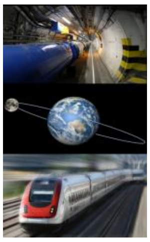


How do things move without contact?

Lesson 1: The Field Concept

VICTORIAN VIRTUAL LEARNING NETWORK

Introduction to Fields

Things move without contact due to the action of ………………… ………. ………. ……………………………… forces. These forces have fields or "zones of influence" associated with them.

Identify the type of field associated with each of the following:

Earth-Moon system

……………………………………………… …………………………

Large Hadron Collider

……………………………………………… …………………………

Maglev Train

……………………………………………… …………………………

You will learn about similarities and differences between three different types of fields:

Gravitational Fields and their effects on …………………………………………………

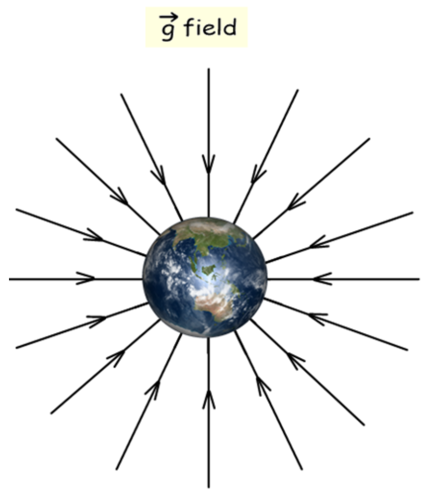
Electric Fields and their effects on …………………………………………………

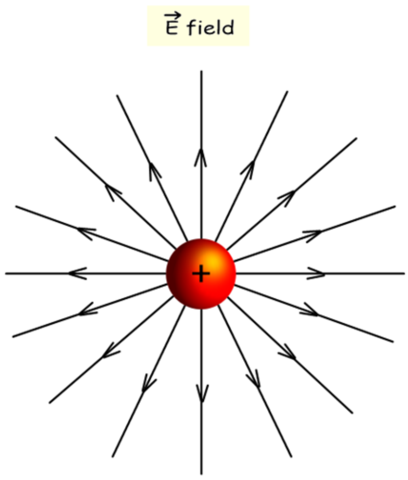
Magnetic Fields and their effects on …………………………………………………

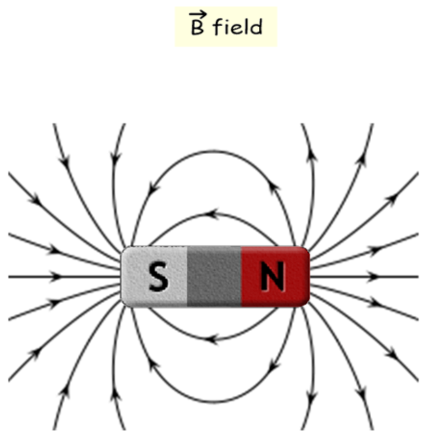
You will study the ………………………… of each of these fields and look at some important ……………………………… of field concepts.

Representing Fields

Examples of the three main types of fields are shown below:







G....................... field surrounding earth

$\vec{g}$ field

E.................. field surrounding a positive charge

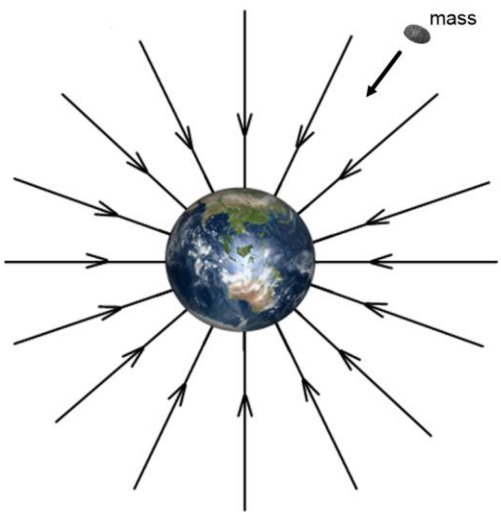
$\vec{E}$ field

M.................. field surrounding a bar magnet

$\vec{B}$ field

Arrows represent the ………………………………………………………….. of the fields. Direction is important so these are known as …………………… fields.
Fields are represented by lines which do not cross each other.
The field strength is ………………………………… where field lines are closer together.
Gravitational and Electric Fields are very similar in shape.

