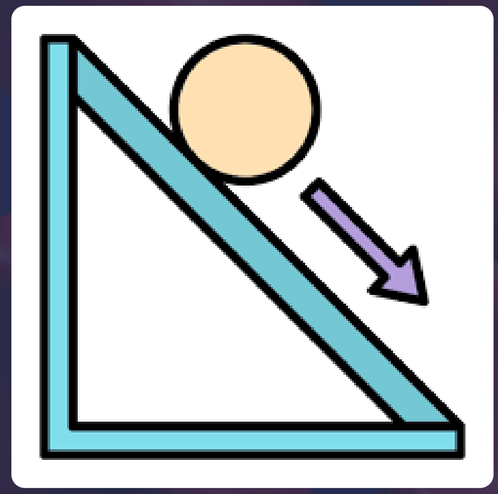
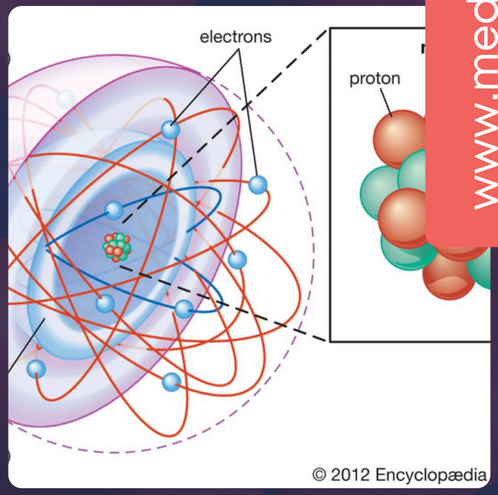
FSC-MIT-1

LEC#8 (8/11/2024)

FIRST-YEAR PHYSICS
FOR RADIOGRAPHERS





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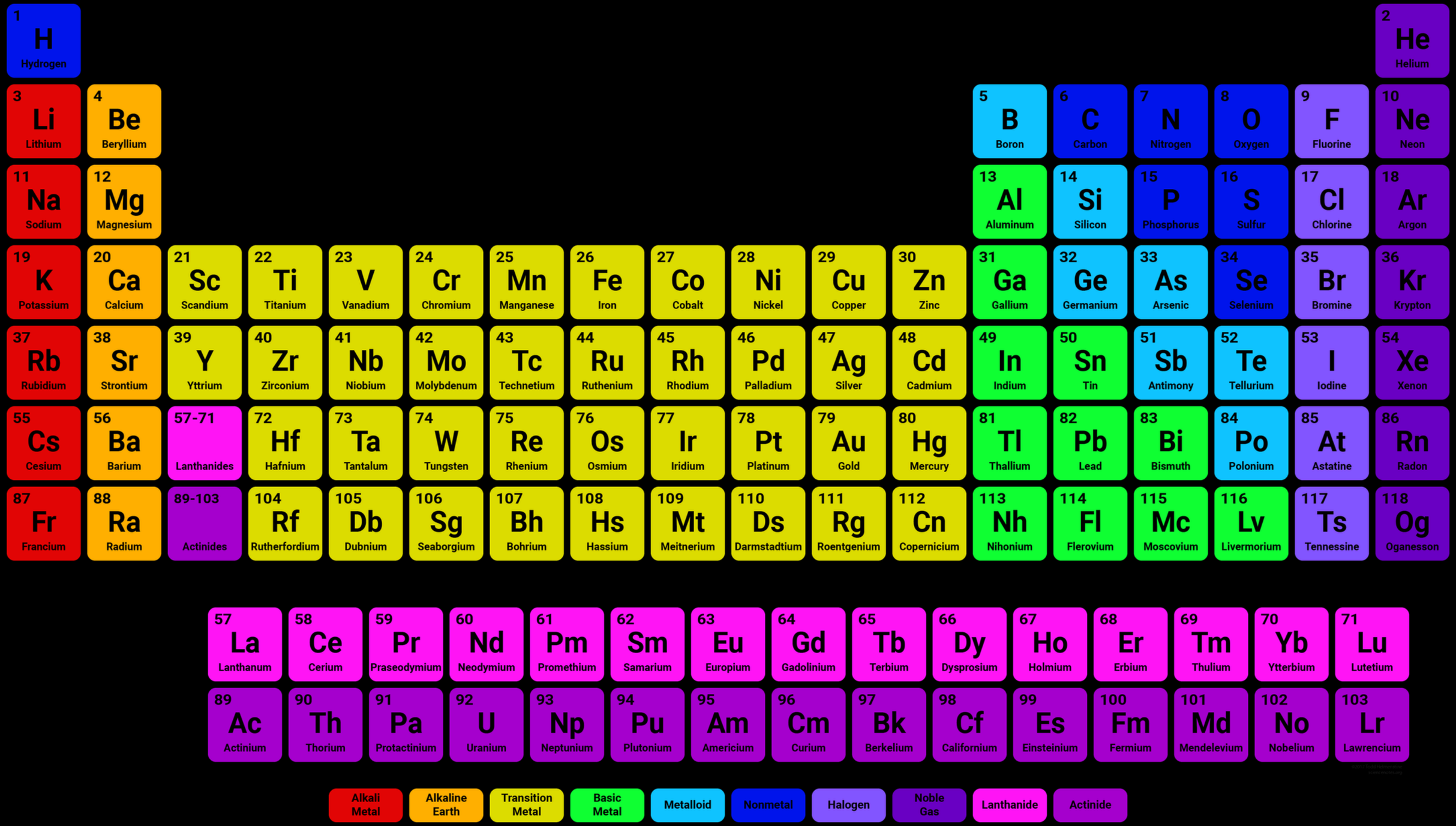
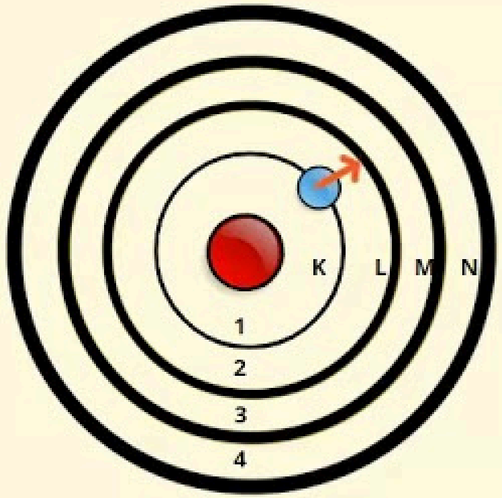
CHAPTER# 3 &4

