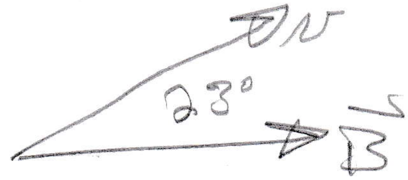
Homework 28.1

A proton traveling at 23.0° with respect to the direction of a magnetic field of strength 2.60 mT experiences a magnetic force of 6.50 x 10^{-17} N. Calculate (a) the protons speed and (b) its kinetic energy in electron-volts.



$B = 2.60\ \text{mT}$

$\phi = 23°$

$F = 6.50 \times 10^{-7}\ N$

$m_p = 1.67 \times 10^{-27}\ \text{Kg}$

$1\,eV = 1.6 \times 10^{-19}\ \text{Kg}$

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

$F = qvB\sin\phi$

$$v = \frac{F}{qB\sin\phi} = \frac{6.50 \times 10^{-17}}{1.6 \times 10^{-19} \times 2.6 \times 10^{-3}\ \sin 23°}$$

a) $v = 400\ \text{Km/s}$

$$\text{b) } KE = \frac{1}{2}mv^2 = \frac{1}{2}\,\frac{1.67 \times 10^{-27}\ (400)^2 \times 10^6\ 1\,eV}{1.6 \times 10^{-19}\ J}$$

$$= 83{,}500 \times 10^{-27+19+6}$$

b) $Ke = 835\ eV$

Homework 28.17

An alpha particle can be produced in certain radioactive decays of nuclei and consists of two protons and two neutrons. The particle has a charge of q = +2e and a mass of 4.00 u, where u is the atomic mass unit, with $1\ u$ = 1.661 x 10^{-27} kg. Suppopse an alpha particle travels in a circular path of radius 4.50 cm in a uniform magnetic field with B = 1.20 T. Calculate (a) its speed, (b) its period of revolution, (c) its kinetic energy, and (d) the potential difference through which it would have to accelerate tp achieve this energy.

$m = 4.00 u = 4 \times 1.661 \times 10^{-27}$ Kg

$B = 1.20\ T$

$R = 0.045 m$

$F = qvB = \frac{mv^2}{R}$

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

$v = \frac{qBR}{m} = \frac{2 \times 1.6 \times 10^{-19} * 1.2 * 0.045}{4. * 1.661 \times 10^{-27}}$

$= 0.0260 \times 10^{8}$ m/s

$= \underline{\underline{2.60 \times 10^{6} \text{ m/s}}}$

a)

$T = \frac{2\pi R}{v} = \frac{2\pi \times 0.045}{2.6} \times 10^{-6} = 0.109 \mu$ Sec

$Ke = \frac{1}{2} m v^2 = \frac{1}{2} * 4. * 1.661 \times 10^{-27} \times (2.6)^2 \times 10^{12}$

$= 2 * 1.661 \times (2.6)^2 \times 10^{-15}$ Joules

$= 2.2457 \times 10^{-15} * \frac{1 eV}{1.6 \times 10^{-19} \text{ Joules}}$

$= 1.40 \times 10^{4} = 0.140$ MeV

d) $V = \frac{1.40 \times 10^{4}}{2} = 70$ KV Since $q = 2e$

Homework 28.49

Figure 28-45 shows a rectangular 20-turn coil of wire, of dimensions 10 cm by 5.0 cm. It carries a currrent of 0.10 A and is hinged along one long side. It is mounted in the xy plane, θ = 30° to the direction of a uniform magnetic field of magnitude 0.50 T. In unit vector notation, what is the torque acting on the coil about the hinge line?