Gravitational Fields

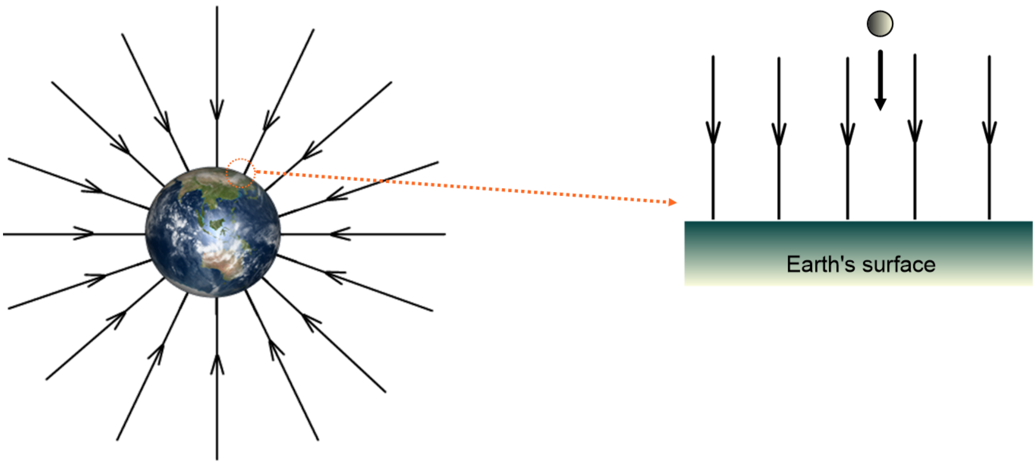


Gravitational fields are always ……………………………………….

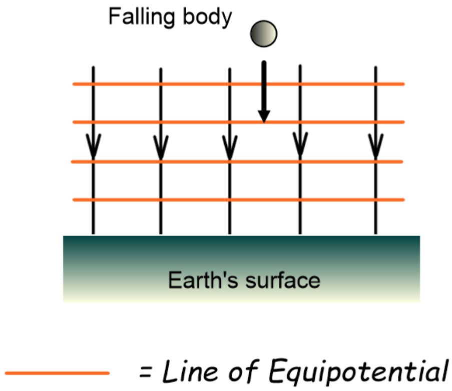
A mass introduced into the field will be attracted by the force of gravity towards the large central body.

The closer the body is to the central mass, the stronger the field and the larger the ………………………………..

Uniform Gravitational Field



A body falling straight to earth will gain .... energy at the expense of its .... potential energy.



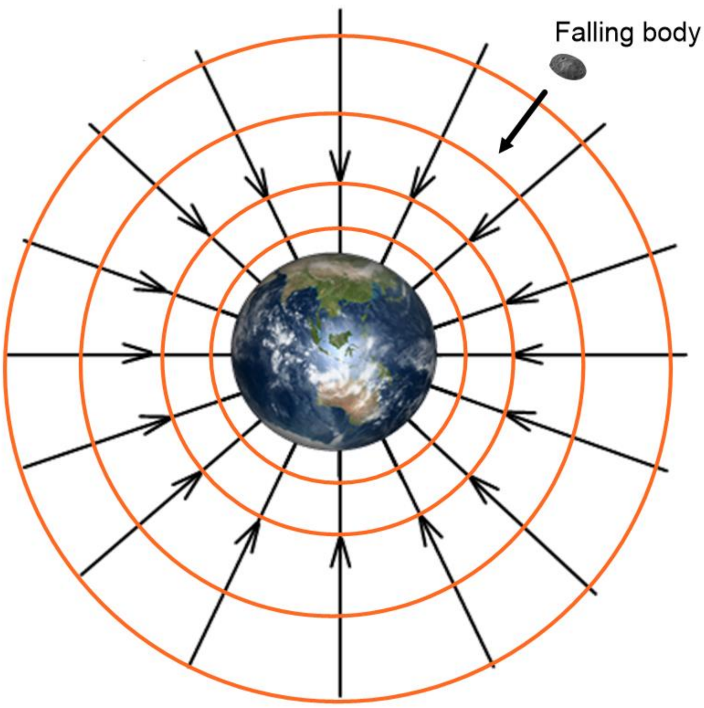
Lines of constant potential energy can be drawn which are at right angles to the gravitational field lines.