MAGNET
MAGNETISM
ELECTROMAGNETISM

H/ DR. AYESHA RAUF


1 H Hydrogen
2 He Helium
3 Li Lithium
4 Be Beryllium
5 B Boron
6 C Carbon
7 N Nitrogen
8 O Oxygen
9 F Fluorine
10 Ne Neon
11 Na Sodium
12 Mg Magnesium
13 Al Aluminum
14 Si Silicon
15 P Phosphorus
16 S Sulfur
17 Cl Chlorine
18 Ar Argon
19 K Potassium
20 Ca Calcium
21 Sc Scandium
22 Ti Titanium
23 V Vanadium
24 Cr Chromium
25 Mn Manganese
26 Fe Iron
27 Co Cobalt
28 Ni Nickel
29 Cu Copper
30 Zn Zinc
31 Ga Gallium
32 Ge Germanium
33 As Arsenic
34 Se Selenium
35 Br Bromine
36 Kr Krypton
37 Rb Rubidium
38 Sr Strontium
39 Y Yttrium
40 Zr Zirconium
41 Nb Niobium
42 Mo Molybdenum
43 Tc Technetium
44 Ru Ruthenium
45 Rh Rhodium
46 Pd Palladium
47 Ag Silver
48 Cd Cadmium
49 In Indium
50 Sn Tin
51 Sb Antimony
52 Te Tellurium
53 I Iodine
54 Xe Xenon
55 Cs Cesium
56 Ba Barium
57-71 Lanthanides
72 Hf Hafnium
73 Ta Tantalum
74 W Tungsten
75 Re Rhenium
76 Os Osmium
77 Ir Iridium
78 Pt Platinum
79 Au Gold
80 Hg Mercury
81 Tl Thallium
82 Pb Lead
83 Bi Bismuth
84 Po Polonium
85 At Astatine
86 Rn Radon
87 Fr Francium
88 Ra Radium
89-103 Actinides
104 Rf Rutherfordium
105 Db Dubnium
106 Sg Seaborgium
107 Bh Bohrium
108 Hs Hassium
109 Mt Meitnerium
110 Ds Darmstadtium
111 Rg Roentgenium
112 Cn Copernicium
113 Nh Nihonium
114 Fl Flerovium
115 Mc Moscovium
116 Lv Livermorium
117 Ts Tennessine
118 Og Oganesson
57 La Lanthanum
58 Ce Cerium
59 Pr Praseodymium
60 Nd Neodymium
61 Pm Promethium
62 Sm Samarium
63 Eu Europium
64 Gd Gadolinium
65 Tb Terbium
66 Dy Dysprosium
67 Ho Holmium
68 Er Erbium
69 Tm Thulium
70 Yb Ytterbium
71 Lu Lutetium
89 Ac Actinium
90 Th Thorium
91 Pa Protactinium
92 U Uranium
93 Np Neptunium
94 Pu Plutonium
95 Am Americium
96 Cm Curium
97 Bk Berkelium
98 Cf Californium
99 Es Einsteinium
100 Fm Fermium
101 Md Mendelevium
102 No Nobelium
103 Lr Lawrencium
Alkali Metal
Alkaline Earth
Transition Metal
Basic Metal
Metalloid
Nonmetal
Halogen
Noble Gas
Lanthanide
Actinide

