PHYSICS 231 – TEST # 3

NAME:

STUDENT ID #:

USEFUL CONSTANTS

$$\epsilon_0 = 8.85 \times 10^{-12} C^2/(N \cdot m^2)$$
$$k = \frac{1}{4\pi\epsilon_0} = 8.988 \times 10^9 \; N \cdot m^2/C^2$$
$$e = 1.6 \times 10^{-19} C$$
$$m_e = 9.1 \times 10^{-31} kg$$
$$\mu_0 = 4\pi \times 10^{-7} \; T \cdot m/A$$
$$g = 9.81 \; N/kg$$

USEFUL FORMULAS

Magnetic force

on point charge: $\vec{F} = q\vec{v} \times \vec{B}$
on wire: $\vec{F} = I \int d\vec{l} \times \vec{B}$
Magnetic flux through closed surface:

$$\Phi_B = \int \vec{B} \cdot d\vec{A} = 0$$

In a constant magnetic field a particle moves on circle of radius

$$R = \frac{mv}{|q|B}$$

Current loop:

force: $\vec{F} = \vec{0}$.
torque: $\vec{\tau} = \vec{\mu} \times \vec{B}$, $\vec{\mu} = I\vec{A}$.
energy: $U = -\vec{\mu} \cdot \vec{B}$.

Magnetic field

due to point charge:

$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \vec{r}}{r^3}$$

due to wire (Biot-Savart law):

$$\vec{B} = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{l} \times \vec{r}}{r^3}$$

Ampère's law:

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$$

outside infinite straight wire:

$$B = \frac{\mu_0 I}{2\pi r}$$

on axis of circular wire of radius a:

$$B_x = \frac{\mu_0 I a^2}{2(x^2 + a^2)^{3/2}}$$

at center of N circular loops:

$$B_x = \frac{\mu_0 N I}{2a}$$

inside solenoid of n turns per unit length:

$$B = \mu_0 n I$$

Emf

in closed loop (Faraday's law):

$$\mathcal{E} = \oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt}$$

in moving loop:

$$\mathcal{E} = \oint (\vec{v} \times \vec{B}) \cdot d\vec{l}$$

wire of length L in uniform $\vec{B} \perp \vec{L} \perp \vec{v}$,

$$\mathcal{E} = vBL$$