Physics 161 Fall 2010 Exam 6 **LAST NAME, FIRST NAME**

$\mu_0 = 4\pi \times 10^{-7}$ W/A·m

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

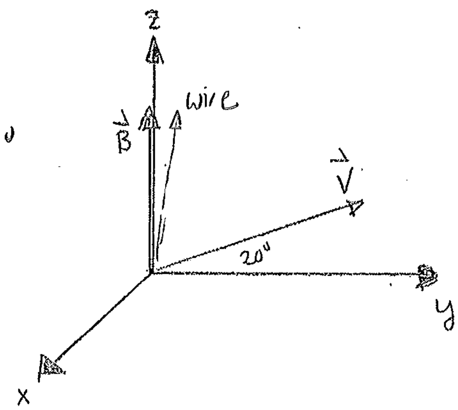
$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v} \times \hat{r}}{r^2}$

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

$d\vec{F} = Id\vec{l} \times \vec{B}$

$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l} \times \hat{r}}{r^2}$

A proton ($q=1.6 \times 10^{-19}$ C) is moving in the yz plane, at an angle of 20° above the y-axis, as shown, at 2×10^5 m/s. A uniform magnetic field of 3.2×10^5 T points in the z direction.



1&2] What is the magnitude of the x-component of the magnetic force on the proton, **in nanoNewtons**? (1 nanoNewton = 1 nN = 10^{-9} N) 9.62 nN

$q v \times B$
$= q v B \sin 70°$

3] What is the sign of the x-component of the magnetic force on the proton?
(A] + B] - C] $F_x = 0$.

4] What can you say about the y- and z-components of the force on the proton?

(A] Both = 0
B] $F_y = 0$ but $F_z > 0$
C] $F_y = 0$ but $F_z < 0$
D] $F_z = 0$ but $F_y > 0$
E] $F_z = 0$ but $F_y < 0$
F] $F_z < 0$ and $F_y > 0$
G] $F_z > 0$ and $F_y < 0$
H] Both F_z and F_y are < 0
I] Both F_z and F_y are > 0

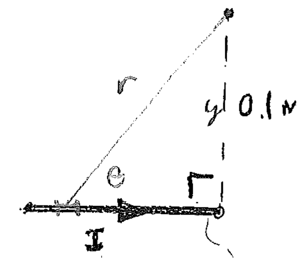
5] What is the motion of the proton in this uniform B field?

A] a parabola at constant speed
B] a parabola with increasing speed
C] a circle with constant speed
D] a circle with increasing speed
(E] a helix with constant speed
F] a helix with increasing speed
G] some path but with decreasing speed

6&7] With the same magnetic field, what would be the **magnitude** of the force on a segment of wire 1 m long, lying in the xz plane at an angle of 7° away from the z-axis (toward –x)? The wire carries a current of 1 milliAmpere (mA). Answer in N. 39 N $F = I l \times B = I l B \sin 7°$

8] What is the direction of the force on the wire? current toward +z

A] +x
(B] +y
C] +z
D] –y
E] 7° away from -x, toward -y
F] 7° away from y, toward -z
G] 7° away from z, toward +x
H] 7° away from z, toward -x
I] 7° away from y, toward x
J] none of these

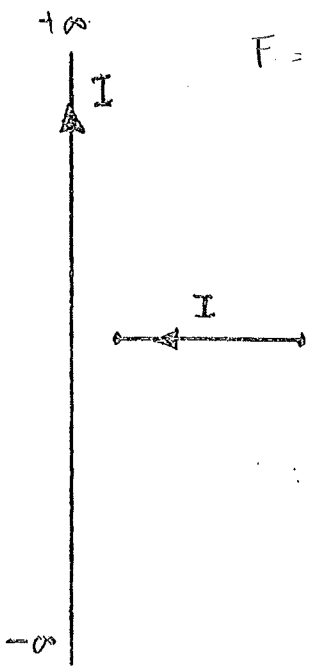


9&10] What is the magnetic field caused by a 0.1 m straight segment of wire carrying a 60 A current, at a point 0.1 m away from the end as shown? **Answer in microTesla (=10^{-6} Tesla).**

