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# What is Magnetic properties of Materials ?

It is common characteristics of Materials . Magnetic properties of material involve concept based on the magnetic dipole moment. Some of the material has the ability to create internal Dipole moment . For this reason this kinds of material present special type of properties. Some common characteristics of this material is ...

1. attracting other magnetic material.
2. Inducing pole in this material .
3. The polarity of two pole are opposite .
4. When magnetizing occurring then some parameter of material is changed ( Current I, Magnetic flux )

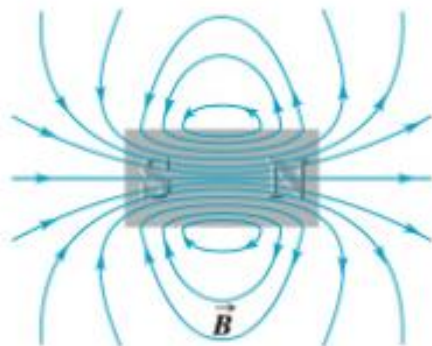
# The most common term which are related to magnetic property .

## Magnetic moment $\mu_m$ :

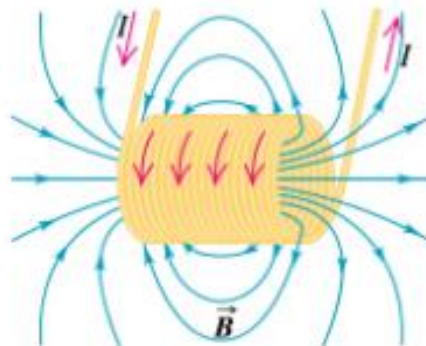
A vector quantity associated with the magnetic properties of electric current loops or, more generally, magnets. It is equal to the amount of current flowing through the loop multiplied by the area encompassed by the loop, and its direction is established by the **right hand rule** for rotations  $\mu_m = IA U_m$

$U_m = A$  unit vector induced from loop as right hand rules.

$I =$  Circulating current ;  $A =$  Area coverage by loop

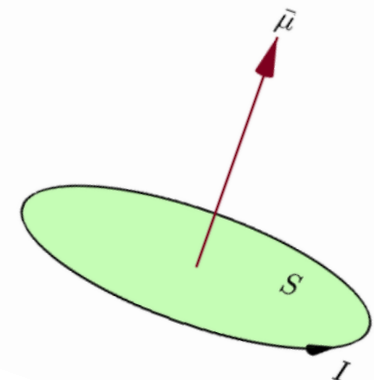


(a)



(b)

Magnetic properties of Materials



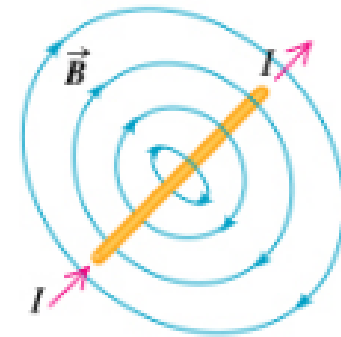
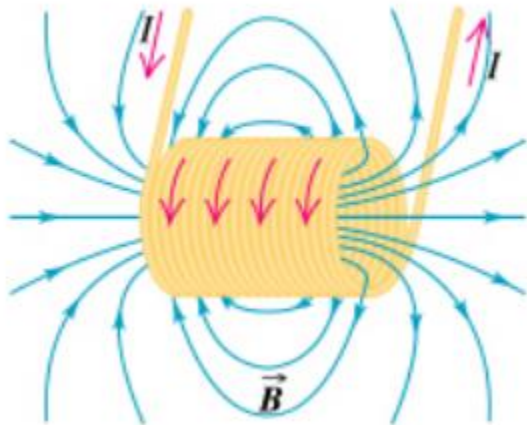
# Magnetic field or Intensity

A field of force associated with changing **electric fields**, as when electric charges are in motion. Magnetic fields exert deflective forces on moving electric charges. Most **magnets** have magnetic fields as a result of the spinning motion of the electrons orbiting the atoms of which they are composed; **electromagnets** create such fields from electric current moving through coils

total magnetic field  $B$  in the material is given by

$$B = \mu_0(H + M)$$

$$H = B / \mu_0$$



# Magnetization Vector M

The Average Dipole moment per unit volume is called Magnetization vector M ,

$$\vec{M} = \frac{1}{V} \sum_{\substack{\text{protons} \\ \text{in } V}} \vec{\mu}_i$$

# Magnetic susceptibility $\chi_m$

In electromagnetism, the **magnetic susceptibility**  $\chi_m$  is a dimensionless proportionality constant that indicates the degree of magnetization of a material in response to an applied magnetic field.

