FIELDS

A field is a region of space under the influence of some physical agency such as gravitation, magnetism and electricity. The field concept is the convenient and informative method for describing the influence of one body over another body separated from the first by some distance.

There are two types of forces: contact force and field force. While contact force acts on a body they are in contact with, field forces act on bodies they are not in contact with.

There are two classes of force fields – scalar fields and vector fields. A scalar field is one that has only magnitude but no direction; e.g. temperature, energy, and density. A vector field is a field that has both

magnitude and direction; e.g. gravitational, magnetic and electric fields.

Gravitational Field

Gravitational field is a force field and influences the motion of bodies in the space where it operates, without coming in contact with the objects. Gravitational field acts over a distance, it surrounds every object that has mass and permeates all of space.

The earth attracts every object existing in the earth's gravitational field. This attraction is called gravitational attraction and its effect is to change the velocity of objects under its influence, i.e. to accelerate such objects.

The acceleration of objects due to the earth's gravitational attraction is called the acceleration due to

gravity. It is represented by the symbol g whose average value is about $9.8ms^{-2}$.

The acceleration due to gravity g is uniform at a given place and is the same for all bodies, irrespective of their masses. It however varies from place to place. It is minimum at the equator ($9.78ms^{-2}$) and increases with latitude reaching the maximum value of $9.83ms^{-2}$ at the poles of the earth.

The force of gravitational attraction is given by $F = mg$, where g is the acceleration due to gravity and m is the mass of the object. When m=1, F=g. This is known as the acceleration of free fall (g) due to gravity. This is the force of attraction on a unit mass.

A stone and a feather or a sheet of paper when dropped from the same height is supposed to reach the

ground at the same time. This is not however the observation, as the stone is seen to fall faster and thus takes a shorter time to reach the ground than the feather. This is due to air friction or resistance which retards the movement of the feather more than that of the heavier stone. Due to its large surface area, the feather falls more slowly than the stone because of the large amount of air that must be pushed aside to let it pass. However in the absence of air resistance (i.e. in a vacuum) both the heavier stone and the lighter feather will reach the ground at the same time.

The strength of the gravitational field is smaller on the Moon than on the Earth. Thus an astronaut has a lower weight on the Moon than on the Earth.

Magnetic Field

Magnetic field is the region or space around a magnet in which the influence of the magnet can be felt or detected. A magnet is a piece of material that attracts some metals by magnetism.

If we put a bar magnet in a plate of iron fillings, on bringing out the bar magnet it is noticed that the iron-fillings cling to the magnet with most of them clinging in heavy bunches or clusters around the ends of the magnet. These ends of the bar magnet where the iron fillings concentrate are called the poles of the magnet. The power of the magnet thus appears to be concentrated at these poles.

A magnet can attract pieces of iron, nickel and cobalt. Such substances that can be attracted by a

magnet are known as magnetic substances and this ability of a magnet to attract magnetic substances is called magnetism. A bar magnet suspended about its centre in such a way as to swing freely, quickly comes to rest with its axis aligned approximately in the North-South direction.

The end of the magnet that points in the northward direction is the North Pole. The other end that points approximately in the southward direction is the South Pole. If we bring the north pole of another magnet near the north of the suspended magnet, we will notice that the suspended magnet moves away from the new magnet. Thus there appears to be a force of repulsion between the two north poles. Similarly a south pole of a magnet brought near the south pole of the suspended magnet will repel it.

Now we can reverse this experiment and bring the north pole of a magnet near the south pole of the suspended magnet. We will notice that the two poles now attract each other. We can conclude that "Like or similar poles of magnets repel one another but unlike or dissimilar poles attract one another."

Magnetic field can be mapped out using a magnetic compass needle. The compass when placed in a magnetic field swings around and settles in a definite direction. The swinging of the needle when in the vicinity of the magnet shows that it has been subjected to a force. This force is known as the magnetic force. Thus magnetic field is a force field. Magnetic force can be felt at a distance. It influences an object even when not in contact with it.

Magnetic field is also a vector field, i.e. it has both magnitude and direction. Its patter can be demonstrated using iron fillings, and magnetic compass needle.

