PHYS 102- MAGNETIC FIELD AND MAGNETIC FORCES

Review: Four fundamental types of forces

1) Gravitational Force

2) Electromagnetic Force

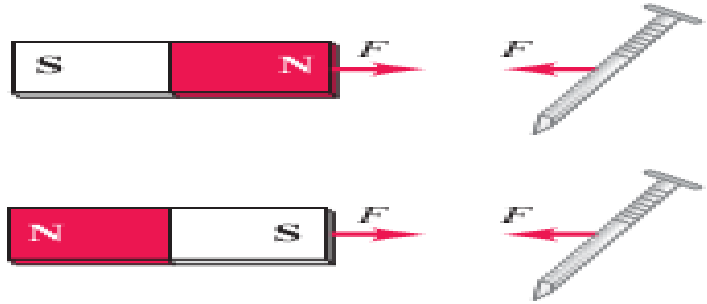
3) Strong Force

4) Weak Force

Curled from University Physics with Modern Physics: Young & Freedman

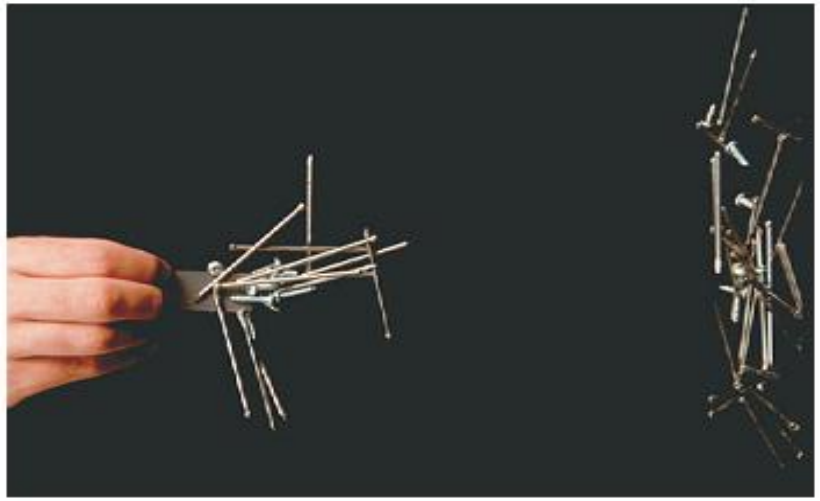
So, What is a Magnet?

Everybody uses magnetic forces: from Electric Motors----Microwave ovens — Loudspeakers----- Computer Printers ---- Iron Gates-----Chains…e.t.c



When certain materials are brought near iron and are found to be attracted to it: they are called **magnets**. The phenomenon of attraction is called **magnetism**.

The most familiar example of magnetism are permanent magnets: which attracts un-magnetized iron objects and can also attract or repel other magnets



History: An Overview

Magnetic Phenomena were first observed at about 2500 years ago.

They were observed in fragments of magnetized iron ore found near the ancient city of Magnesia (now Manisa, in western Turkey).

These fragments were what are now called permanent magnets.

Permanent magnets were found to exert forces on each other as well pieces of iron that were not magnetized.

The first evidence of relationship of magnetism to moving charges was discovered in 1820 by Danish Scientist Hans Christian Oersted

The earth itself is a magnet: the northern geographic pole is close to a magnetic south pole, that is why the northern pole of a compass needle points north.