These are called lines of ....

Lines are equally ....

A falling object loses .... amounts of gravitational potential in moving from one line to the next.

Non-Uniform Gravitational Field



Again, lines of equipotential can be drawn which are at right angles to the gravitational field lines.

Again, the falling object loses .... amounts of gravitational potential in moving from one line to the next.

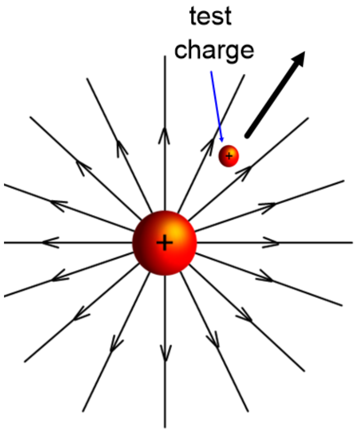
Lines are .... equally spaced.

Gravitational Potential Energy is lost over a shorter distance where the gravitational field is ....

Electric Fields

Electric fields exist around ch………………………………. objects.

Electric fields can be either **a…………………** or **r……………………………**depending on the charge at the centre.

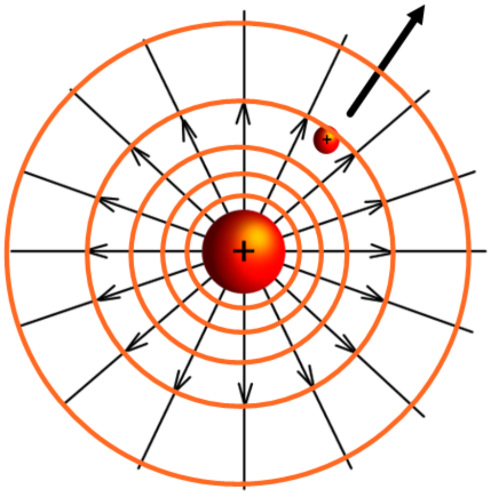


Electric Field surrounding
a **positive** charge.

A test **positive** charge introduced into this field will be **repelled** by the central charge.

The **closer** the test charge is to the central charge, the **stronger** the field and the **larger** the **electric ………………………..**

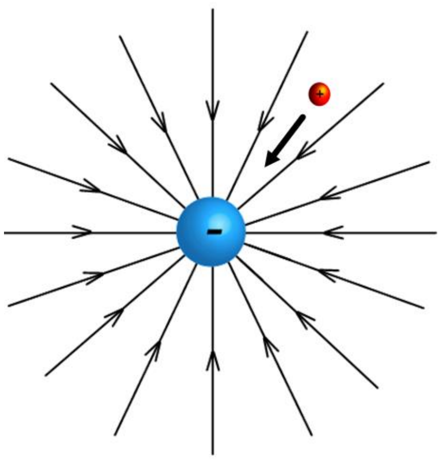
A test positive charge will lose ……………………………….. potential energy and gain ………………………… energy as it moves away from the large central charge.



Lines of ………………………………… can be drawn around the central positive charge.

Electrical potential energy of a test charge will be the same on a line of equipotential.

Electrical potential energy is lost over a shorter distance where the electric field is ……………………………………..



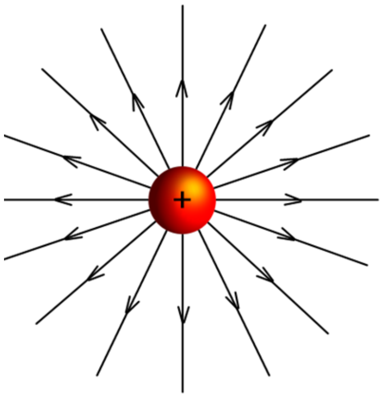
Electric Field surrounding
a **negative** charge.

A test **positive** charge introduced into this field will be **……………………………** by the central charge.