Electrons in the orbitals



+

s

2 electrons

n = 1

or

K-shell

8 electrons

p

s

n = 2

or

L-shell

18 electrons

s

p

d

n = 3 or M-shell

s

p

d

f

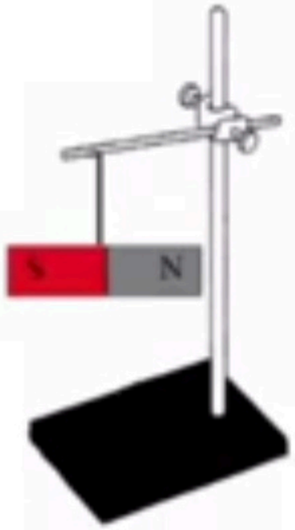
32 electrons

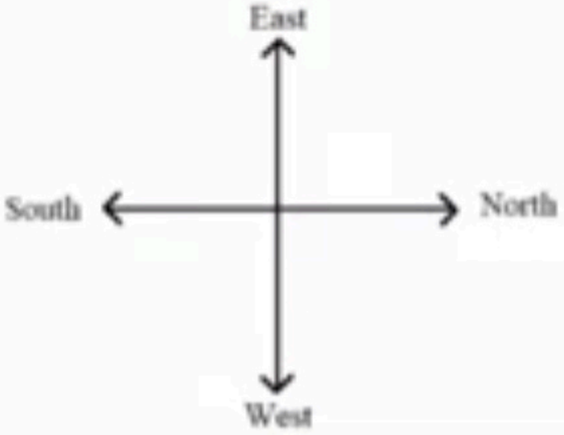
n = 4 or N-shell

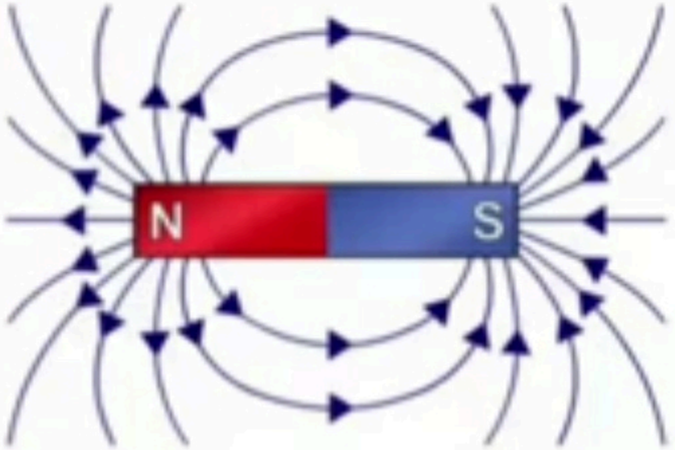
What is Magnet ?

A magnet is a material or artificial setup that can produce its own field called magnetic field by which it attract ferromagnetic materials like iron, cobalt or nickel.

- *Magnets, suspended through a string, always point towards the north-south direction.*
- *A magnet always comes with a pair of magnetic poles, which cannot be seperated.*







Ferromagnetic

- Any material that possess magnetization WITHOUT an external magnetic field is ferromagnetic
- large and positive susceptibility
- Examples of ferromagnetic materials

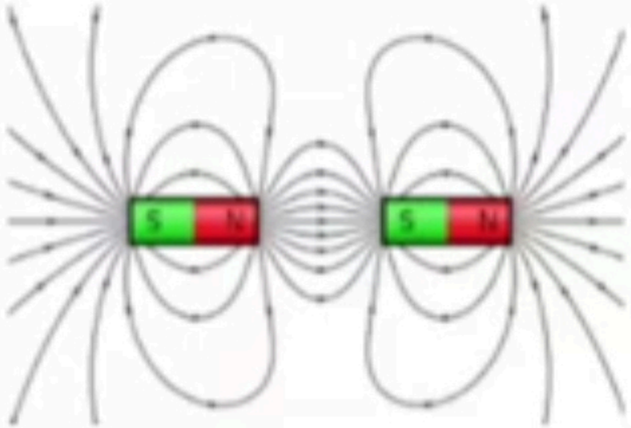
Iron (Fe)

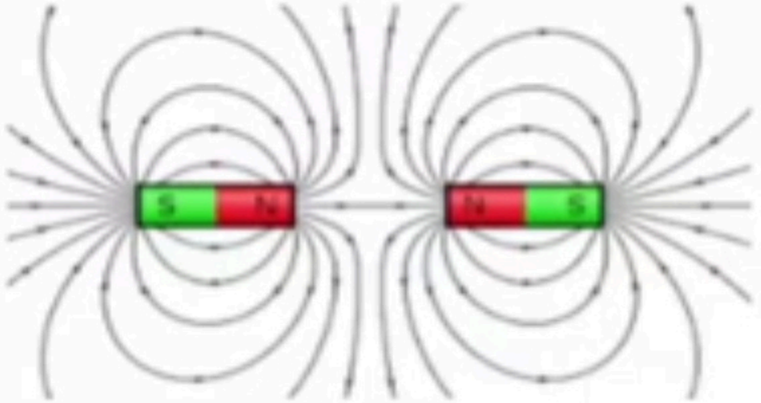
Susceptibility = 200

Cobalt (Co)

