PHYS 2212

Look over
Chapter 28 sections 1, 2, 6, 7, 8
Examples 1, 3, 4, 6

PHYS 1112

Look over
Chapter 20 sections 1, 2, 3, 4
Examples 1, 2, 4, 5, 7, 8

Good Things to Know

1) Properties of Magnetic fields.
2) How to find the force on a charged particle moving in an electric field.
3) Properties of the Circular motion of a particle in an electric field.
4) How to find the force on a wire in an Magnetic field.

The Magnetic Field

We have discussed how a charged object produces a vector field -the electric field **E**- at all points in the space around it.

Similarly, a magnet produces a vector field -the Magnetic Field ***B***- at all points in the space around it.

How Do We Get Magnetic Fields

We have seen that an electric charge sets up an Electric Field that can influence other charges.

So we might reasonably expect that a magnetic charge will set up a magnetic field that can then affect other magnetic charges.

Although such magnetic charges called magnetic "Monopoles" are predicted by certain theories, their existence has not been confirmed.

Magnetic fields are set up by moving charges.

B From the Force

$$F = |q||\vec{v}||\vec{B}|\sin\phi$$

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

$$B = \frac{|\vec{F}_B|}{|q||\vec{v}|}$$

Right-Hand Rule

For a positive charge your thump gives the direction of the force. For a negative charges the force is in the opposite direction.

Using the Force

The Force $\boldsymbol{F_B}$ acting on a charged particle moving with velocity $\boldsymbol{v}$ through a magnetic field $\boldsymbol{B}$ is always perpendicular to $\boldsymbol{v}$ and $\boldsymbol{B}$.

$\boldsymbol{F_B}$ can not change the particle's speed.

Units of **B**

The SI unit for **B** is the Newton per (Coulomb-meter per second) which is called a Tesla (T).

$$1\,tesla = 1T = 1\frac{Newton}{(Coulomb)(meter/\sec ond)} = 1\frac{N}{A \cdot m}$$

Another (non-SI) unit of B is a gauss (G):

$$1T = 10^4 G$$

Magnetic Field Lines

We can represent magnetic fields with field lines, just as we did for electric fields. Similar rules apply:

❶The direction of the tangent to a magnetic field line at any point gives the direction of **B** at that point.
❷The spacing of the lines represents the magnitude of **B**.

Magnetic Fields

Opposite magnetic poles attract each other, and like poles repel each other.

All magnetic field lines produced by a bar magnet pass through the magnet, and they form closed loops.

Magnetic field lines enter one end of the magnet (The South Pole) and exit at the other end of the magnet (The North Pole).

Example 1

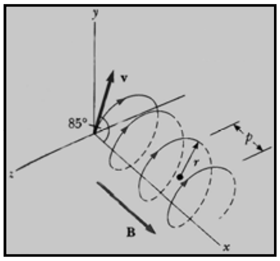
1) An alpha particle travels at a velocity ***v*** of magnitude *550 m/s* through a uniform magnetic field ***B*** of magnitude *0.045 T*. The angle between ***v*** and ***B*** is *52°*. What are the magnitudes of:

a) The force F_B acting on the particle due to ***B***
b) The acceleration of the particle.
c) Does the speed of the particle increase, decrease or remain the same?

(An alpha particle has a charge of $+3.2\times10^{-19}C$ and a mass of 6.6×10^{-27} *kg*.)

Example 2

2) A uniform magnetic field of magnitude *0.150 T*, is directed along the positive *x* axis. A positron moving at 5.00×10^{6} *m/s* enters the field along a direction that makes an angle of 85.0^{o} with the *x* axis. The motion of the particle is expected to be a helix, Find:
a) the pitch and b) the radius of the trajectory.



Magnetic Force on an Current Carrying Wire

We have already seen that a magnetic field exerts a sideways force on moving charges. This will also be true for moving charges in a current carrying wire. This force that the electrons that make up the current feel gets transmitted to the wire itself since the electrons can not move out of the wire.

PHYS 2212

Look over
Chapter 29 section 1, 2, 3, 4, 5
Examples 1, 2, 3, 4

Good Things to Know

1) The Biot-Savert Law
2) How to calculate the Magnetic field due to a current carrying wire.
3) The force between to current carrying wires.
4) How to use Amperes Law To find the Magnetic fields due to current carrying wires.

Calculating Magnetic fields due to a Current

We have seen that a current in a wire will produce a magnetic field.

We now want to calculate the field produced by a current.

The Biot-Savert Law

Too find the magnetic field due to a wire we can break the wire up into a large number of pieces *ds* and look at the magnetic field due to one of these pieces as:

$$dB = \frac{\mu_0}{4\pi}\frac{i\,d\vec{s} \times \hat{r}}{r^2}$$

μ_0

μ_0 and ε_0 play similar roles.

$$\mu_0 = 4\pi \times 10^{-6}\, T\, m / A \approx 1.26 \times 10^{-6}\, T\, m / A$$

The Magnetic Field Due to a Long Wire

$$B = \frac{\mu_0\, i}{2\pi\, \mathrm{r}}$$

To find the direction of the magnetic fields point your right thumb in the direction of the current and your fingers will curl around in the direction of the magnetic field.

Two Current Carrying Wires

Since all current carrying wires produce magnetic fields, there will be a force between two current carrying wires.

Force Between Two Wires

To find the force between two wires we have to find the magnetic field that wire *a* produces at wire *b*.

$$F_{ba} = \frac{\mu_0 L i_a i_b}{2\pi d}$$

The direction of the force is given by: Parallel currents attract, and antiparallel currents repel.

Example 3

2) Two long straight parallel wires are 15 cm apart. Wire A carries 2.0 A. Wire B's current is 4.0 A in the same direction.

a) Determine the magnetic field magnitude due to wire A at the position of wire B.
b) Determine the magnetic field magnitude due to wire B at the position of wire A.
c) Are these two magnetic fields equal and opposite?
d) Determine the force on wire A due to wire B.
e) Determine the force on wire B due to wire A.
f) Are these forces equal?

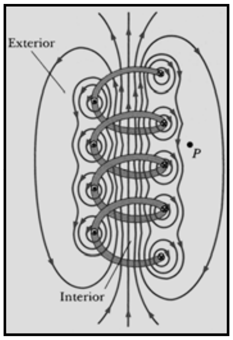
Ampere's Law

We can always use the Biot-Savart law to find the magnetic field. In some cases we can use the symmetry of the situation and Ampere's law (just like we used Gauss' law for electrostatics) to make finding the magnetic field easier.

$$\lim_{\Delta s \to 0} \sum_i \vec{B}_i \bullet \Delta \vec{s}_i = \mu_0 i_{\text{enc}}$$

$$\oint \vec{B}_i \bullet d\vec{s} = \mu_0 i_{\text{enc}}$$

Example 4



3)What is the magnetic field inside a solenoid?