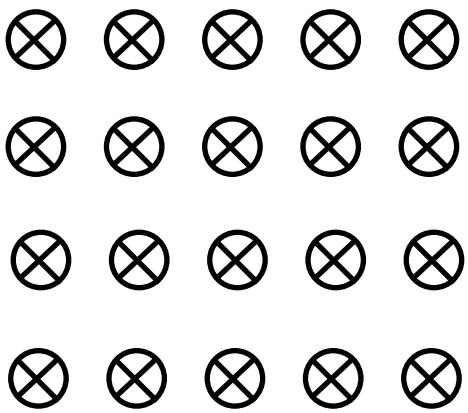
Shadow of Cross with electron beam

Charges in a Magnetic Field

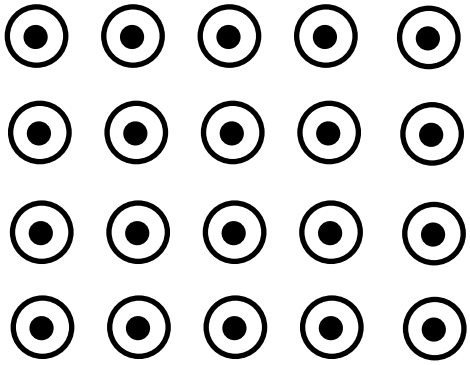
We have seen that magnetic fields , like other fields , can be represented by lines.



Magnetic field lines are going away from us. This can be represented by:



Magnetic field lines coming towards you is represented by this diagram



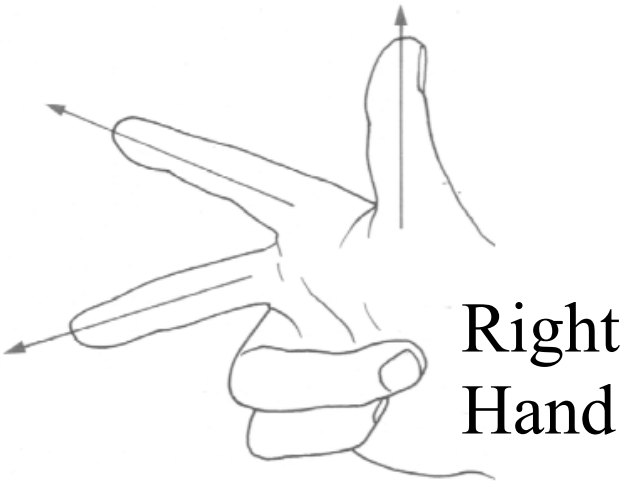
There is a special rule we use with the fingers of our hand to find out the direction of the force acting on charged particles.

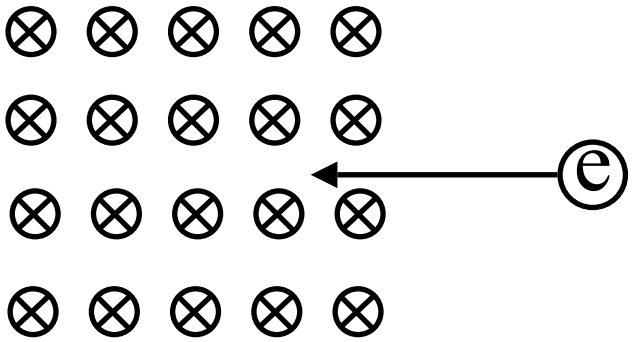
Fleming`s Right Hand Rule for Negative Charges