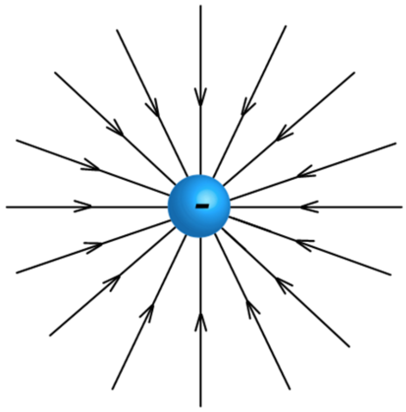
The **closer** the test charge is to the central charge, the **stronger** the field and the **…………………………………** the electric force.

Monopoles

In field terminology, a monopole exists where an electric field begins or ends.



Monopole

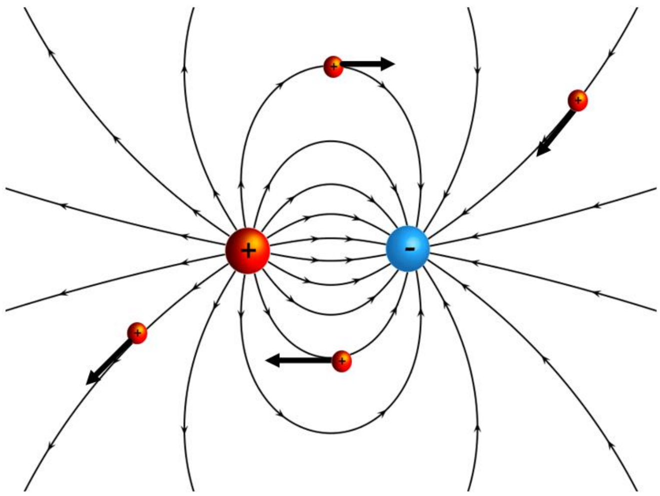


Monopole

Dipoles

In field terminology, a dipole has ………… poles as shown at right.

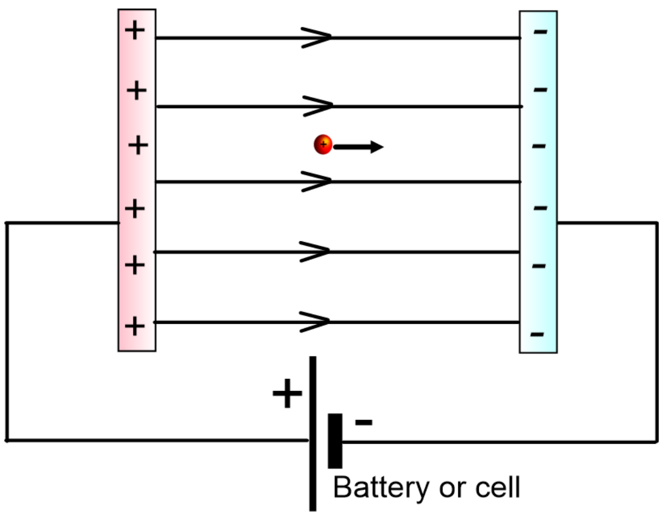
A test charge placed anywhere in the electric field will experience a ……………….. in the direction of the arrow.



Extra Notes.

Uniform Electric Fields

A uniform electric field exists between two .... charged metal plates as shown below.

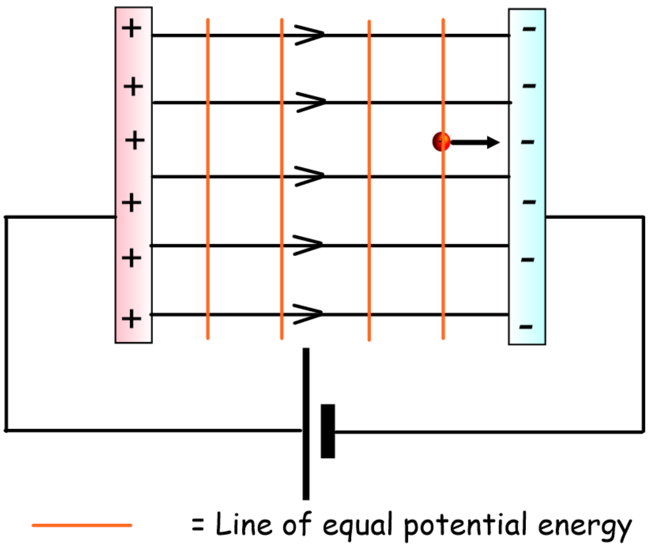


Field lines are parallel and .... spaced.