$$\mathbf{M} = \chi_v \mathbf{H}$$

The Relation Between  $\chi_m$  and  $\mu_r$ ,

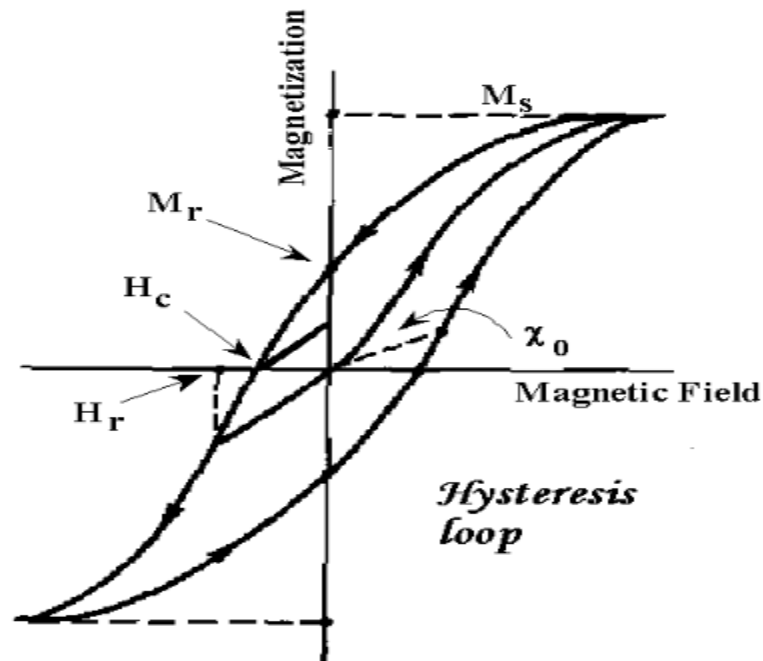
$$\mu = \mu_0(1 + \chi_v).$$

$$\mu_r = 1 + \chi_m$$

# Hysteresis

In addition to the Curie temperature and saturation magnetization, ferromagnetism can retain a memory of an applied field once it is removed. This behavior is called hysteresis and a plot of the variation of magnetization with magnetic field is called a hysteresis loop

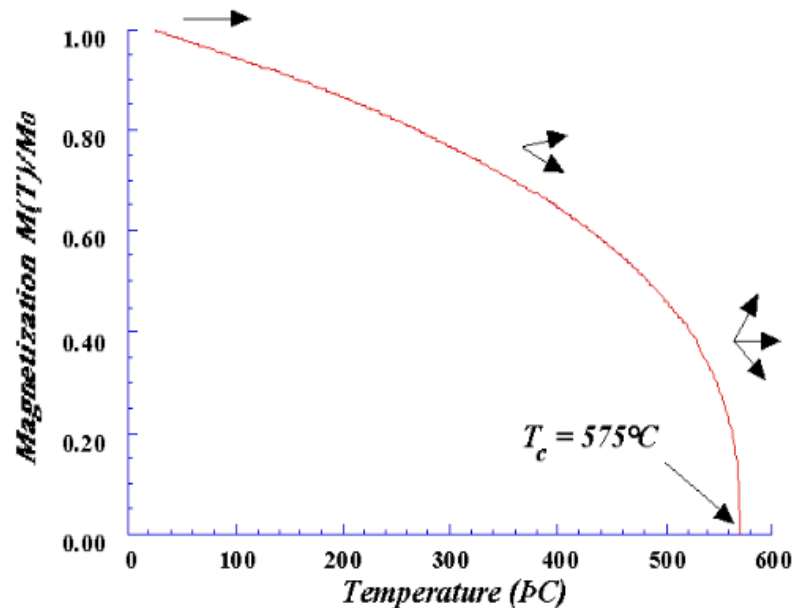
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# Curie Temperature

Even though electronic exchange forces in ferromagnets are very large, thermal energy eventually overcomes the exchange and produces a randomizing effect. This occurs at a particular temperature called the Curie temperature ( $T_C$ ). Below the Curie temperature, the ferromagnet is ordered and above it, disordered. The saturation magnetization goes to zero at the Curie temperature. A typical plot of magnetization vs temperature for magnetite is shown below.