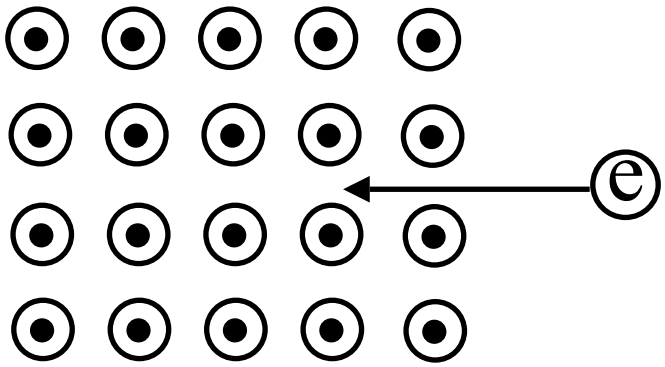
First finger

Second finger

Thumb





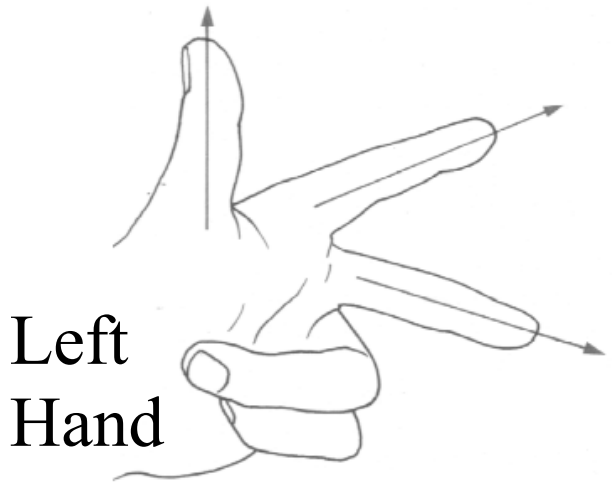


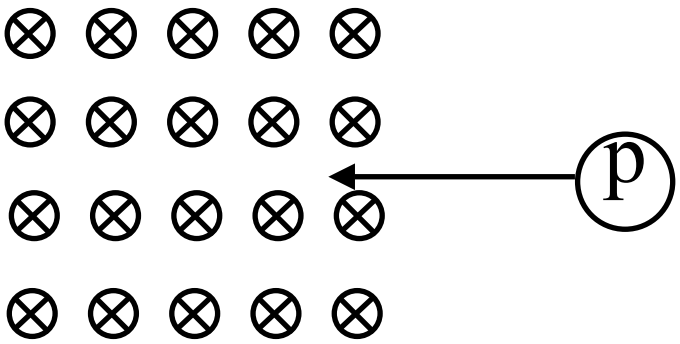
Fleming`s Left Hand Rule for Positive Charges

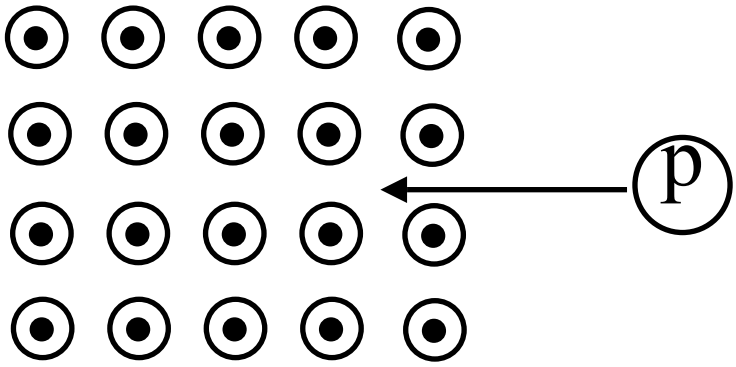
First finger

Second finger

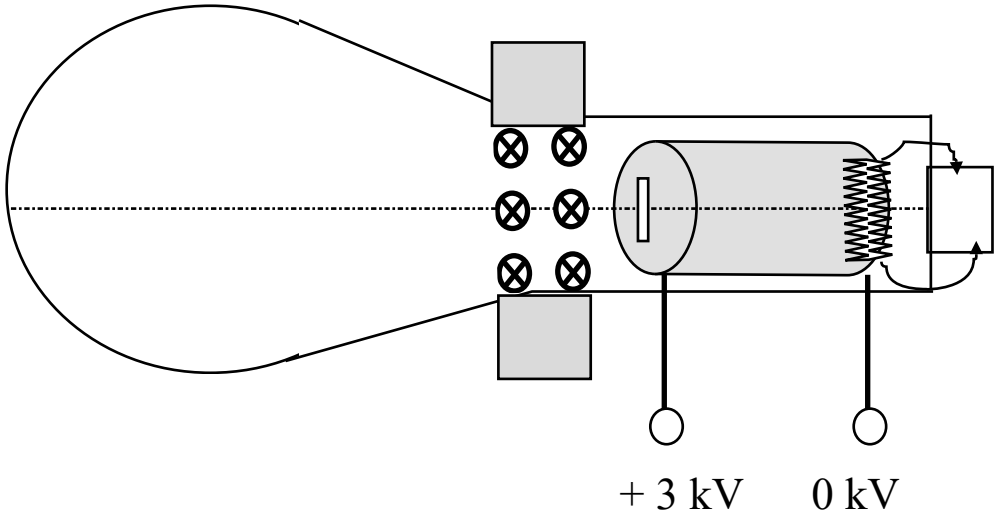
Thumb







Cathode Ray Tube



Calculate the speed of the electrons as the leave the anode to enter the magnetic field

Describe the motion of the electrons from the moment they leave the cathode.