A positive test charge placed anywhere in the electric field will experience a .... force in the direction of the arrow.

The charge gains .... energy at the expense of its electrical potential energy as it moves between the plates.

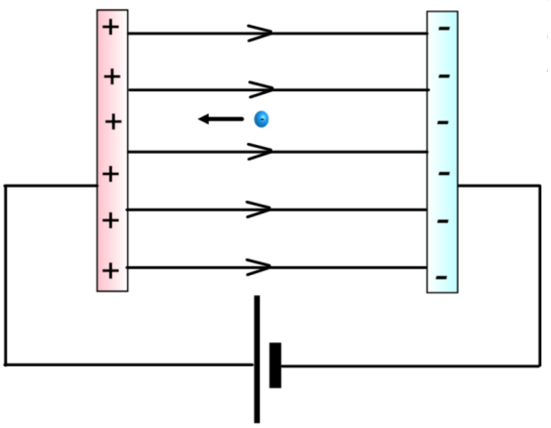
Lines of Equipotential in a Uniform Electric Field



Field lines are parallel and .... spaced.

A positive test charge placed anywhere in the electric field will experience a .... force in the direction of the arrows.

Between successive lines of equipotential, the charge gains the same amount of kinetic energy (at the expense of its electrical potential energy).



A negative charge such as an electron will experience a constant force in the ....direction to the arrows.

Magnetic Fields

Magnetic field are similar to gravitational or electric fields in that they are …………………….. fields (direction is important).

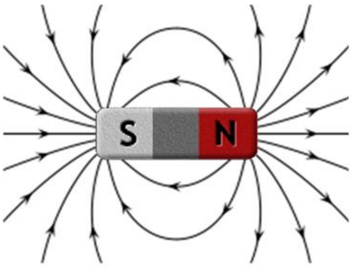
The ………………………. of magnetic field lines is an indication of the magnetic field intensity or field strength.

Different magnetic field lines must not meet or …………………..

Magnetic monopoles do not exist and so magnetic fields have no single starting or finishing points.

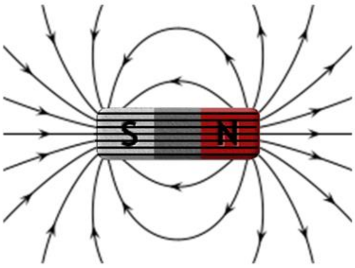
Magnetic fields are different to gravitational or electric fields in that they must be represented by continuous …………………………..

Bar Magnets

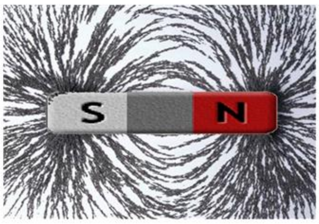


Arrows on field lines indicate field direction.

Lines are closer together near North and South Poles indicate …………………….. field strengths here.



Magnetic field lines are continuous loops, they actually continue ……………… the bar magnet.

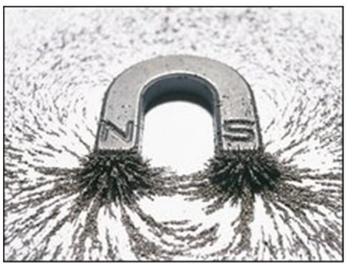


Iron filings can indicate the ……………………………… of magnetic field lines.

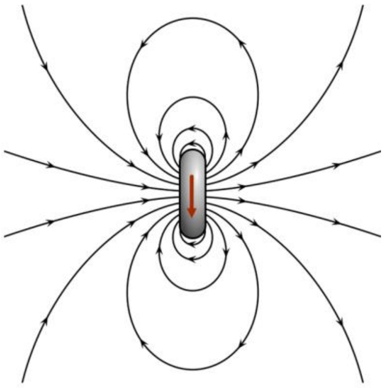
Horseshoe Magnets

Horse shoe and bar magnets are called permanent magnets.

They produce permanent magnetic fields which do not change over time.



Magnetic field around a single loop of current carrying wire.



This is a non-permanent magnetic field.

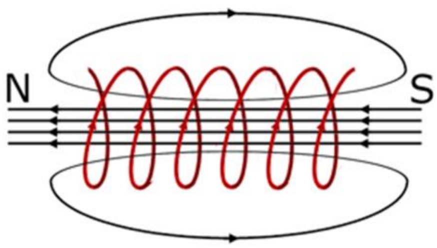
The strength and direction of the magnetic field will change depending on the size and direction of the electric ……………………….. passing through the wire loop.