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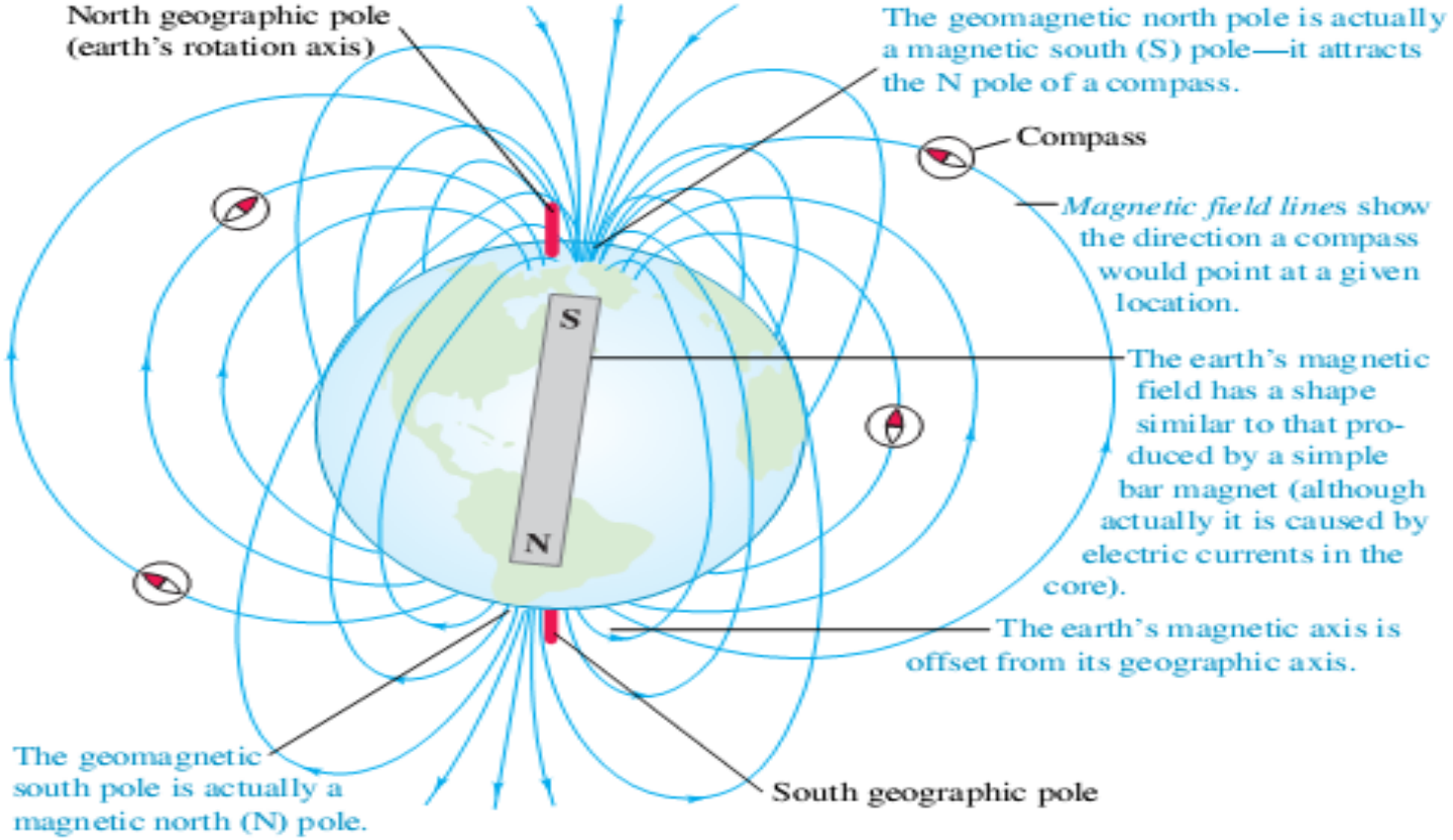
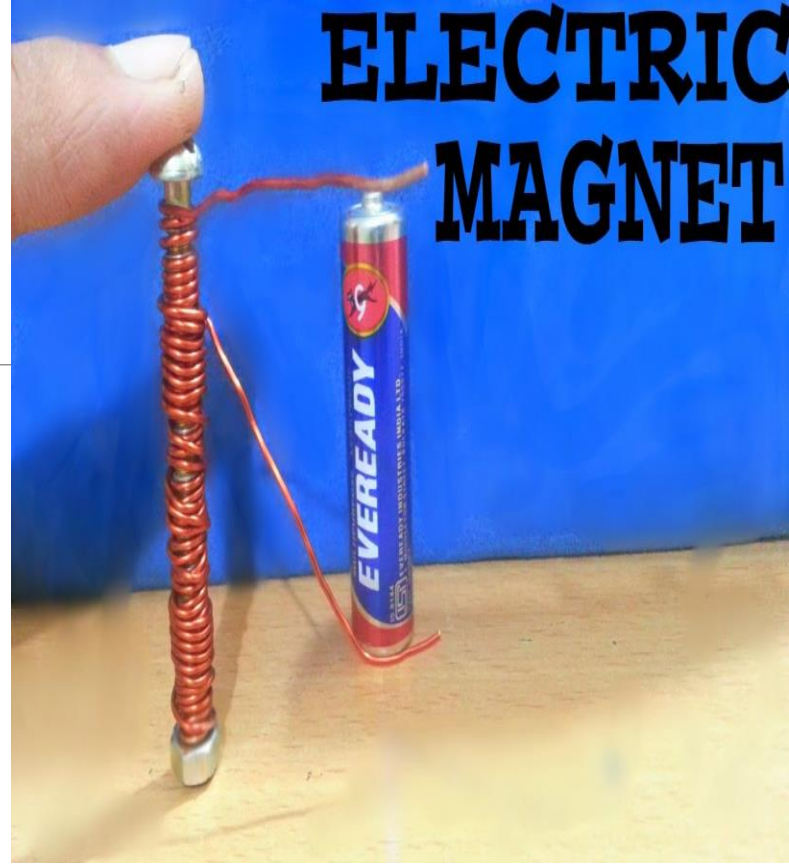
A sketch of the earth's magnetic field



