Examining Magnetism and its Types

This project is based upon the topic “ Magnetism” that is the phenomena of the magnet to due to which the magnet can attract or repel the metals like iron , cobalt , nickel etc toward it. In this project I will discussed firstly the Magnet and its properties ,I have also discuss the types of the magnet , after this I will completely discuss the phenomena of the magnet i.e. the magnetism . Under the Magnetism I have discuss the many of the concepts like the Introduction to magnetism: in which I have defined the basics of the magnetism, then I have discuss origin and the history of the magnet that is how a magnet formed and what is its origin. After this I have discuss the Magnet field that is the space around the magnet in which its influence can be felt, this is due to the magnetic line of forces around the magnet thus after this I have discuss the magnetic line of forces and its properties. Further I have discuss the types of the magnetism their domains that is how the domain of a magnet get aligned with the temperature , after this I have discuss the Curies law of Magnetism which tells the change in the permeability of magnet with the temperature , and at last I have discuss the most important topic that is the electromagnetism , and its application and the applications and the future prospective of the magnetism , that is hoe it is useful in our daily life and what are the advantages or benefits we will get from it in the future.

Introduction To Problems In Magnetism:

The main problem occurred in the Magnetism are:

The first problem occurred in the ferromagnetic material is that they don’t work at the high temperature they loose their magnetic properties if they are heated up .so the magnet are not used in the high temperature area’s or they are also not used in the industries where the high temperature is used .because The atoms become too excited by the heat to remain pointing in one direction for long. Due to which they does not act as magnetized and remains a metals .this is the main problem occur in the magnetism .

Core Chapters:

In this point that is in “ core chapter” I have completely discuss the Magnetism., the whole idea about magnetism its applications , origin of magnetism and many more topics related to the magnetism this point is basically the body of this project in which each and every thing is completely described. In this I have firstly discuss the Magnets , Magnetic field after this I have discuss the phenomena of magnet that is magnetism and its complete applications in daily life.

Introduction To Magnet:

A magnet is an object that exhibits a strong magnetic field and will attract materials like iron towards it. Magnets have two poles, called the north (N) and south (S) poles. Two magnets will be attracted by their opposite poles, and each will repel the like pole of the other magnet. Each part of the magnet is a complete magnet itself because if we break up the magnet into the smallest parts then the each part has both the north pole(N) and south pole (S) . and have magnetic field around it that means they have the property to attract the material toward it . that is why the every Part Of Magnet is Act as the Complete magnet . The poles of the Magnet that is the North and South Pole are named so because when we hung up the magnet with the thread then its poles are in direction south and north means it represent the directions that is why they are named as North (N) pole , South(S) Pole.

Types Of Magnets:

(Link : http://www.school-for-champions.com/science/magnets.html)

The magnets are mainly categorize into the three category:

Permanent Magnet:

Temporary Magnet:

Electromagnet:

Permanent magnets:

A permanent magnet is one that will hold its magnetic properties over a long period of time.

Magnetite:

Magnetite is a magnetic material found in nature. It is a permanent magnet, but it is relatively weak.

Alloys

Most permanent magnets we use are manufactured and are a combination or alloy of iron, nickel and cobalt. Rare-earth permanent magnets are a special type of magnet that can have extreme strength.

Temporary magnets:

A temporary magnet is one that will lose its magnetism. For example, soft iron can be made into a temporary magnet, but it will lose its magnetic power in a short while.

Electromagnet

By wrapping a wire around an iron or steel core and running an electrical current through the wire, you can magnetize the metal and make an electromagnet. If the core is soft iron, the magnetism will diminish as soon as the current is turned off. This feature makes electromagnets good for picking up and dropping objects. Typically DC electricity is used, but AC current will also result in an electromagnet.

Various shapes

The magnet can be made into various shapes. The bar magnet is the most common configuration.

Bar magnet

Magnets also can be square, spherical, shaped like a horseshoe, and even shaped like a donut.

Horseshoe magnet

If you put an iron plate across the N and S poles of a horseshoe magnet, that would essentially "short circuit" the effect of the magnetism, such that its strength would not be very great. As soon as the plate was removed, the magnet would regain its full strength. That method is sometimes used in magnets that are temporary to help keep their magnetic properties for a longer time.