Magnetic field of a Solenoid

A solenoid consist of a large number of coils (or windings) one after the other.

Electric ………………………… passed through the solenoid produces a …………………….. magnetic field inside the coil.

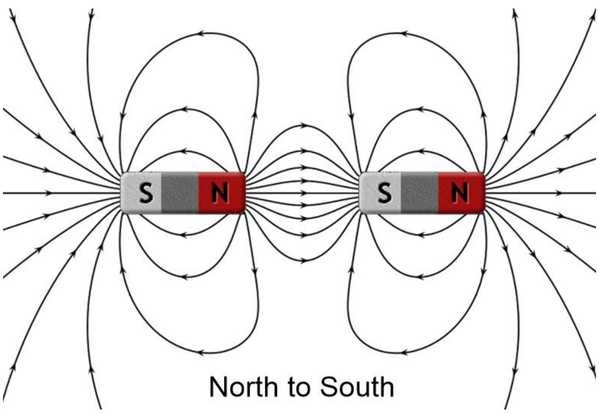
The strength and direction of the uniform magnetic field will change depending on the size and direction of the electric ……………………….. passing through the wire loop.

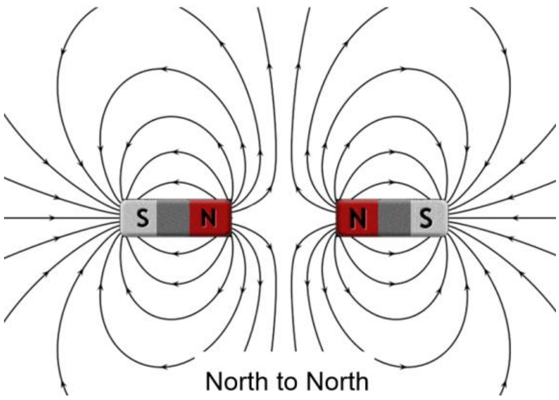


Magnetic field lines are parallel and evenly spaced inside the coil.

This indicates a **uniform** magnetic field

Magnetic Field surrounding two bar magnets





Gravitational, Electric and Magnetic Fields

In the remaining lessons of this topic you will looks at the **effects** and **applications** of the three different kinds of fields.

Gravitational field and gravitational force concepts including Newton's famous Law of Universal Gravitation. Application of gravitational fields in satellite motion.

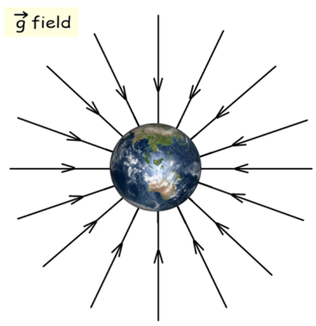
Effects of **magnetic fields** in current carrying wires and applications in electric motors.

Effects of **magnetic and electric fields** on the motion of charged particles and applications such as the Australian Synchrotron and the Large Hadron Collider.

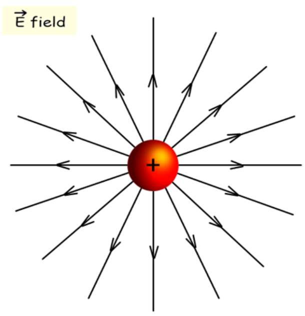
Summary

Fields

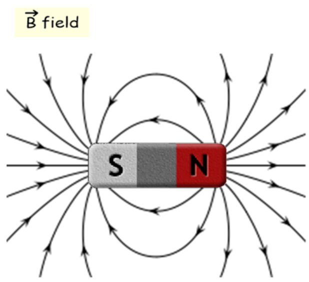
Things move without contact due to the action of action-at-a-distance forces. These forces have fields or "................... of influence" associated with them.