$$B = \frac{\mu_0 I}{4\pi}\int \frac{d\vec{x} \times \hat{r}}{r^2} = \frac{\mu_0 I y}{4\pi}\int \frac{dx}{(x^2+y^2)^{3/2}} = \frac{\mu_0 I}{4\pi}\left.\frac{x}{y\sqrt{x^2+y^2}}\right|_{-y}^{0} = \frac{\mu_0 I}{4\pi}\frac{1}{\sqrt{2y^2}}$$

$$= 4.24 \times 10^{-5}\ T = 42\ \mu T$$

11&12] What is the magnitude of the total magnetic force **on** a segment of wire 1 m long, placed perpendicular to an infinite wire, each carrying a current of 13 A? The close end of the segment is 0.1 m from the infinite wire. **Give your answer in microNewtons.**

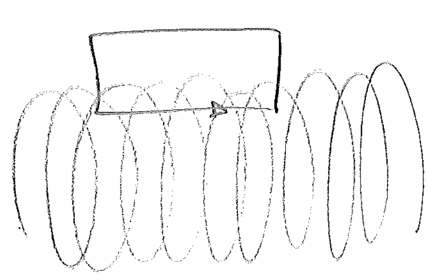


$$F = \int I\, d\ell \times B \qquad B = \frac{\mu_0 I}{2\pi r}$$

$$= \frac{\mu_0 I^2}{2\pi}\int \frac{dr}{r} = \frac{\mu_0 I^2}{2\pi}\cdot \ln 10 = 7.78 \times 10^{-5}\ N$$

$$\approx 80\ \mu N$$

13&14] Use Ampere's law to find the magnetic field in long solenoid carrying a current of 7 A with 10^6 turns per meter. **Give your answer in microTesla.**



$$B \cdot \ell = \mu_0 N I$$

$$B = \mu_0 \frac{N}{\ell}\cdot I$$

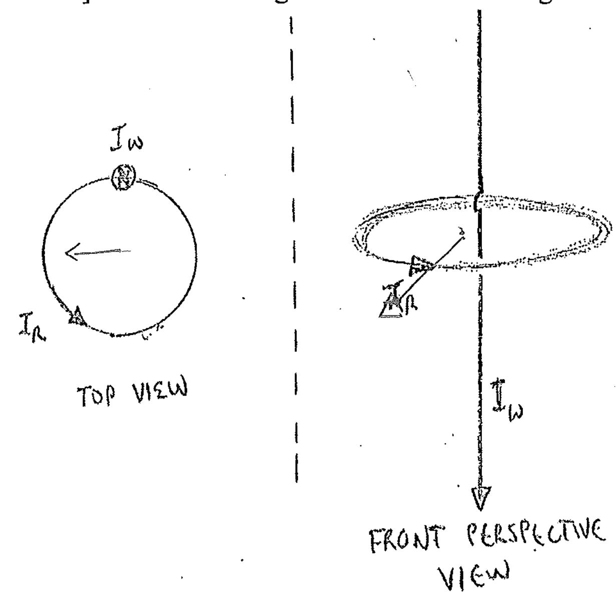
$$= \left(\frac{\mu_0}{4\pi}\right)\cdot 4\pi \cdot 10^6 \cdot 7$$

$$= 8.8\ T = 9 \times 10^6\ \mu T$$

The magnitude of the magnetic field at the center of a ring of current is $\frac{\mu_0 I}{2r}$, as we showed in class. A ring carries a current of 0.32 A. An infinite wire is perpendicular to the plane of the ring, as shown, and carries a current of 1 A. The radius of the ring is 1 cm.

The magnitude of the magnetic field at the center of the ring *caused by the infinite wire alone* would be $B_\infty = \frac{\mu_0 I}{2\pi r}$, as you can easily show using Ampere's law.

15&16] What is the magnitude of the total magnetic field at the center of the ring? **(in microTesla)**



$B_{ring} = \frac{\mu_0}{4\pi} \cdot \frac{2\pi I_r}{r} = 2\times10^{-5}$ T

$B_{wire} = \frac{\mu_0}{4\pi} \cdot \frac{2 I_w}{r} = 2\times10^{-5}$ T

$B_{net} = \sqrt{B_{wire}^2 + B_{ring}^2} = 2.8\times10^{-5}$ T

$= 28\ \mu$T.