Cutting a magnet

An interesting characteristic of magnets is that when you cut a magnet into parts, each part will have both N and S poles.

Bar magnet cut into three parts

Attraction and repulsion

Magnets strongly attract iron, nickel and cobalt, as well as combinations or alloys of these metals. Also, unlike poles of two magnets will attract, but like poles will repel. Thus, N and S attract, while S and S will repel each other.

Properties Of Magnet:

1.

This is all about the basics of the magnet .now discus the phenomena of magnet known as the Magnetism:

"Magnetism A Phenomena"

The magnet can attract or repel the materials toward it, the phenomena of attracting of small bits of iron toward ore of the magnet is known as a magnetism . Magnetism is a force of attraction or repulsion that acts at a distance. It is due to a magnetic field, which is caused by moving electrically charged particles or is inherent in magnetic objects such as a magnet.

Origin Of Magnetism:

(Link: http://science.jrank.org/pages/4082/Magnetism-Origin-magnetism.html)

Magnetism arises from two types of motions of electrons in atoms—one is the motion of the electrons in an orbit around the nucleus, similar to the motion of the planets in our solar system around the sun, and the other is the spin of the electrons around its axis, analogous to the rotation of Earth about its own axis. The orbital and the spin motion independently impart a magnetic moment on each electron causing each of them to behave as a tiny magnet. The magnetic moment of a magnet is defined by the rotational force experienced by it in a magnetic field of unit strength acting perpendicular to its magnetic axis. In a large fraction of the elements, the magnetic moment of the electrons cancel out because of the Pauli exclusion principle, which states that each electronic orbit can be occupied by only two electrons of opposite spin. However, a number of so-called transition metal atoms, such as iron, cobalt, and nickels have magnetic moments that are not cancelled; these elements are, therefore, common examples of magnetic materials. In these transition metal elements the magnetic moment arises only from the spin of the electrons. In the rare earth elements (that begin with lanthanum in the sixth row of the periodic table of elements), however, the effect of the orbital motion of the electrons is not cancelled, and hence both spin and orbital motion contribute to the magnetic moment. Examples of some magnetic rare earth elements are: cerium, neodymium, samarium, and europium. In addition to metals and alloys of transition and rare earth elements, magnetic moments are also observed in a wide variety of chemical compounds involving these elements. Among the common magnetic compounds are the metal oxides, which are chemically bonded compositions of metals with oxygen

History Of Magnetism:

(Link: http://science.jrank.org/pages/4081/Magnetism-History-magnetism.html)

The history of magnetism dates back to earlier than 600 B.C., but it is only in the twentieth century that scientists have begun to understand it, and develop technologies based on this understanding. Magnetism was most probably first observed in a form of the mineral magnetite called lodestone, which consists of iron oxide-a chemical compound of iron and oxygen. The ancient Greeks were the first known to have used this mineral, which they called a magnet because of its ability to attract other pieces of the same material and iron. The Englishman William Gilbert (1540-1603) was the first to investigate the phenomenon of magnetism systematically using scientific methods. He also discovered that Earth is itself a weak magnet. Early theoretical investigations into the nature of Earth's magnetism were carried out by the German Carl Friedrich Gauss (1777-1855). Quantitative studies of magnetic phenomena initiated in the eighteenth century by Frenchman Charles Coulomb (1736-1806), who established the inverse square law of force, which states that the attractive force between two magnetized objects is directly proportional to the product of their individual fields and inversely proportional to the square of the distance between them. Danish physicist Hans Christian Oersted(1777-1851) first suggested a link between electricity and magnetism . Experiments involving the effects of magnetic and Electric Fields on one another were then conducted by Frenchman Andre Marie Ampere (1775-1836) and Englishman Michael Faraday (1791-1869), but it was the Scotsman, James Clerk Maxwell (1831-1879), who provided the theoretical foundation to the physics of electromagnetism in the nineteenth century by showing that electricity and magnetism represent different aspects of the same fundamental force field. Then, in the late 1960s American Steven Weinberg (1933-) and Pakistani Abdus Salam (1926-96), performed yet another act of theoretical synthesis of the fundamental forces by showing that electromagnetism is one part of the electroweak force. The modern understanding of magnetic phenomena in condensed matter originates from the work of two Frenchmen: Pierre Curie (1859-1906), the husband and scientific collaborator of Madame Marie Curie (1867-1934), and Pierre Weiss (1865-1940). Curie examined the effect of temperature on magnetic materials and observed that magnetism disappeared suddenly above a certain critical temperature in materials like iron. Weiss proposed a theory of magnetism based on an internal molecular field proportional to the average magnetization that spontaneously align the electronic micromagnets in magnetic matter. The present day understanding of magnetism based on the theory of the motion and interactions of electrons in atoms (called quantum electrodynamics) stems from the work and theoretical models of two Germans, Ernest Ising and Werner Heisenberg (1901-1976). Werner Heisenberg was also one of the founding fathers of modern quantum mechanics.