Gravitational field surrounding earth



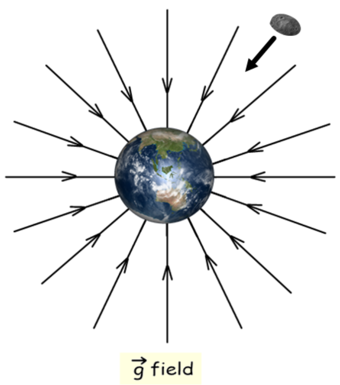
Electric field surrounding a positive charge



Magnetic field surrounding a bar magnet

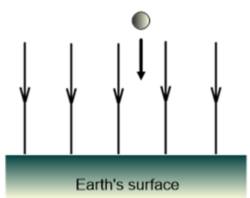
Arrows represent the direction of the fields. Direction is important so these are known as **vector** fields.
Fields are represented by **lines** which **do not cross** each other.
The **field strength** is **greater** where field lines are **closer** together.
Gravitational and Electric Fields are very **similar** in shape.

Gravitational Fields



Gravitational fields are always ....

The closer a body is to the central mass, the .... the field and the larger the force.

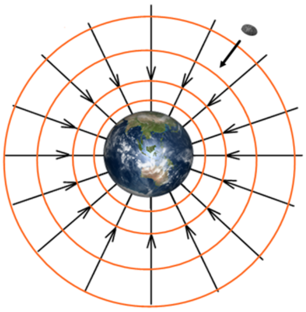


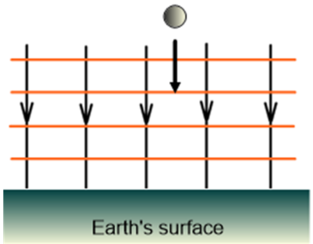
Near the Earth's surface, the gravitational field is approximately ....

Summary (continued)

Lines of Equipotential for Gravitational Fields

As an object falls under the influence of a gravitational field it, it loses .... potential energy and gains .... energy.



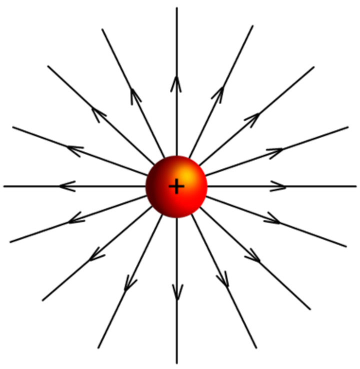


Lines of equipotential show where gravitational potential energy is the ....

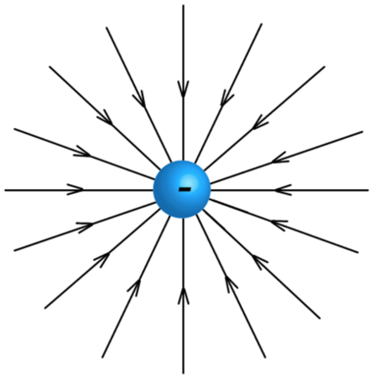
Equal amounts of gravitational potential energy are lost between each line.

Electric Fields

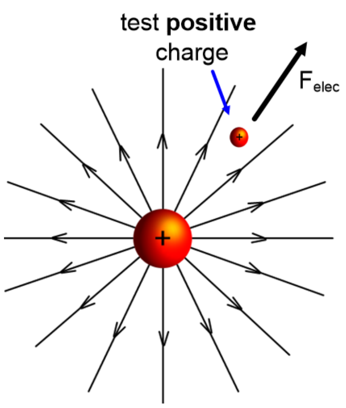
Electric fields can be either .... or .... depending on the .... of the charge at the centre.



Repulsive field with positive charge at the centre



Attractive field with negative charge at the centre

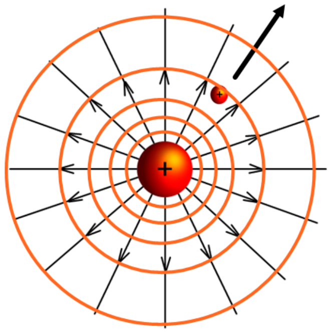


A test **positive** charge introduced into this field will be .... by the central charge.

The **closer** the test charge is to the central charge, the .... the field and the **larger** the **electric force**.

Summary (continued)

Lines of **equipotential** can be drawn around the central positive charge.