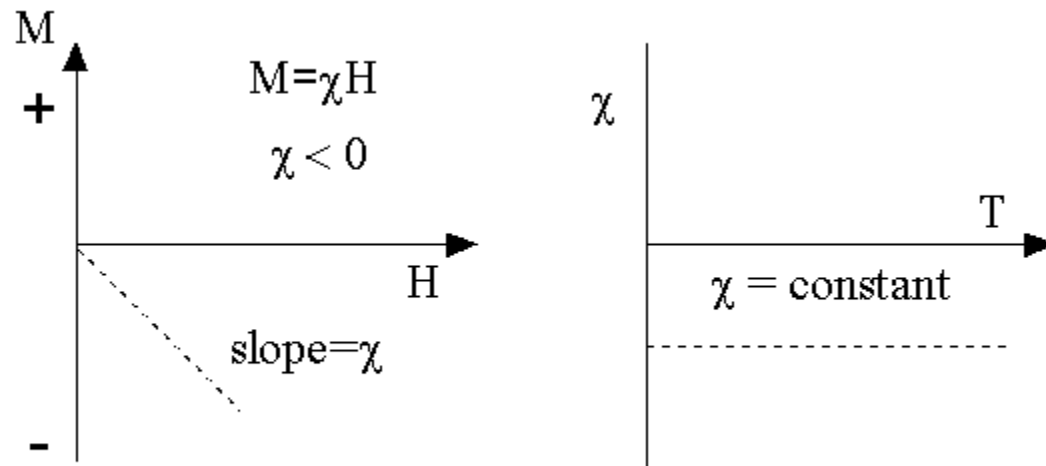
# Types of Magnetic Material

The magnetic behavior of materials can be classified into the following five major groups:

1. Diamagnetism
2. Paramagnetism
3. Ferromagnetism

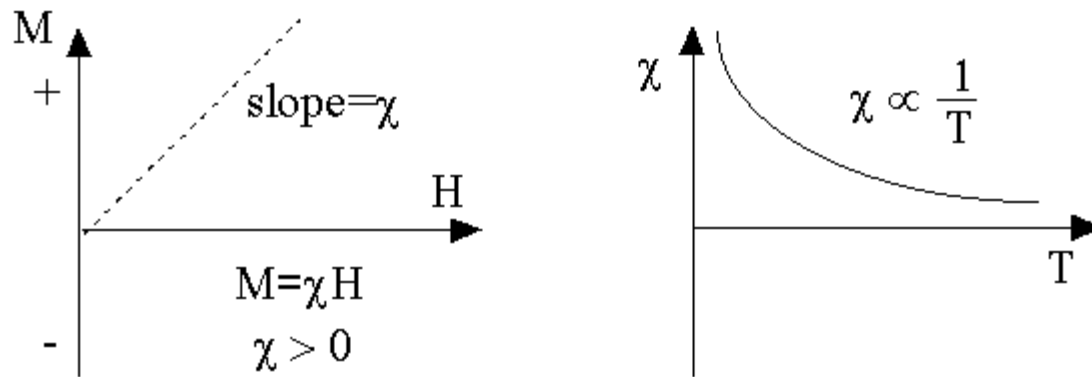
# Diamagnetism

Diamagnetism is a fundamental property of all matter, although it is usually very weak. It is due to the non-cooperative behavior of orbiting electrons when exposed to an applied magnetic field. Diamagnetic substances are composed of atoms which have no net magnetic moments (ie., all the orbital shells are filled and there are no unpaired electrons). However, when exposed to a field, a negative magnetization is produced and thus the susceptibility is negative. If we plot  $M$  vs  $H$ , we see:



# Paramagnetism

This class of materials, some of the atoms or ions in the material have a net magnetic moment due to unpaired electrons in partially filled orbitals. One of the most important atoms with unpaired electrons is iron. However, the individual magnetic moments do not interact magnetically, and like diamagnetism, the magnetization is zero when the field is removed. In the presence of a field, there is now a partial alignment of the atomic magnetic moments in the direction of the field, resulting in a net positive magnetization and positive susceptibility.

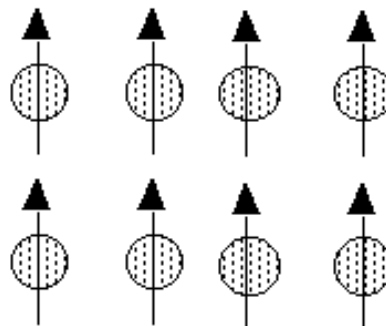


*Paramagnetism*

# Ferromagnetism

When you think of magnetic materials, you probably think of iron, nickel or magnetite. Unlike paramagnetic materials, the atomic moments in these materials exhibit very strong interactions. These interactions are produced by electronic exchange forces and result in a parallel or antiparallel alignment of atomic moments. Exchange forces are very large, equivalent to a field on the order of 1000 Tesla, or approximately a 100 million times the strength of the earth's field.