Magnetic Field:

A magnetic field is a space around the magnet or the space around the conductor carrying current in which magnetic influence can be experienced . A magnetic field consists of imaginary lines of flux coming from moving or spinning electrically charged particles. Examples include the spin of a proton and the motion of electrons through a wire in an electric circuit. What a magnetic field actually consists of is somewhat of a mystery, but we do know it is a special property of space.

Magnetic field or lines of flux of a moving charged particle

Names of poles:

The lines of magnetic flux flow from one end of the object to the other. By convention, we call one end of a magnetic object the N or North-seeking pole and the other the S or

South-seeking pole, as related to the Earth's North and South magnetic poles. The magnetic flux is defined as moving from N to S.

Magnets:

Although individual particles such as electrons can have magnetic fields, larger objects such as a piece of iron can also have a magnetic field, as a sum of the fields of its particles. If a larger object exhibits a sufficiently great magnetic field, it is called a magnet.

Magnetic Lines Of Forces:

The main question arises " How A magnetic Field " is created Around the Magnet or "How Magnetism " occurs , the Answer is only due to the Magnetic lines of forces.

The concept of magnetic lines of forces or simply the field lines was developed to visualize the effect of magnetic field .the magnetic field lines represent the magnetic field as electric line of forces represent the electric field.

Magnetic line of forces are defined as" Path along an isolated north pole would move , if it free to do so. Tangent to magnetic field line at any point would represent the direction of magnetic field at that point .as an isolated magnetic pole do not exist a small magnetic needle , called compass needle is used to plot the field lines of magnetic field.

The magnetic lines of force do not exist in reality. They are only "Hypothetical" lines , which enable us to understand certain phenomena in magnetism. If we imagine a number of small compass around a magnet , each compass needle experienced a torque due to the field of the magnet . the torque acting on a compass needle align It in the direction of magnetic field . "The path along which the compass needle are aligned is known as magnetic line of forces".

Here represent the magnetic line of forces in the two magnets placing under the magnetic field of each other , due to this they experienced the Attraction or Repulsion .

Repulsion:

When two magnetic objects have like poles facing each other, the magnetic force pushes them apart.

Force pushes magnetic objects apart

Properties Of Magnetic Lines Of Forces:

The magnetic lines of forces can have the following Properties :

Magnetic lines of forces are closed continues curves, we may imagine them to be extending through the body of magnet.

Outside the body of the magnet, the direction of magnetic lines of forces , is from north pole to south pole .

The tangent to magnetic lines of forces at any point gives the direction of magnetic field strength at that point .

No two magnetic lines of forces can intersect each other .

Magnetic lines of forces contract longitudinally and they dilate laterally .

Crowding of magnetic lines of forces represent the strong magnetic field and less no of magnetic lines of forces represent the weak magnetic field .

Thus these are the main properties of magnetic lines of force .

Types of magnetism:

The magnetism can be of three types , here I have represent the hierarchy of types of magnetism;

(Link: http://en.wikipedia.org/wiki/Magnetism)

Diamagnetism:

These are those substances in which individual atoms/molecules/ ions do not posses any net magnetic moment on their own.

When a sample of diamagnetic material Is placed in external magnetic , a small magnetic moment is produced in each atom/molecule/ions proportional to magnetic field , but pointing in the opposite direction. For example bismuth, mercury, alcohol, air are all diamagnetic substances.

