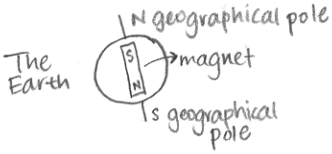
March 11-March 18 Concepts – azj

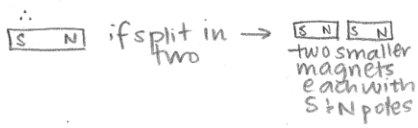
Physical Sciences 3
Lectures 11 and 12 – March 12, 2008 – Binary Coding, Digital Circuits, and Magnetism
Reading for Understanding: Chapter 27 s1-6, Chapter 28

MAGNETS

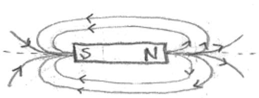


a magnet has both a S pole and a N pole. these poles are inseparable, cannot isolate

∴



now, look at field lines: ($\vec{B}$)



N pole is the "source" like a positive ch.

S pole is the "sink" like a negative ch

∴ $\vec{B}$ from N pole to S pole

magnetic field has units of Tesla (T)

$\vec{B}$ lines into the page: ⊗

$\vec{B}$ lines out of the page: ⊙

LORENTZ FORCE

is the force on a charged particle in motion in a magnetic field.

$\vec{F}_B = q\vec{v} \times \vec{B}$

↖ cross product: means that the vector quantities of velocity and magnetic field are perpendicular to the Lorentz force.

$\vec{F}_B = q\vec{v} \times \vec{B} = q\vec{v}\vec{B}\sin\theta$

has its own RHR

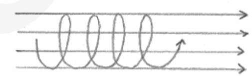
--- consider → Two cases:

- Cyclotron motion: charged particle is flying in a circular path, in a uniform $\vec{B}$ field.

  V and $\vec{B}$ are perpendicular

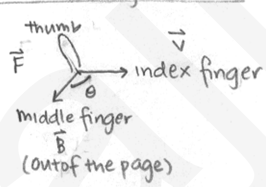
  $\vec{F} = q\vec{v} \times \vec{B} = \frac{m\vec{v}^2}{r} \Rightarrow r = \frac{mv}{qB}$

- Helical motion: constant motion in the direction parallel to $\vec{B}$. The trajectory is wrapped around $\vec{B}$ field lines:

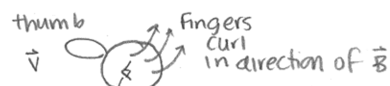


RIGHT HAND RULES •

* Three-Finger Gun *



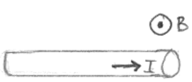
Palm-Rule



perpendicular to your palm, coming out of the page is the $\vec{F}$

- Both these rules are for protons. If have electron, find RHR results and then switch/flip answer

FORCE ON A CURRENT-CARRYING WIRE



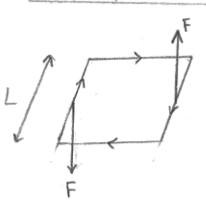
Given the $\vec{B}$ direction the direction of current in the wire.

∴ ch. particles are flowing to the right in the wire ∴ RHR

$\vec{F}_B = I\vec{L} \times \vec{B}$

Only for straight wires. Integrate for curved wires! → $F_B = I\int_a^b d\vec{l} \times \vec{B}$

TORQUE ON SQUARE LOOP



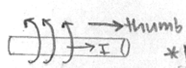
equal and opposing force

$F = ILB$

$\tau = IL^2B$

MAGNETIC FIELDS: created by electric currents b/c no magnetic charge!

$\vec{B} = \frac{\mu_0 I}{2\pi r}$ for the magnetic field on a CURRENT CARRYING WIRE (infinitely long) $\mu_0 = 4\pi \times 10^{-7}$ Tm/A



RIGHT HAND RULE for $\vec{B}$ field

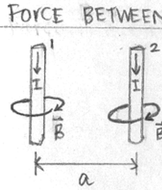
point thumb in direction of current in wire

$\vec{B}$ curls up & around

FORCE BETWEEN CURRENTS

running in the same direction (↓↓) attract

running in opposite directions repel



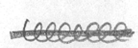
the $\vec{B}$ field felt at I_2 due to I_1 is $\vec{B} = \frac{\mu_0 I_1}{2\pi a}$

the force felt at I_2 is $F = I_2 L B$

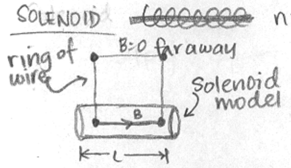
∴ $F_2 = \frac{\mu_0 I_1 I_2 L}{2\pi a}$

leads to: AMPERE'S LAW, for any closed path $\oint \vec{B} \cdot d\vec{s} = \mu_0 I$ ← total current passing through any surface bounded.

SOLENOID



$n = N/L$ N = turns L = length



remember perpendicular parts of wire ⫶ ⫶ have $\vec{B} = 0$

total current = $nL \times I$ (↑ # turns in path)

$\oint \vec{B}\, ds$ where $\vec{B}$ is parallel to solenoid axis

$= BL = \mu_0 I = nLI\mu_0 \Rightarrow \vec{B} = n\mu_0 I$

alishajwani