**parallel alignment**



*Ferromagnetism*

# Application Of Magnetic property

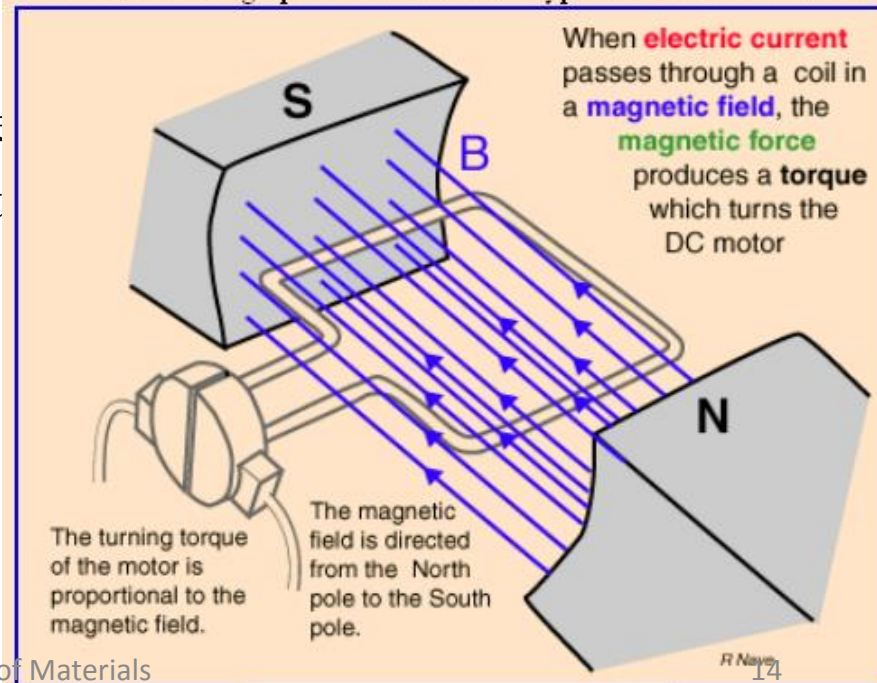
In real world there many operation of magnetic property . This property is use as two form as Electromagnetic field and magnetic field .

## Electronic Motor and Generator

An electric motor that uses electromagnets in the spinning stator to turn. There is an electrical 'slip-ring' on the stator that directs the power to a different magnet section of the stator to achieve rotation. Quick & dirty, but here are books written on the subject.

### Magnetic Field in DC Motor

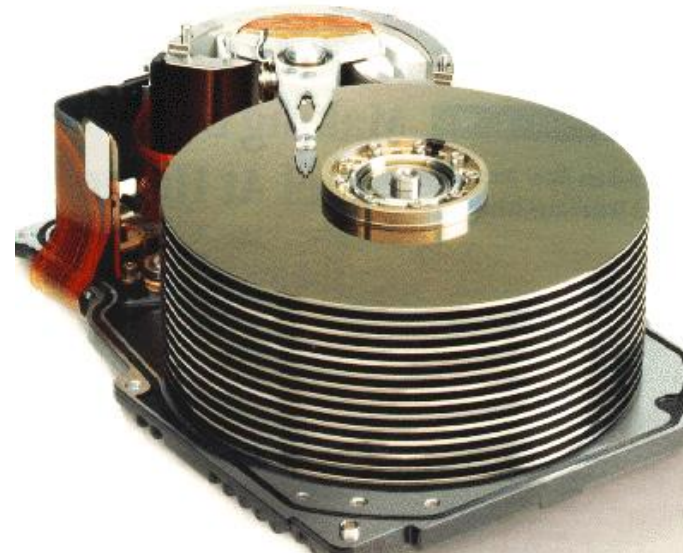
This is an active graphic. Click on bold type for further illustration.



# Magnetic storage

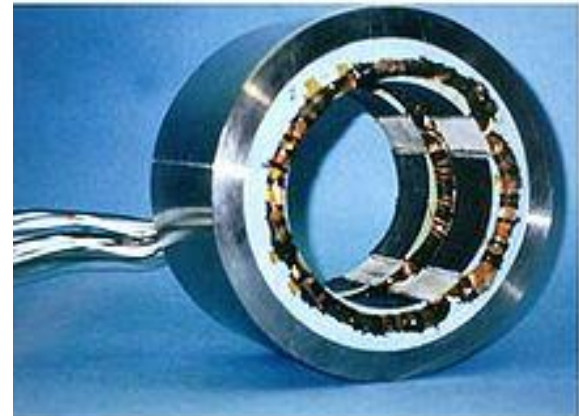
**Magnetic storage** and **magnetic recording** are terms from engineering referring to the storage of data on a magnetized medium. Magnetic storage uses different patterns of magnetization in a magnetizable material to store data and is a form of non-volatile memory. The information is accessed using one or more read/write heads.