Susceptibility = 70

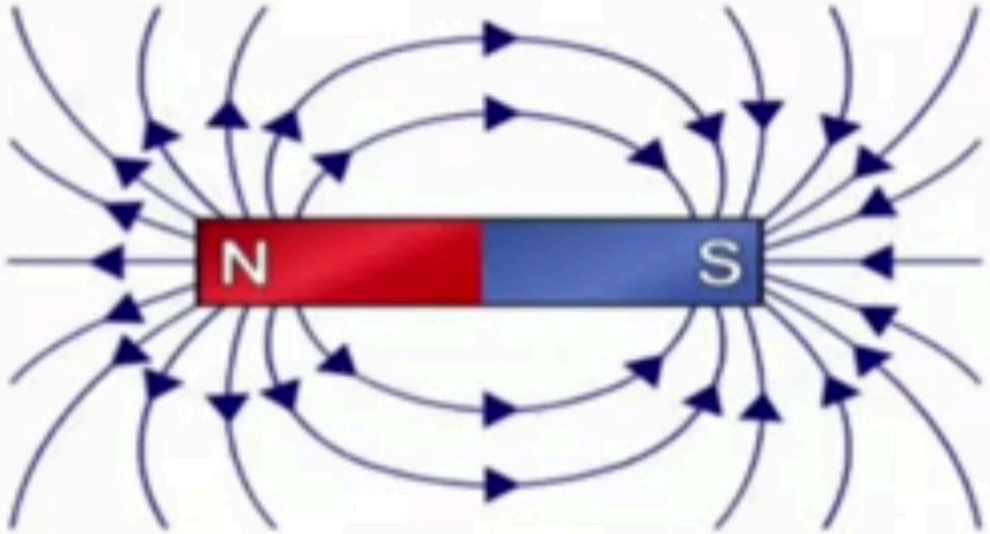
4. Maximum force at poles and zero at middle.
5. When a magnet is broken into two parts then each part becomes a magnet with north and south pole that mean magnetic poles always exist in pairs.
6. Magnet produce its own magnetic field in which other magnet experiences magnetic force which can be repulsive or attractive.





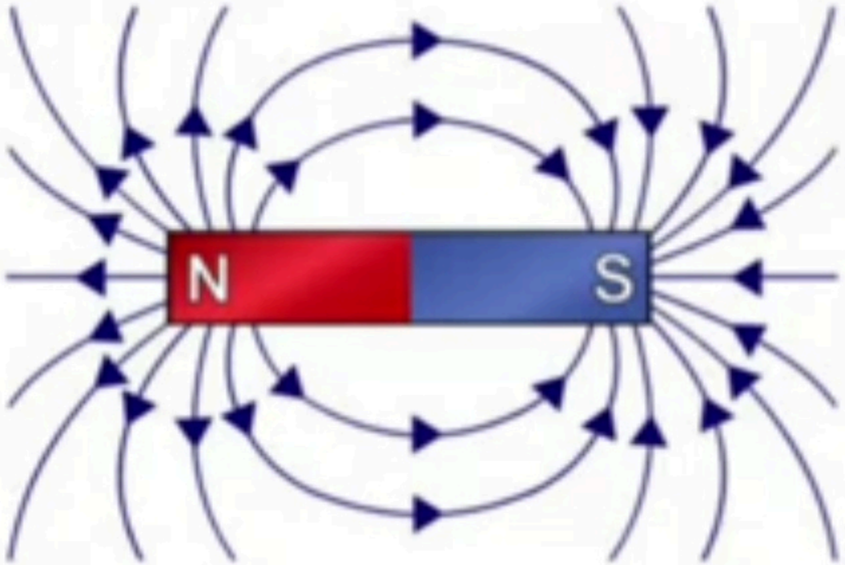
Magnetic Field & Lines of force

- *The space around a magnetic pole in which another pole feel a force is called the magnetic field.*
- *Magnetic field can be visualized by magnetic lines of forces, which are imaginary lines.*
- *A line of force can be defined as the path taken by an independent north pole moving from the north pole of magnet to the south pole.*