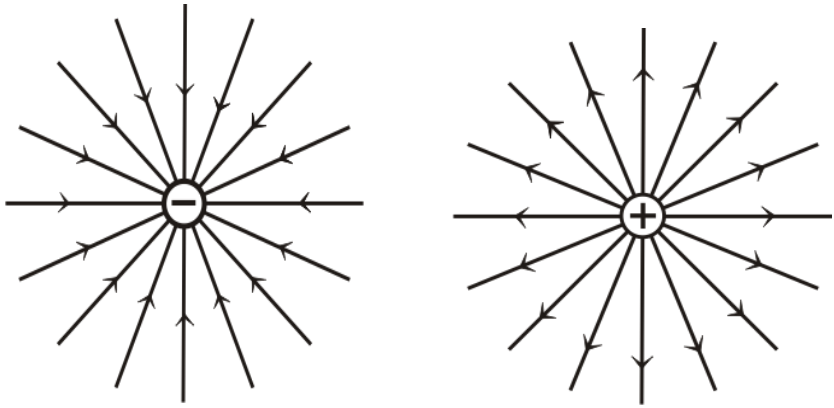
Electric Field

An electric field is a region or space where a charged body experiences an electric force. The electric field is just a way of describing the action at a distance of one charge upon another. Such a field is another example of a force field and is represented by electric lines of force. Since force is a vector quantity, an electric force field has both magnitude and direction.

The direction of an electric field at any point is given by direction of the force acting on a small positive

charge place at that point. The direction of a field force is indicated using arrows.

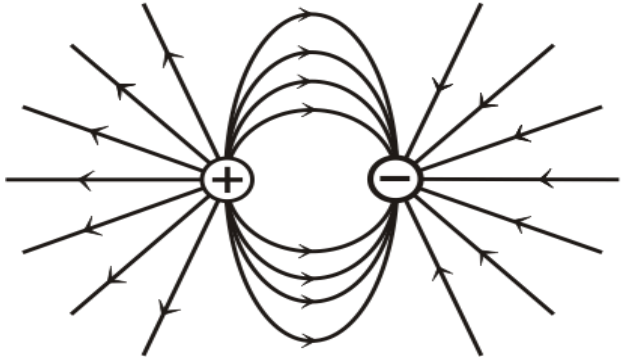
Electric field could be uniform or variable. In uniform electric field, field lines are straight while in variable electric field, field lines are curved. Field lines are imaginary lines drawn in an electric field in such a way that the direction at any point (or the direction of the tangent) gives the direction of the electric field at such a point. Also field lines can be seen as the path which an isolated small positive charge would follow if placed in the field.



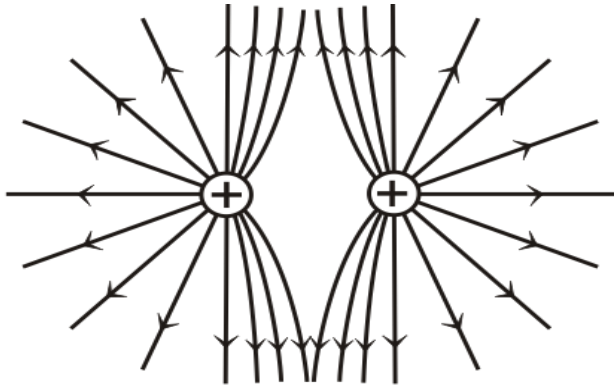
Electric Field around Positive and Negative Charges

The field about an isolated positive charge is radially outward, because a positive charge placed at any point around it is repelled outward along a line through the two charges. The field about a negative charge is radially inwards as seen above.

The fields for other charges or a combination of charges are as shown below:



Attraction among Unlike Charges



Repulsion among like Charges

Summarily, lines of force start only on positive charges and end only on negative charges. The number of field lines starting or ending is proportional to the magnitude of the charges. Lines of force do not cross each other. Also they indicate the direction of the electric field. They are continuous in any region with free charges. The lines are drawn such that the electric field is proportional to the number of lines crossing unit area perpendicular to the lines.

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