Paramagnetism :

These are those substances in which each individual molecule/atom/ions have a net non zero magnetic moment of its own. When such a materiel is placed in an external magnetic field , it tries to align the individual dipole moments in the direction of the magnetic field. For example: aluminum, platinum, chromium , manganese , copper sulphate , crown glass. These all are paramagnetic materials .

Ferromagnetism:

These are those substance In which each individual atom/molecules/ions has a non zero magnetic moment , as in a paramagnetic substance. The individual magnetic moment interacts with one another in such a way as to align themselves spontaneously in a common direction over microscopic volume. This leads to the formation of domains .all the atomic dipole moments in a domain are lined up leading to some net magnetic moment . as net magnetic moment varies randomly from one domain to another , there is no bulk magnetic moment of ferromagnetic materials . when a ferromagnetic material is placed in an magnetic field, magnetic moment of different domains are aligned and the material gets strongly magnetized in the direction of magnetic field applied. For example iron , cobalt, nickel and the number of their alloys are ferromagnetic materials.

Properties Of types Of Magnetisms:

The diamagnetic , paramagnetic and ferromagnetic materials have some of following properties under the different conditions:

Diamagnetic substances:

When suspended in a uniform magnetic field, they set their longest axis at right angles to the direction of field that is the shortest axis is along the field .

When placed in a non uniform magnetic field these substances move form strongest part of the field to weaker part. For example consider a diamagnetic liquid put in watch glass placed on two pole pieces of an electromagnet held close to each other .when the current is switched on the liquid level aquires the shape . the liquid accumulates on side where the field is weaker. The depression in the middle is due to the strongest field at the center. If the distance between poles is increased the effect is reversed .

The level of diamagnetic liquid in U tube is depressed , instead of rising when subjected to a magnetic field.

Paramagnetic substances:

When suspended in uniform field , they rotate so as to bring their longest axis along the direction of the field.

When placed in a non uniform magnetic field they move from weaker part of the field to stronger part. For example : consider liquid in a watch glass placed on two poles of pieces of an electromagnet held close to each other as the current switched on , the liquid level acquire a shape . accumulating at the center , where the field if strong . if the distance between the poles is increase the effect is reversed.

When a magnetic field is applied to level of a paramagnetic liquid in one limb of U-tube the level rises it confirms that paramagnetic substance move from stronger part to weaker part.

Thus these are the main properties of these substances the ferromagnetic substance can extend the paramagnetic to the higher level it have same properties as paramagnetic substances can have.

Permeability Of Magnetism:

The permeability of the magnetism is defined according to the type of the magnetism substances:

For Diamagnetic Substances:

Permeability Of diamagnetism substances are always less than unity:

From the relation $\mu=1+Xm$ as $\mu<1$

Xm is negative .hence the Susceptibility of Diamagnetic substance is negative.

For Paramagnetic Substances :

From the relation $\mu=1+Xm$ as $\mu >1$,

Therefore ,Xm must be positive .

Hence the susceptibility of paramagnetic substances is positive:

For Ferromagnetic substances:

From the relation $\mu=1+Xm$ as $\mu >>1$

Therefore ,Xm is positive

Hence susceptibility of Ferromagnetic substance is Positive.

Domains Of Magnetism:

(link http://en.wikipedia.org/wiki/Magnetism)

Ferromagnetism:

The magnetic moment of atoms in a ferromagnetic material cause them to behave something like tiny permanent magnets. They stick together and align themselves into small regions of more or less uniform alignment called magnetic domains or Weiss domains. Magnetic domains can be observed with a magnetic force microscope to reveal magnetic domain boundaries that resemble white lines in the sketch.There are many scientific experiments that can physically show magnetic fields.

Effect of a magnet on the domains.

When a domain contains too many molecules, it becomes unstable and divides into two domains aligned in opposite directions so that they stick together more stably as shown at the right. When exposed to a magnetic field, the domain boundaries move so that the domains aligned with the magnetic field grow and dominate the structure as shown at the left. When the magnetizing field is removed, the domains may not return to anun magnetized state. This results in the ferromagnetic material's being magnetized, forming a permanent magnet. hen magnetized strongly enough that the prevailing domain overruns all others to result in only one single domain, the material is magnetically saturated. When a magnetized ferromagnetic material is heated to the Curie point temperature, the molecules are agitated to the point that the magnetic domains lose the organization and the magnetic properties they cause cease. When the material is cooled, this domain alignment structure spontaneously returns, in a manner roughly analogous to how a liquid can freeze into a crystalline solid.