The Line of Force have the following properties:-

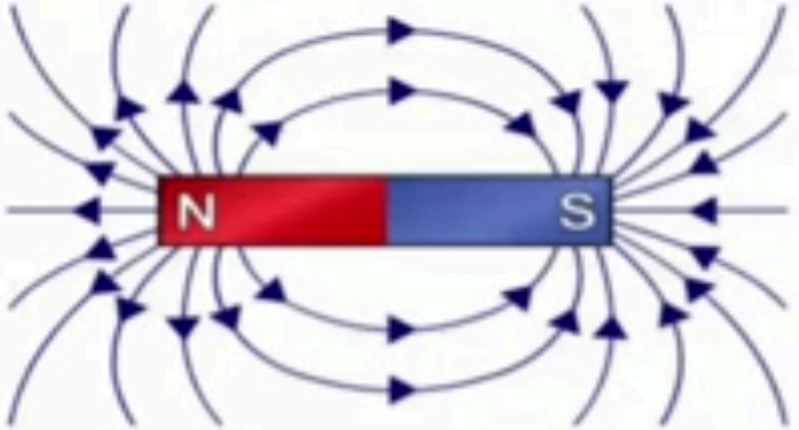
- They are imaginary lines.
- Starts at north pole and ends at the south pole.
- Two lines of force never cross each other.
- The lines of force are greater near the poles.
- Can never be closed loop.



Magnetic Flux & Flux Density

- The total number of lines of force used to express pole strength is called the magnetic flux.
- Unit is weber (Wb).

- The term magnetic flux density (B) is defined as the magnetic flux per unit area.
- Unit is Wbm^{-2}.
- SI unit of magnetic flux density is Tesla (T)
- CGS unit is Gauses (G)
- 1 Tesla (1T) = 10,000 Gauss.
- One Tesla = $1Wbm^{-2}$.
- The magnets used in MRI is in the range of 0.3-3 Tesla

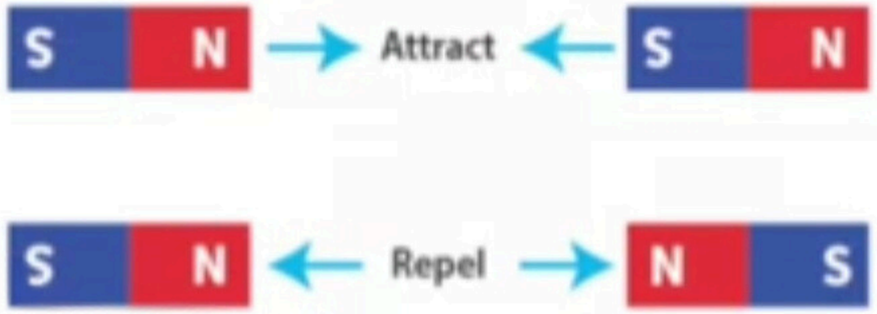


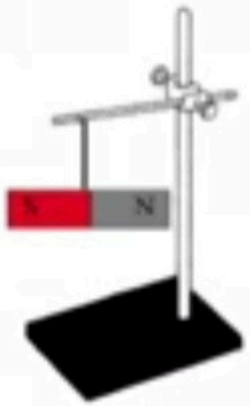
What is Magnetism ?

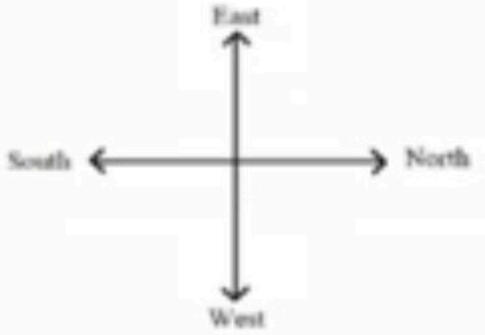
- Magnetism: A magnet produce its own magnetic field by which it attract other magnet or iron-filling or iron substances, this property of attraction of magnet is called magnetism.
- This magnetic property is due to the motion of charged particles.
- As we know atom consist of positive charged nucleus & negatively charged electrons.
- These electrons circulate around the nucleus own orbit called orbital angular momentum & spin around own axis called spin angular momentum both the orbital and spin angular momentum form a tiny current loop which is turned produced magnetism.

