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PHYS 223 University Physics III
Exam 3

March 24, 2021

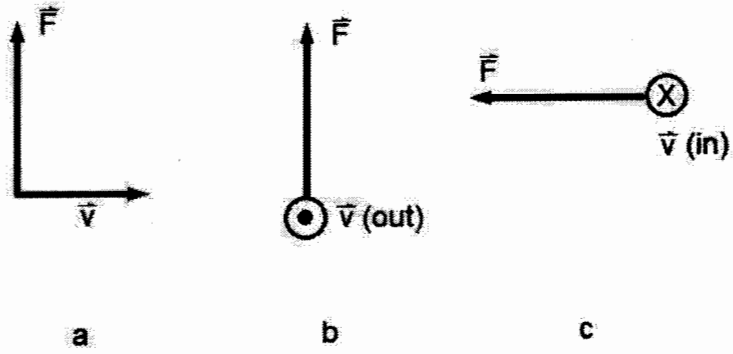
Name J. C. Daly

1. Find he direction of the magnetic field acting on a positively charged particle moving in the various situations shown in Figure 1 if the direction of the magnetic force acting on it is as shown.

a. INTO the PAGE

b. To the RIGHT

c. DOWN



a b c

Figure 1

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2. A conductor consists of a circular loop of radius R = 12.0 cm and two long, straight sections as shown in Figure 2. The wire lies in the plane of the paper and and carries a current I = 2.00 A. Find the magnetic field at the center of the loop.

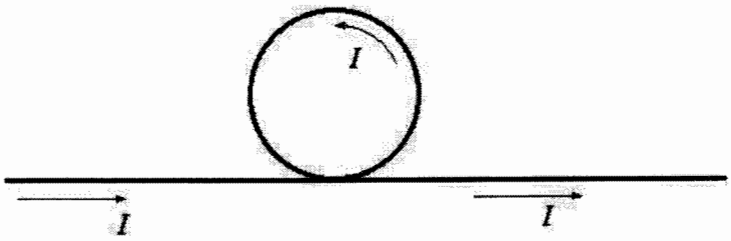
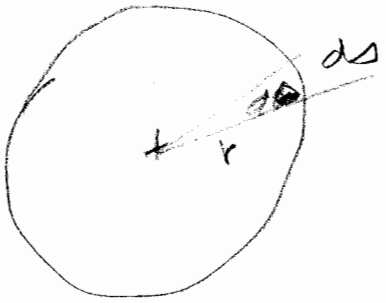


Figure 2

$B = B_1 + B_2$ OUT OF PAGE

$B_1 = \frac{\mu_0 I}{2\pi R}$ due to LONG STRAIGHT WIRE



$d\vec{B} = \frac{\mu_0}{4\pi}\frac{\vec{I}d\vec{s}\times\hat{r}}{R^2}$

$ds = R\,d\theta$

$|\vec{I}d\vec{s}\times\hat{r}| = R\,d\theta$

$B = \int dB = \int \frac{\mu_0 I R\,d\theta}{4\pi R^2} = \frac{\mu_0 I}{4\pi R}\int_0^{2\pi} d\theta$

$= \frac{\mu_0 2\pi I}{4\pi R} = \frac{\mu_0 I}{2R}$

$B = \frac{\mu_0 I}{2\pi R} + \frac{\mu_0 I}{2R} = \frac{\mu_0 I}{2\pi R}\left[1+\pi\right]$

$= \frac{4\pi\times10^{-7}*2}{2\pi*0.12}(1+\pi) = \boxed{6.90\times10^{-6}\ T}$

$6.90\,\mu T$

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3. An electron moves in a circular path perpendicular to a uniform magnetic field with a magnitude of 4.00 mT. If the speed of the electron is 2.50×10^7 m/s, determine

   a. the radius of the circular path 3.55 cm
   and

   b. the time interval required to complete one revolution. 8.92 ns

$$qvB = \frac{mv^2}{r}$$

$$qB = \frac{mv}{r}$$

$$r = \frac{mv}{qB} = \frac{9.1 \times 10^{-31} \times 2.5 \times 10^{7}}{1.6 \times 10^{-19} \times 4 \times 10^{-3}} = 3.55 \times 10^{-2}\ m$$

$$v = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi \times 3.55 \times 10^{-2}}{2.5 \times 10^{7}} = 8.92 \times 10^{-9}\ s$$

Physical Constants

Constant	Symbol	Magnitude
Avogadro's Number	N_A	6.022×10^{23} molecules/mole
Boltzmann's constant	k	1.38×10^{-23} J/K = 8.62×10^{-5} eV/K
Stefan-Boltzmann constant	σ	5.67×10^{-8} J/(s*m^2*K^4)
Electronic charge	q	1.6×10^{-19} C
Electronvolt	eV	1.6×10^{-19} J
Planks constant	h	6.625×10^{-34} J-s
Thermal voltage, kT, at 300 ^oK	V_t	25.8 mV
Velocity of light	c	3×10^8 m/s
Permeability of free space	u_o	1.257×10^{-6} H/m
Permittivity of free space	ε_o	8.854×10^{-12} F/m
Electron mass	m_e	9.1×10^{-31} kg
Proton mass	m_p	1.673×10^{-27} kg

Atomic Masses

Element	Symbol	Atomic Mass	Atomic Number
Hydrogen	H	1.00794 u	1
Helium	He	4.00260 u	2
Lithium	Li	6.941 u	3
Beryllium	Be	9.0122 u	4
Boron	B	10.811 u	5
Carbon	C	12.0107 u	6
Nitrogen	N	14.0067 u	7
Oxygen	O	15.9994 u	8
Fluorine	F	18.9984 u	9
Neon	N	20.1797 u	10
Sodium	Na	22.9897 u	11
Magnesium	Mg	24.305 u	12
Aluminum	Al	26.9815 u	13
Silicon	Si	28.0855 u	14
Phosphorus	P	30.9738 u	15