Anti Ferromagnetism:

Antiferromagnetic ordering

In an antiferromagnet, unlike a ferromagnet, there is a tendency for the intrinsic magnetic moments of neighboring valence electrons to point in opposite directions. When all atoms are arranged in a substance so that each neighbor is 'anti-aligned', the substance is antiferromagnetic. Antiferromagnets have a zero net magnetic moment, meaning no field is produced by them. Antiferromagnets are less common compared to the other types of behaviors, and are mostly observed at low temperatures. In varying temperatures, antiferromagnets can be seen to exhibit diamagnetic and ferrimagnetic properties. In some materials, neighboring electrons want to point in opposite directions, but there is no geometrical arrangement in which each pair of neighbors is anti-aligned. This is called a spin glass, and is an example of geometrical frustration.

Ferrimagnetism:

Like ferromagnetism, ferrimagnets retain their magnetization in the absence of a field. However, like antiferromagnets, neighboring pairs of electron spins like to point in opposite directions. These two properties are not contradictory, because in the optimal geometrical arrangement, there is more magnetic moment from the sub lattice of electrons that point in one direction, than from the sub lattice that points in the opposite direction. The first discovered magnetic substance, magnetite, was originally believed to be a ferromagnet; Louis Néel disproved this, however, with the discovery of Ferrimagnetism.

Laws In Magnetism :

There are the many theories and laws that can explains the concept of magnetism . I have discussed the “ Curies Law In Magnetism”.

Curies Law In Magnetism:

According To Curies Law , intensity of magnetism (I) of a magnetic material is

Directly Proportional To magnetic Induction (B)

Inversely Proportional to the temperature (T) Of material.

i.e. I œ B

I œ 1/T

Combining these Factors We get

I œ B/T

As B œ H , magnetic intensity

Therefore, I œ H/T or

I/H œ1/T

i.e. Xm œ 1/T Or Xm =C/T

where c is the constant of proportionality and called Curie’s Constant.

Thus for paramagnetic materials , both Xm and µ depends not only on the material , but also on the sample temperature.

This defines the Curies Law in magnetism

Variation of B with H.

Electromagnetism:

(http://www.school-for-champions.com/science/electromagnetism.html)

An electromagnet is an object that acts like a magnet, but its magnetic force is created and controlled by electricity—thus the name electromagnet. By wrapping insulated wire around a piece of iron and then running electrical current through the wire, the iron becomes magnetized. This happens because a magnetic field is created around a wire when it has electrical current running through it. Creating a coil of wire concentrates the field. Wrapping the wire around an iron core greatly increases the strength of the magnetic field.

How electromagnetism works:

When electricity passed through a wire, a magnetic field is created around the wire. Looping the wire increases the magnetic field. Adding an iron core greatly increases the effect and creates an electromagnet. You can create an electromagnet without the iron core. That is usually called a solenoid.

Magnetic field

When DC electricity is passed through a wire, a magnetic field rotates around the wire in a specific direction.

Magnetic field rotating around wire

Compass can show field

Connecting a wire to a battery and placing a compass near the wire can demonstrate a magnetic field. When the current is turned on, the compass-needle will move. If you reverse the direction of the current, the needle will move in the opposite direction.

Right hand rule

To find the direction the magnetic field is going, you can use the "right-hand rule" to determine it. If you take your right hand and wrap it around the wire, with your thumb pointing in the direction of the electrical current (positive to negative), then your fingers are pointing in the direction of the magnetic field around the wire. Try it with the picture above.

Wire in a coil

Wrapping the wire in a coil concentrates and increases the magnetic field, because the additive effect of each turn of the wire.

Coiled wire increases magnetic field

A coil of wire used to create a magnetic field is called a solenoid.

Iron core

Wrapping the wire around an iron core greatly increases the magnetic field. If you put a nail in the coil in the drawing above, it would result in an electromagnet with the a north seeking pole on the "N" side.