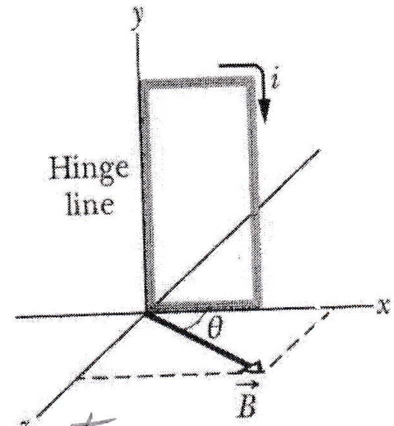


Figure 28-45

$\vec{\tau} = \vec{\mu} \times \vec{B}$

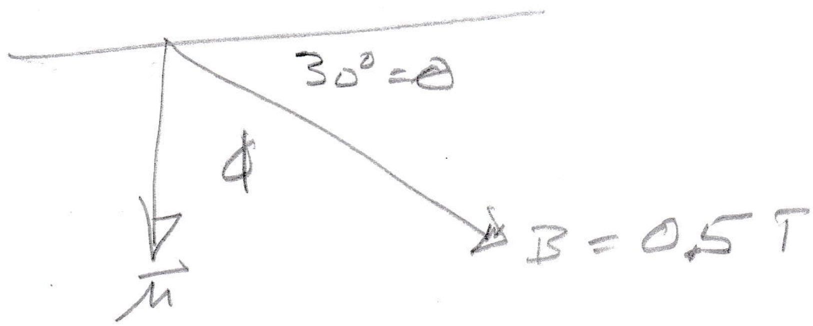
Where μ is the magnetic moment

$\mu = \mathcal{I} A = I n A = 0.1 \times 20 \times 0.1 * 0.5$

$\mu = 0.1\ A \cdot m^2$

$\phi = 90 - 30$

$= 60°$



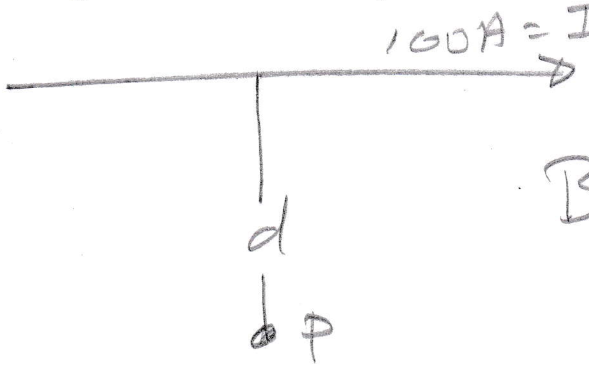
$\tau = \mu B \sin\phi$

$= 0.1 * 0.5 \sin 60°$

$\tau = 0.0433\ N \cdot m$

Homework 29.1

A surveyor is using a magnetic compass 6.1 m below a power line in which there is a steady current of 100 A. (a) What is the magnetic field at the site of the compass due to the power line? (b) Will this field interfere seriously with the compass reading? The horizontal component of Earth's magnetic field at the site is 20 *u*T



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

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

$$= \frac{4\pi \times 10^{-7} \times 100}{2\pi \times 6.1} = 32.7 \times 10^{-7}$$

$$= 3.27 \times 10^{-6}\ T$$

a) $= 3.27\ \mu T$

b) $B_{earth} = 20\ \mu T$

yes a 15% error is possible

Homework 29.7

In fig 29-39 two circular arcs have radii a = 13.5 cm and b = 10.7 cm, subtend angle θ = 74.0 °, carry a current i = 0.411 A, and share the same center of curvature P. What are the (a) magnitude and (b) direction (into or out of the page) of the net magnetic field at P?

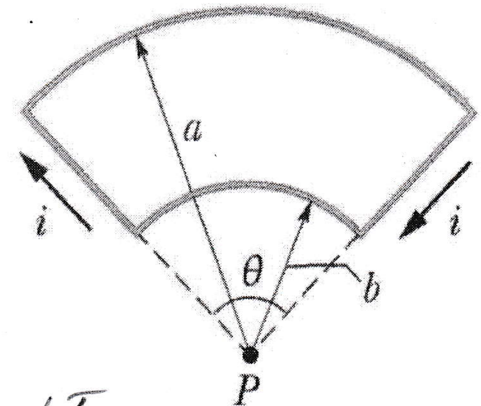


Figure 29-39

Arcs only contribute since $\overrightarrow{Idl} \times \hat{r} = 0$ on straight sections

$$dB = \left| \frac{\mu_0}{4\pi} \frac{\overrightarrow{Idl} \times \hat{r}}{r^2} \right| = \frac{\mu_0}{4\pi} \frac{I\,dl}{r^2} \text{ on arcs } (\overrightarrow{dl} \perp \hat{r})$$

If $r = a$ $\quad dl = r\,d\theta = a\,d\theta$

$$B_1 = \int_{\theta_1}^{\theta_2} \frac{\mu_0 I \, a\,d\theta}{4\pi a^2} = \frac{\mu_0 I}{4\pi a} 74° \times \frac{\pi}{180} \text{ (INTO PAPER)}$$

$r = b$

$$B_2 = \frac{\mu_0 I}{4\pi b} 74 \times \frac{\pi}{180} \text{ (OUT of the paper)}$$

$$B = B_2 - B_1 = \frac{\mu_0 I}{4\pi} 74 \times \frac{\pi}{180} \left[\frac{1}{b} - \frac{1}{a} \right]$$

$$= \frac{4\pi \times 10^{-7}}{4\pi} \times 0.411 \times 74 \times \frac{\pi}{180} \left[\frac{1}{10.7} - \frac{1}{13.5} \right] \times 10^{2}$$

$$= 0.411 \times 74 \times \frac{\pi}{180} \left[\frac{1}{10.7} - \frac{1}{13.5} \right] \times 10^{-5}$$

$$\underline{B = 0.103 \times 10^{-6} \text{ T}} \quad \text{OUT OF PAPER}$$