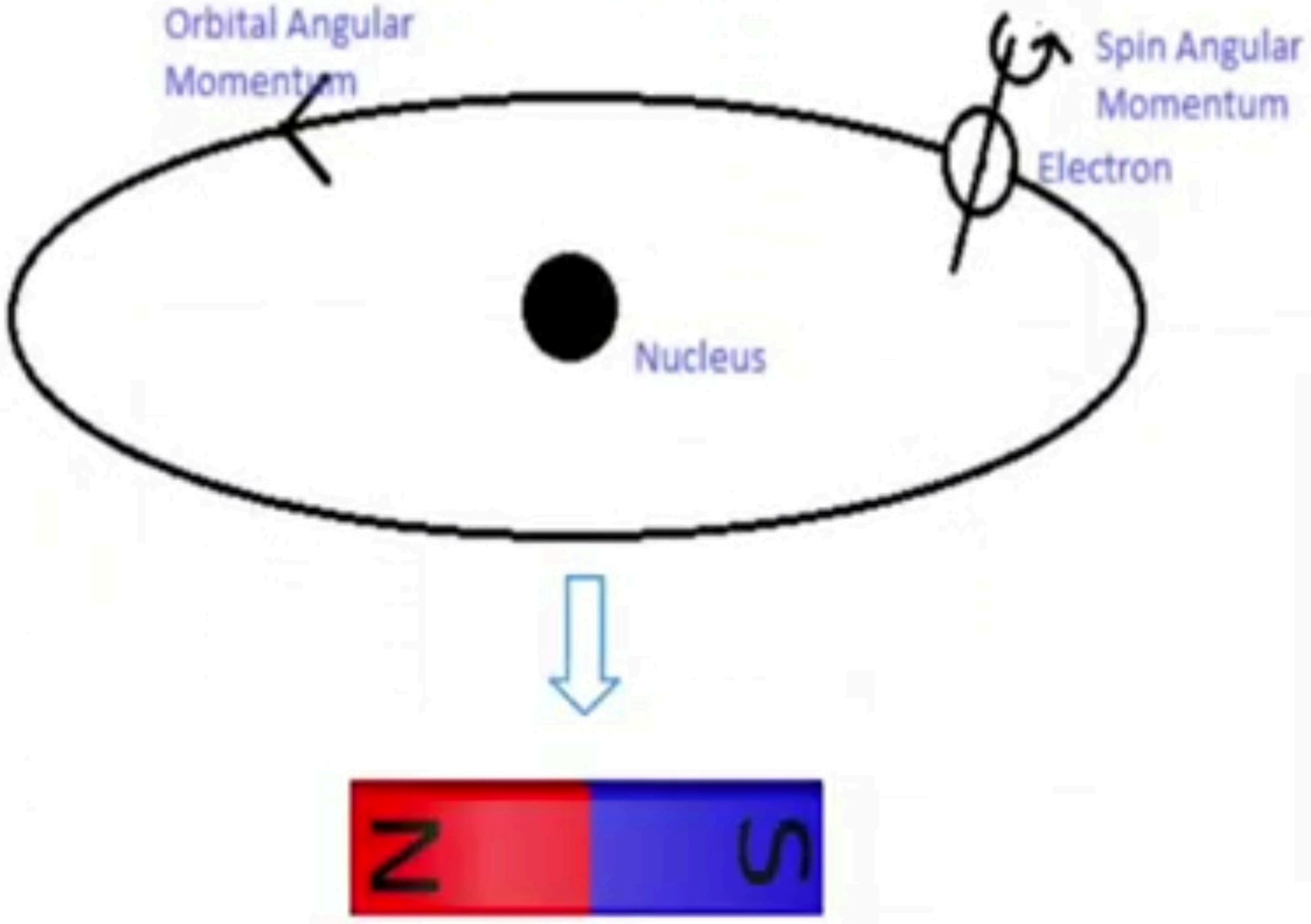
Properties of Magnet

1. Attractive property :- Magnet attracts ferromagnetic materials like - iron, cobalt and nickel.
2. Repulsive property:- Like magnetic poles repel each other and unlike magnetic poles attract each other.
3. Directive property:- A freely suspended magnet always points in northh-south direction.








Orbital Angular
Momentum
Spin Angular
Momentum
Electron
Nucleus
N
S
Tiny Bar Magnet