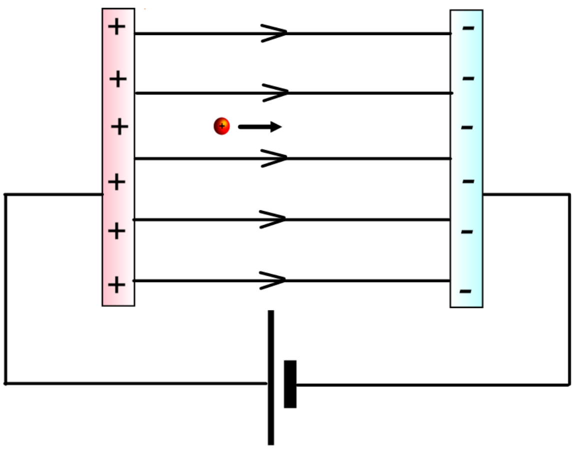


A test positive charge will .... electrical potential energy and .... kinetic energy as it moves away from the large central charge.

Electrical potential energy of a test charge will be the .... on a line of equipotential.

Electrical potential energy is lost over a .... distance where the electric field is strongest

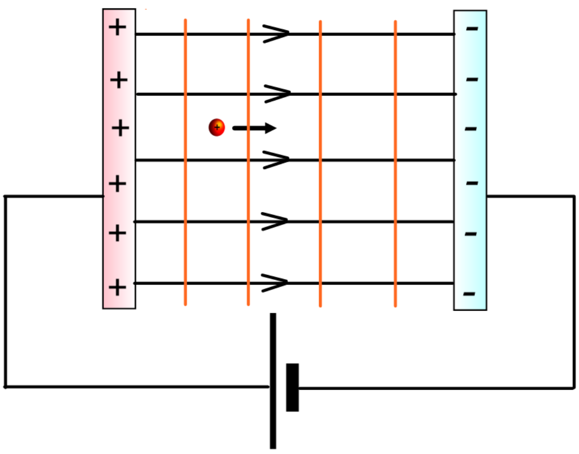
Uniform Electric Fields



A uniform electric field exists between two .... charged plates.

This uniform field will .... a charged particle at a constant rate.

Lines of Equipotential Uniform Electric Fields



The charge .... electrical potential energy and .... kinetic energy.

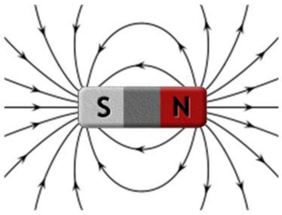
Lines of equipotential are .... spaced.

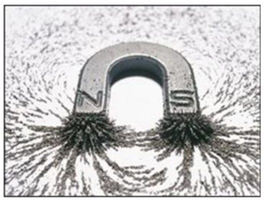
Summary (continued)

Magnetic Fields

Magnetic fields are different to gravitational or electric fields in that they must be represented by .... loops.

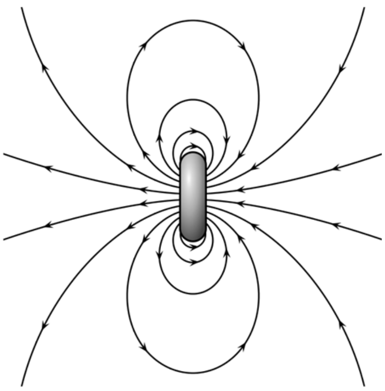
Magnetic monopoles do not exist and so magnetic fields have no single starting or finishing points.





Horseshoe and **bar magnets** are called .... magnets. They produce permanent magnetic fields which do not change over time.

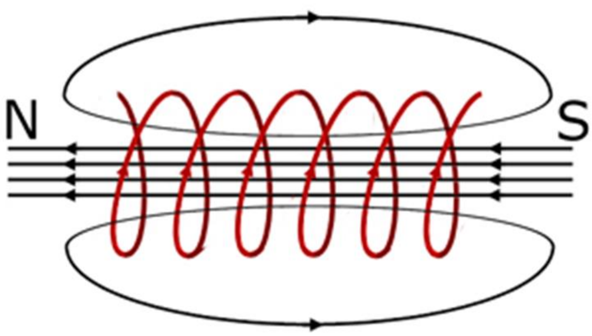
Magnetic field around a single loop of current carrying wire.



This is a ....-permanent magnetic field.

The strength and direction of the magnetic field will change depending on the .... size and direction.

Magnetic Field of a Solenoid



Magnetic field lines are parallel and .... spaced inside the coil. This indicates a .... magnetic field