Magnetic/Electric Forces



1) For Electric Forces: They arise in two stages:

a) A charge produce an electric field in the space around it.

b) A second charge responds to this field.

2) For Magnetic Forces: They also arise in two stages:

a) A **moving charge** or collection of moving charges produces a magnetic field.

b) A second current or **moving charge** responds to this magnetic field and so experiences a magnetic force.

Hence, Electric forces acts on electric charges whether they are moving or not. While, Magnetic force act only on **moving charges**.

What to know about Magnetic Field?

Recall: We represented electric interactions in two steps:

1) A distribution of electric charges creates an electric field $\vec{E}$ in the surrounding space.

2) The electric field exerts a force $\vec{F} = q\vec{E}$ on any other charge q that is present in the field.

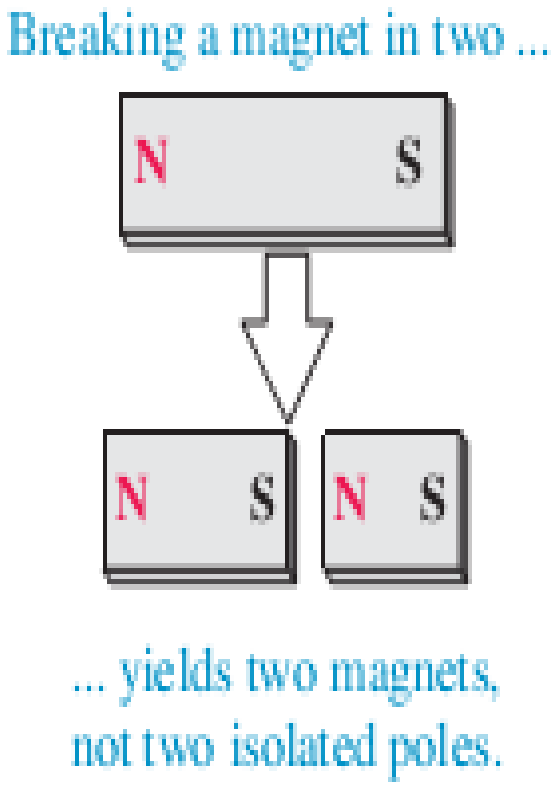
For Magnetic Field, magnetic interactions can be represented in a similar way:

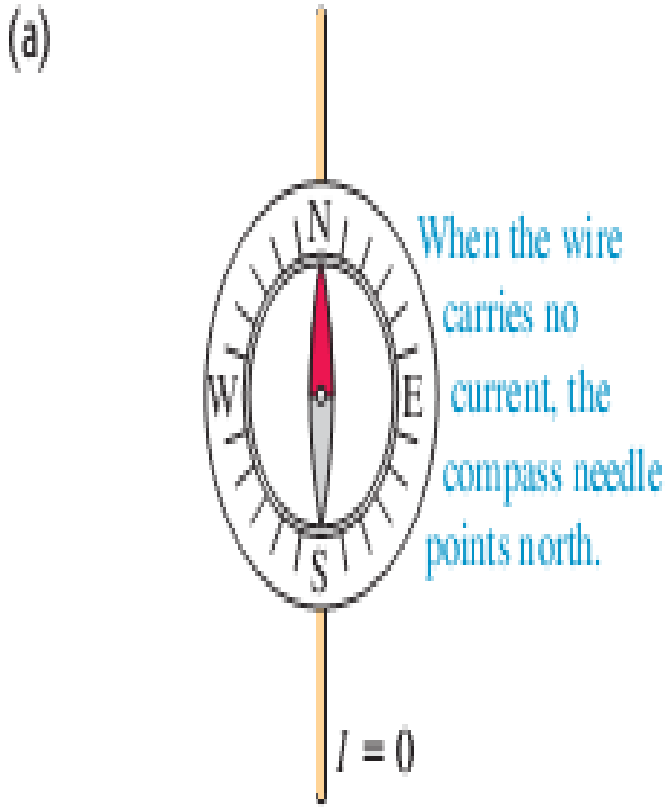
1) A moving charge or a current creates a magnetic field in the surrounding space (in addition to its electric field).

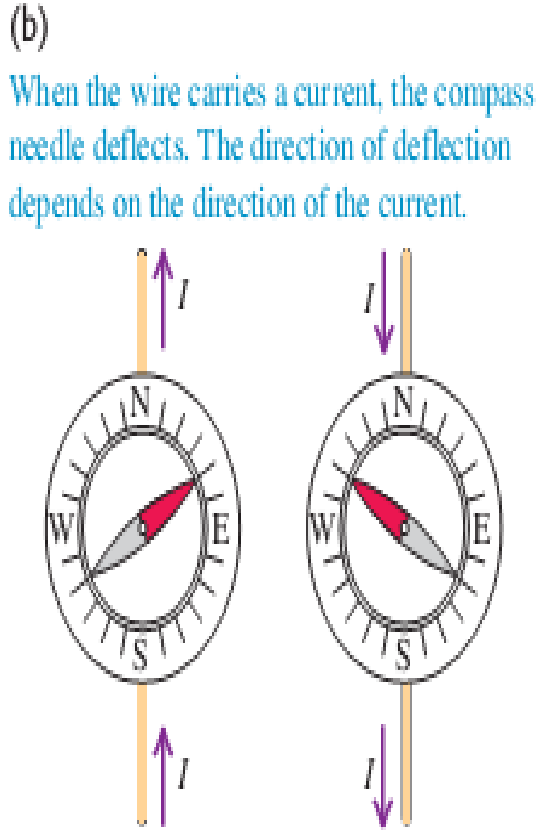
2) The magnetic field exerts a force $\vec{F}$ on any other moving charge or current that is present in the field.

The symbol for magnetic field is represented as $\vec{B}$

A compass needle tends to align with the magnetic field at the needle's position.