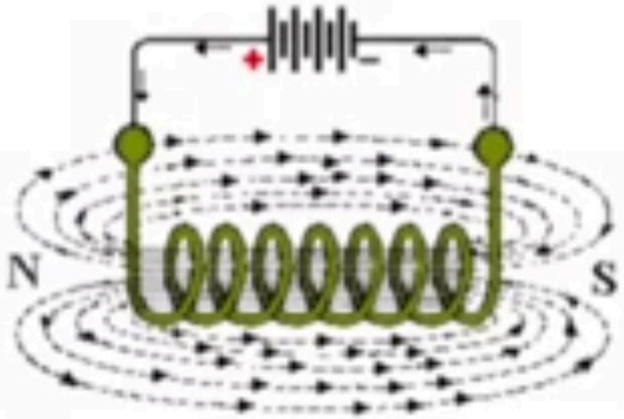
Types of Magnet

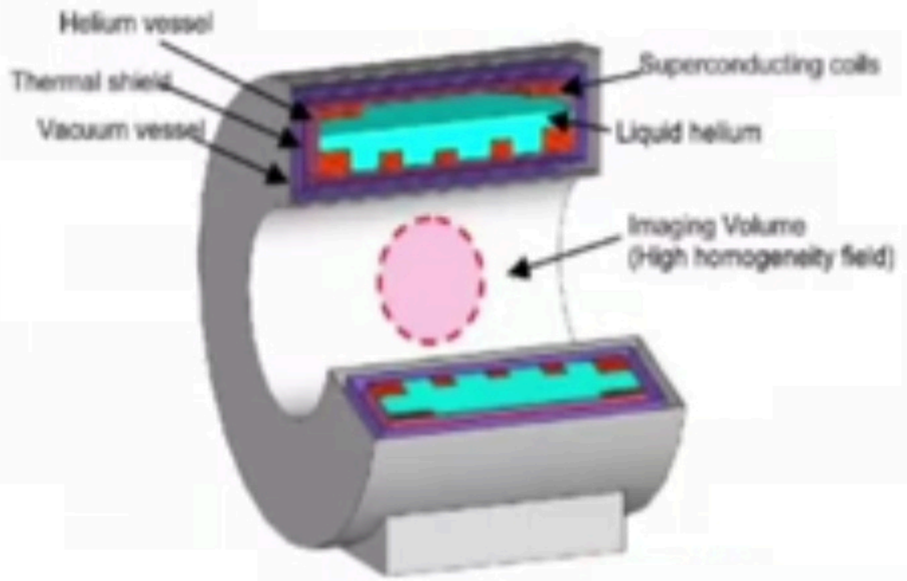
A). Natural Magnet :- Only Permanent

B). Artificial Magnet :- 1. Permanent

2. Temporary :- i) Electromagnet

ii) Superconducting Magnet





A). Natural Magnet

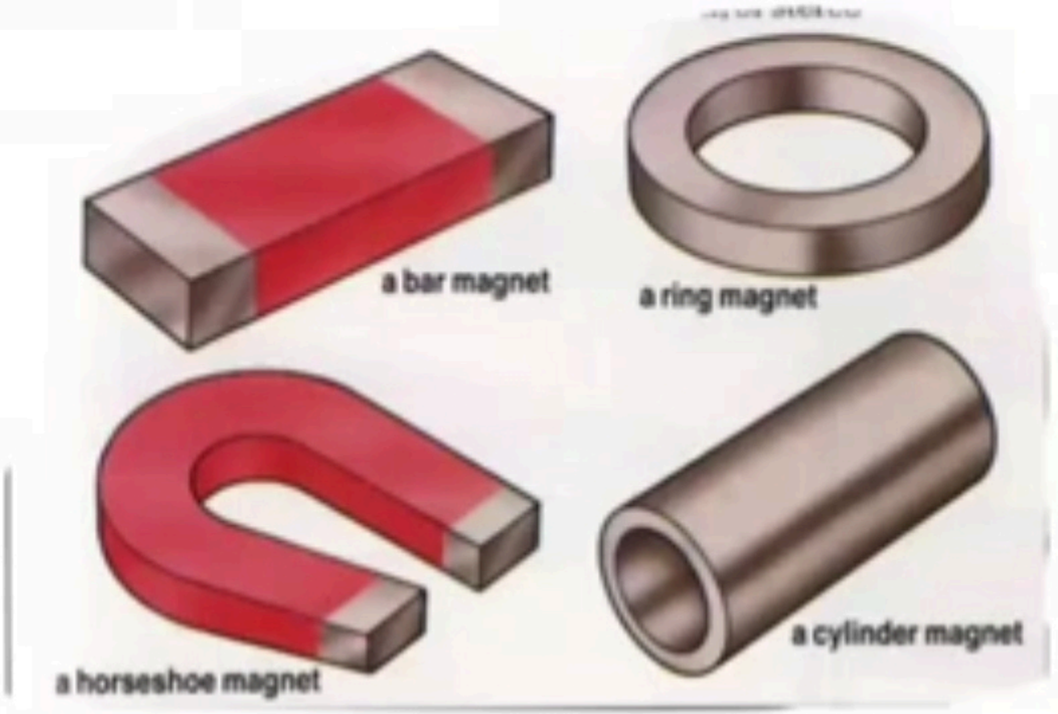
- Natural magnets are magnets that found in nature.
- Natural magnets are minerals or metals that generate a stable magnetic field without artificial inducement.
- All natural magnets are permanent.
- Example:- Lodestone(Magnetite) :- Fe_3SO_4

B). Artificial Magnet

- *Magnet that are made artificially by the human by using different techniques or by inducing external source of energy is called artificial magnet.*
- *These magnets are magnetized piece of iron, nickel or cobalt by the external source of energy.*
- *They are stronger as compare to natural magnet.*
- *They can be permanent or temporary.*

a). Permanent Artificial Magnet

- *Permanent magnet do not loss their magnetic property once they are magnetized (Induced by external source of energy).*
- *Ex :- Neodymium Magnet like - Bar magnet, Cylindricalmagnet, Circular magnet, Horse shoe magnet.*