Using AC electricity

If AC electricity is used, the electromagnet has the same properties of a magnet, except that the polarity reverses with the AC cycle.

Strength of electromagnetic field

The strength of the electromagnetic field is determined by the amount of current, number of coils of wire, and the distance from the wire.

Unit

The unit of magnetic force is called the tesla (T). Near a strong magnet the force is 1-T. Another unit used is the gauss, where 104 gauss (10,000) equals 1 tesla.

Current

The strength of the magnetic field is proportional to the current in the wire. If you double the current, the magnetic force is doubled.

Since Voltage = Current x Resistance (V = I*R), you can double the current in a wire by doubling the voltage of the source of electricity.

Turns of coil

If you wrap the wire into a coil, you increase the magnetic force inside the coil, proportional to the number of turns. In other words, a coil consisting of 10 loops has 10 times the magnetic force as a single wire with the same current flowing through it. Likewise, a coil of 20 loops has 2 times the magnetic force than one with 10 loops.

Varies with distance

The magnetic force decreases with distance. It varies inversely proportional to the square of the distance. For example the force at 2 cm. from a wire is 1/4 that of at 1 cm., and the force at 3 cm. is 1/9 the force at 1 cm.

Applications & Future Prospective Of Magnetism:

(Link : http://science.jrank.org/pages/4085/Magnetism-Applications-magnetism.html)

The main applications of the magnetism in the real life are:

Electromagnets are utilized as key components of transformers in power supplies that convert electrical energy from a wall outlet into direct current energy for a wide range of electronic devices, and in motors and generators.

High field superconducting magnets (where superconducting coils generate the magnetic field) provide the magnetic field in MRI (magnetic resonance imaging) devices that are now used extensively in hospitals and medical centers.

Magnetic materials that are difficult to demagnetize are used to construct permanent magnets. Permanent magnet applications are in loudspeakers, earphones, electric meters, and small motors.

Electromagnets can also be used to create continual motion such as with electric motors and maglev trains

A loudspeaker consists of a wire carrying an alternating current. When the wire is in the magnetic field of the permanent magnet it experiences a force that generates a sound wave by alternate compression and rarefaction of the surrounding air when the alternating frequency of the current is in the audible range.

The more esoteric applications of magnetism are in the area of magnetic recording and storage devices in computers, and in audio and video systems.

Magnetic storage devices work on the principle of two stable magnetic states represented by the 0 and 1 in the binary number system. Floppy disks have dozens of tracks on which data can be digitally written in or stored by means of a write-head and then accessed or read by means of a read-head. A write-head provides a strong local magnetic field to the region through which the storage track of the disk is passed. The read-head senses stray magnetic flux from the storage track of the disk as it passes over the head.

Another example of digital magnetic storage and reading is the magnetic strip on the back of plastic debit and credit cards. The magnetic strip contains identification data which can be accessed through, for example, an automatic teller machine.

Used in levitation: The most popular application of diamagnetic materials is magnetic levitation, where an object will be made to float in are above a strong magnet. Although most experiments use inert objects, researchers as the University of Nijmegen in the Netherlands demonstrated levitating a small frog in a powerful magnetic field.

Levitated Frog

(link: http://www.school-for-champions.com/science/magnetic_materials.htm)

Used in MRI devices : Another important application of diamagnetic materials is magnetic resonance imaging (MRI). In this useful diagnostic tool in medicine. The way it works is that when carbon-based atoms in the body are exposed to a strong magnetic field, they are slightly repelled by the field. This movement of the atoms can be detected and used for analysis.

These are the main applications of the magnetism in the daily life:

Future Prospective Of Magnetism:

The main future prospective of Magnetism are as follows:

The magnets will used in order to cure the cancer .

Researchers Use the magnetism to target cells to animals Arties.

The another future prospective of the magnetism in a micro space system to study frustration in buckled monolayer of micro sphere at Penn.

A sensor network Protect Containers, navigate Robots.

Disappearing superconductivity reappears in 2 D striped materials offers more clues to high temperature superconductivity

Reports adds Global magnetic materials market analysis

Maglev Trains. The Future Of Transport.

Manipulating Magnetism For Future Data Storage Devices.