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# Magnetic bearing

A **magnetic bearing** is a bearing which supports a load using magnetic levitation. Magnetic bearings support moving machinery without physical contact, for example, they can levitate a rotating shaft and permit relative motion with very low friction and no mechanical wear.





# Magnetic separator and Holding Device

Magnetic separator for particle size less than 3mm magnetite, pyrrhotite, ilmenite and other materials, wet magnetic separation, but also for coal, non-metallic minerals, building materials and other materials in addition to iron work. Available downstream, semi-reflux, reflux-type and other forms of magnetic separator, cylinder surface magnetic field strength can be produced according to the actual use of the special.



# Magnetic property in Medical

## The Attraction of Magnet Therapy

Some magnets are multipolar, with both the north and south poles facing the patient/desired body part, often with manufacturers touting that their circular or checkerboard or triangular pattern is in some way superior. But this also further limits how far the magnetic field reaches. Any effect inside the body must be limited to a few millimeters, only skin deep.

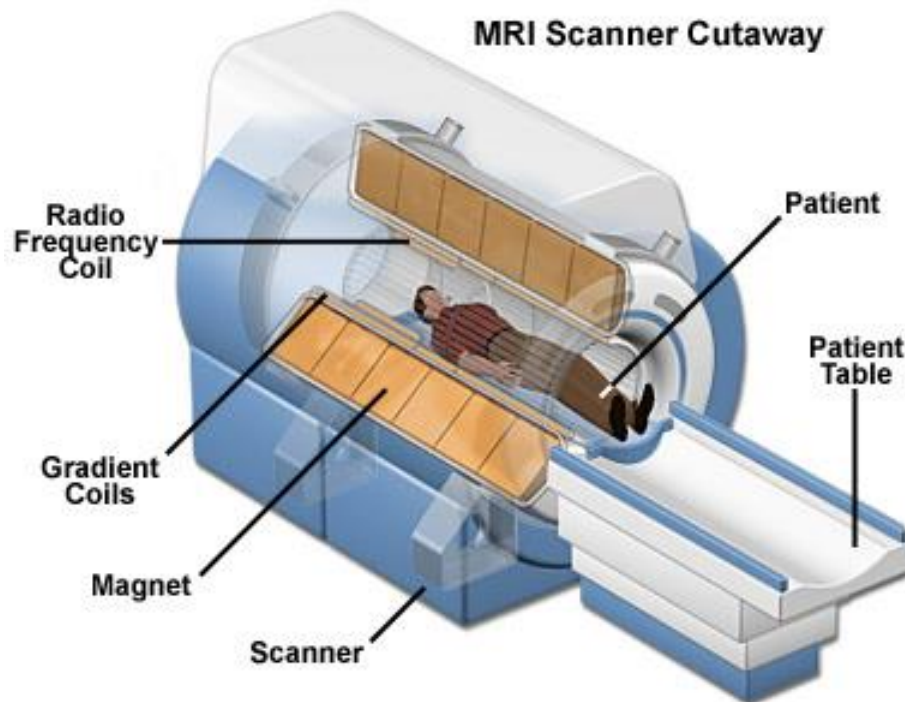


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# Magnetic Resonance Angiogram (MRA)

A magnetic resonance angiogram (MRA) is a type of magnetic resonance imaging (MRI) scan that uses a magnetic field and pulses of radio wave energy to provide pictures of blood vessels inside the body. In many cases MRA can provide information that can't be obtained from an X-ray, ultrasound, or computed tomography (CT) scan.



# Using In Security System

## **Burglar alarm**


### **Passive magnetic field detection**

This buried security system is based on the Magnetic Anomaly Detection principle of operation. The system uses an electromagnetic field generator powered by two wires running in parallel. Both wires run along the perimeter and are usually installed about 5 inches apart on top of a wall or about 12"/30 cm below ground. The wires are connected to a signal processor which analyzes any change in the magnetic field.

# Eddy current brake

An **eddy current brake**, like a conventional friction brake, is responsible for slowing an object, such as a train or a roller coaster. However, unlike electro-mechanical brakes, which apply mechanical pressure on two separate objects, eddy current brakes slow an object by creating eddy currents through electromagnetic induction which create resistance, and in turn either heat or electricity.



An eddy current brake of a German ICE 3   
in action.

## Magnetic relays

A type of overload relay that senses the strength of the magnetic field that the current flow produces. Magnetic relays are often used in areas that experience extreme changes in temperature.