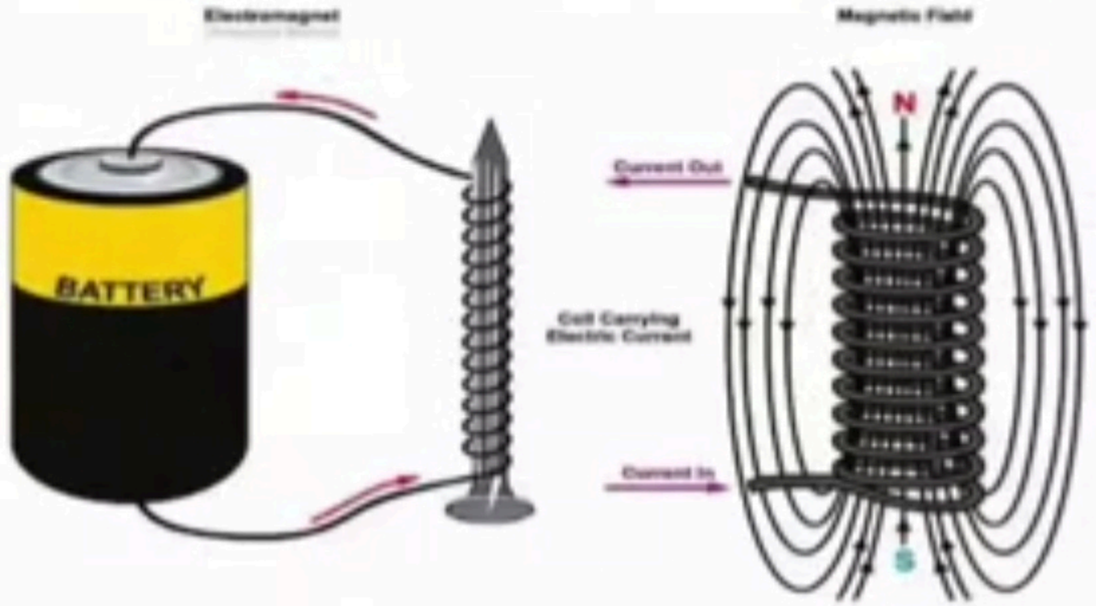


b). Temporary Artificial Magnet

- *Made by the soft metals that are magnetized by the permanent Magnetic Field or electric current.*
- *After remove from the permanent magnetic field or electric current they behave like a soft metal.*
- *Ex :- 1. Electromagnet*
  2. Superconducting magnet

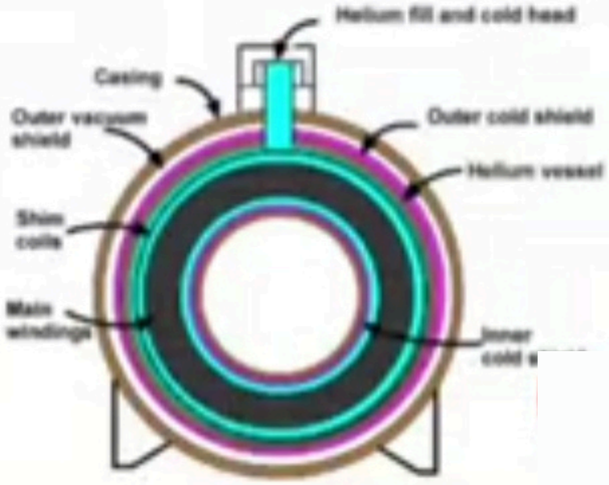
Electromagnet

- An electromagnet is a type of temporary magnet in which the magnetic field is produced by an electric current.
- Electromagnets usually consist of wire wound into a coil.
- The wire turns are often wound around a magnetic core made from a ferromagnetic or ferromagnetic material such as iron or nickel.
- A current pass through the wire creates a magnetic field in the coil,and coil behave like A magnet.
- The magnetic field disappears when the current is turned off.



Superconducting Magnet

- A superconducting magnet is an electromagnet made from coils of superconducting wire.
- They must be cooled to cryogenic temperatures during operation.
- In its superconducting state the wire has no electrical resistance and therefore can conduct much larger electric currents than ordinary wire, creating intense magnetic fields.
- Liquid helium is used as a coolant for many superconductive windings. It has a boiling point of 4.2 K, far below the critical temperature of most winding materials.
- The magnet and coolant are contained in a thermally insulated container (dewar) called a cryostat.
- Use :- In MRI



What is Electromagnetism ?

- *Electromagnetism is the branch of physics that studies the behaviour and interactions of electric and magnetic fields.*
- *Electromagnetism is the force that gives rise to electric fields and magnetic fields, with the electric field exerting a force on charged particles, and the magnetic field exerting a force on moving charges.*
- *Electric fields are caused by electric charges, while magnetic fields are caused by moving electric charges.*
- *Applications of Electromagnetism :-*

1.Electric motors and generators

2. Electric power transmission

3. Electromagnets in MRI etc.