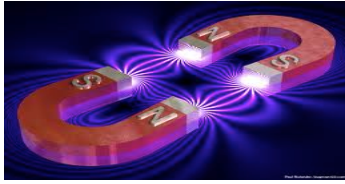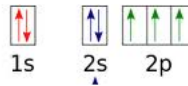# Chapter 21- Magnetism

Demo - horse shoe magnet and paperclips and bars

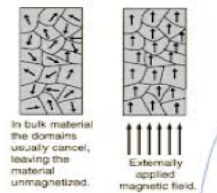
Magnetism-

Demo- magnet and compass and iron filings

Caused by spinning unpaired electrons

1s   2s   2p


Spinning e⁻ create **magnetic domains**

- domains can be jumbled = non-magnetic
- put in strong magnetic field and line up = magnetic
- drop or heat = jumble magnetic domains = nonmagnetic

In bulk material the domains usually cancel, leaving the material unmagnetized.
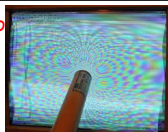
Externally applied magnetic field.

Magnetic Field- (B-Field)

1) Surrounds magnet...where force of magnet can be felt (just like E-field)

2) Arrows point from N to S

3) Stronger near poles (lines closer)

4) CANNOT have a monopole
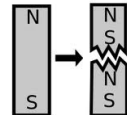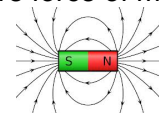
Computer monitor demo

Because $F_B \perp q$...F_B **CANNOT do work**

B fields are created by MOVING electrons

$E = F/q$

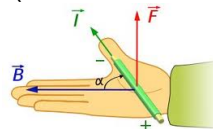$B = F/qv\sin\theta$ ...only $\perp$ component causes force

or $F_B = qvB\sin\theta$ $B = Tesla\ (T)$

θ = angle between F and q

Right Hand Rules:

1) **Force** on a wire or charged particle (remember charged particles must be moving!)

Fingers = B...point FROM N to S

Thumb = Current (+ charge)

Palm = Force (think SLAP!)

*** Force on electron use LEFT hand***

Panel 1

Practice......

O = out of page
x = into page

N

S

N

S

Panel 2 — Right Hand Rule #2

Right Hand Rule #2

Thumb = current

Fingers (CURVED)

= B

Panel 3 — Rule #2 practice

Rule #2 practice

Panel 4 — Force on a wire equation

Force on a wire equation....

$F = qvB$ = $C(m/s)T$ = $(C/s)mT$ = ILB

$F_{wire} = BILsin\theta$

Panel 5 — Mass Spectrometers

Mass Spectrometers - shoot charged particles into magnetic field to determine mass and/or charge

x x x x
x x x x
x x x x
x x x x

$Fc = Fb$

$mv^2/r = qvB$

$r = mv/qB$

Panel 6 — Relationship between E and B

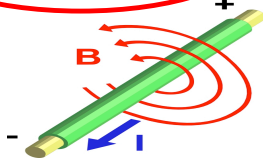*Relationship between E and B*

$qvB = F = Eq$

$E = vB$

v = E/B

E

B

__Magnetic Field around a wire__

$$B = \mu_o I / 2\pi r$$

μ_o = permability of free space

= $4\pi \times 10^{-7}$ Tm/A

r = distance from wire

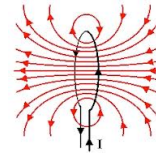*__Magnetic Field inside a loop__*

$$B = \mu_o I / 2r$$

r = radius of loop

__For multiple loops....__

$$B = N\mu_o I / 2r$$ N = number of loops
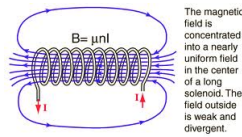

__Magnetic Field inside a solenoid = many parallel loops in shape of cylinder__
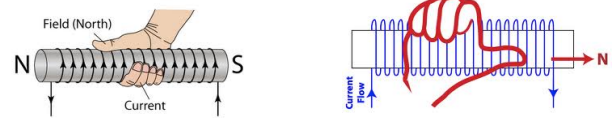
$$B = \mu_o n I$$

n = turns/length

$B = \mu n I$

The magnetic field is concentrated into a nearly uniform field in the center of a long solenoid. The field outside is weak and divergent.

__Solenoid Rt Hand Rule (can also use #2)__

Fingers = I

Thumb = N pole

(NOT B-field direction)

Field (North)

N   S

Current

Current Flow   N

__Motors__ **- covert electrical energy into mechanical energy**

demo - motor

Coil of Insulated Wire

Blacken the top half of one of the stripped wires.

Stripped Wires   Stripped Wire

S   F

B

N

F

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side view   top view
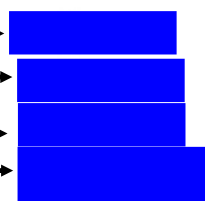
$$\tau = \frac{w}{2} I \ell B \sin\theta$$
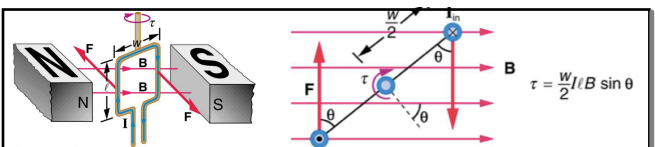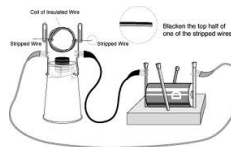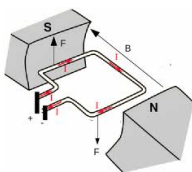
$$\tau = FL\sin\theta$$

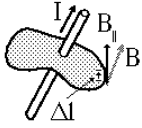since each side is pushed opposite direction   x2

since Lw = Area

if multiple loops (N)

Ampere's Law

For any closed loop path, the sum of the length elements times the magnetic field **in the direction of the length element** is equal to the permeability times the electric current enclosed in the loop.

$$\sum B_{\parallel} \Delta l = \mu_0 I$$