Magnetic Forces on moving charges (F)

The magnitude of the magnetic force (F) on a charge moving in magnetic field depends on the product of four factors:

1) q, the charge.

2) v, magnitude of the velocity of the charge.

3) B, the strength of the magnetic field.

4) sin θ, where θ is the angle between the field lines and the velocity $\vec{v}$.

$$\boldsymbol{F = qvBsin\theta}$$

Where 1 Tesla can also be expressed as weber per square meter. i.e: $1T = 1\ Wb/m^2$

Also, in cgs unit, Guass is used for B; where $1G = \ 10^{-4}T$

$$1T = 1\,Wb/m^2 = 1\ \frac{N}{C.(\frac{m}{s})} = 1\ \frac{N}{A.m}$$

Magnetic Forces on moving charges (F)

When a charge is moving perpendicular to the magnetic field, it experiences a maximal magnetic force with magnitude.

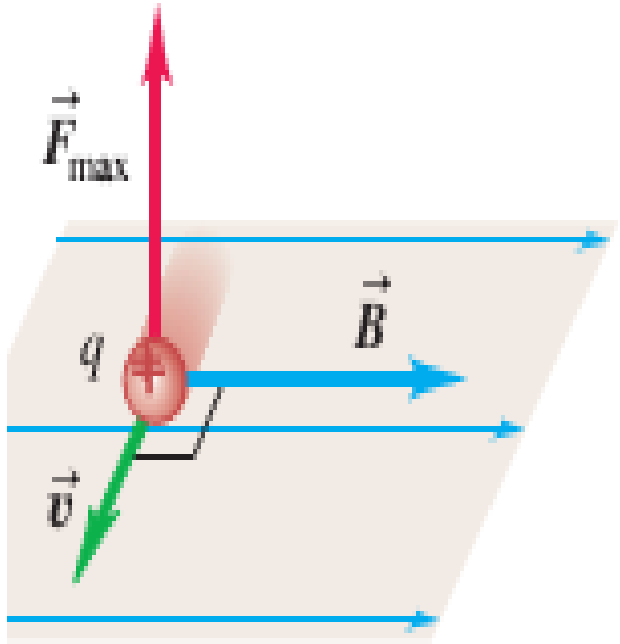
$F = qvB$

The path followed by the charge is expressed as:

$r = \frac{mv}{qB}$

The speed of the charge particle is expressed as:

$v = \frac{rqB}{m}$



Work Problems

1) A uniform magnetic field, $B = 3.0G$, exists in the +x-direction. A proton (q = +e) shoots through the field in the +y-direction with a speed of $5.0 \times 10^6\, m/s$. A) Find the magnitude and the direction of the force on the proton. B) Repeat same procedure for electron instead of proton.

2) If a proton charge (q = +e, $m_p = 1.67 \times 10^{-27}\, kg$) with speed $5.0 \times 10^6\, m/s$. If it is passing through a uniform magnetic field with B = 30G. Describe the path followed by the proton if the proton velocity is perpendicular $\vec{\boldsymbol{B}}$

3) A proton enters a magnetic field of flux density of 1.5 Wb/m^2 with a velocity of $2.0 \times 10^7\, m/s$ at an angle of 30° with the field. Compute the magnitude of the force on the proton.

4) A cathode ray beam (i.e an electron beam; $m_e = 9.11 \times 10^{-31}\, kg$, q = -e) is bent in a circle of radius 2.0cm by a uniform field with B = 4.5×10^{-3} T. What is the speed of the electrons?

Answers:

1) 2.4×10^{-16} N and the force is in the –z direction for proton.

The magnitude of force for electron is the same. But, because electron is negative, the force direction is reversed. Hence, the force is in the +z direction

2) 17m

3) 2.4×10^{-12} N

4) 1.58×10^{7} m/s

If you got em' four.....BGH is on me.
Yeah!!!!!!!!!!

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If you have any questions, let me know