Ch 20 ex.

$\hat{\mu}, \hat{k}$ $\hat{B}$

60, 30

$\cos\theta \, \hat{\mu} \cdot \hat{b}$

1) a) $v_0 = \frac{E}{B} = \frac{2.50\times10^5\ N/C}{0.200\ T} = \boxed{1.26\times10^6\ m/s}$

b) $V = Ed = (2.50\times10^5\ N/C)(2.00\times10^{-2}\ m) = \boxed{5.00\times10^3\ V}$

2) $F_c = F_m = qvB = \frac{mv^2}{r} \Rightarrow qB = \frac{mv}{r}$

$B = \frac{mv}{qr}$ $= \cancel{\frac{(12)(1.673\times10^{-27}\ kg)(v)}{(+e)(0.15\ m)}} = \cancel{8.365\times10^{-7}\ v}$

$\frac{(12\ amu)v}{1e \cdot 0.15\ m} = 80\ \frac{v\ amu}{e}$

$D_1 = 30\ cm$ $D_2 = 35\ cm$

$r_2 = 17.5\ cm$

$m_2 = \frac{qBr_2}{v} = \frac{(1e)(80)(v)(1amu)(0.175\ m)}{1e \cdot v}$

$= \boxed{14\ amu}$

3) $V_{Hall} = \frac{IB}{nqd}$

$B = \frac{V_{Hall}\, nqd}{I} = \frac{(-11\times10^{-6}\ V)(8.49\times10^{28}\ \frac{e}{m^3})(-1.602\times10^{-19}\ C)(0.0\ m)}{25.0\ A}$

$= \boxed{116\ T}$

$B = \frac{V_{Hall}\, nqd}{I} = \frac{(-11\times10^{-6}\ V)(8.49\times10^{28}\ \frac{e}{m^3})(-1.60\times10^{-19}\ C)(1250\times10^{-6}\ m)}{25.0\ A}$

$= 7.47\ T$

$B = 0.75\ T$

4) $F = I\,l\times B = IlB\sin 90$

a) $F = IlB$ to the left

b) F is to the right

5) $F_{total} = 0$

6) $dW = 0\ J$

$W = 0\ J$ $\quad W = F\cdot d$

$= F\,d\cos\theta$ $\quad \cos 90 = 0$

$W = 0$

7) a) $\vec{\mu} = I\vec{A}$

$= 15.0\ A \cdot (0.05\ m)^2 \cdot \pi\ \hat{k}$

$= 0.118\ A\cdot m^2\ \hat{k}$

b) $\tau = \vec{\mu}\times\vec{B} = (0.118\ Am^2\ \hat{k})(0.150\ T)\sin(60)$

$= \boxed{0.0153\ N\cdot m}$

c) $PE = -\vec{\mu}\cdot\vec{B}$

$= -(0.118\ Am^2)(0.150\ T)\cos(60)$

$= \boxed{-8.85\times10^{-3}\ J}$

direction - $\vec{\mu}$ $\vec{B}$

8) $\vec{\mu} = I\vec{A}$ $\quad A = \pi r^2\ \hat{k}$

$I = \frac{dQ}{dt}$

$I = ef = \frac{e}{T}$ $\quad T = \frac{2\pi r}{v}$

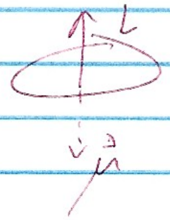
$I = \frac{ev}{2\pi r}$ $\quad \mu = IA = \frac{ev}{2\pi r}\cdot\pi r^2$

$= \frac{evr}{2}$

conventional current

$\hat{\mu}$

$L = r \times p = rp\sin 90 = rp = mvr$



$\mu = \frac{evr}{2}$ $L = mvr$

$\mu = \frac{evr \cdot m}{2m}$

$= -\frac{e}{2m}\vec{L}$ (dir)

a) R, I

$B = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{r}}{r^2}$ ~~$\sin\theta$~~ $\sin\theta = 1$

$l = 2\pi r$ $dl = 2\pi dR$

$B = \frac{\mu_0 I}{4\pi} \int \frac{2\pi dR}{R^2}$

$= \frac{\mu_0 I}{2} \cdot -\frac{1}{R} = \boxed{\frac{-\mu_0 I}{2R}}$

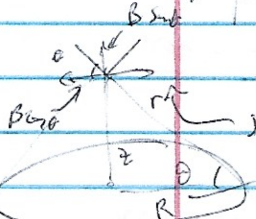
$B = \frac{\mu_0}{4\pi} \cdot \frac{2\pi I}{R}$? why leave the pi's?

$I = \frac{-BR2}{\mu_0} = \frac{-(1\times10^{-4}\,T)(0.05\,m)\,2}{(4\pi\times10^{-7}\,H/m)}$

$= \boxed{-7.96\,A}$

$+8\,A$

10)

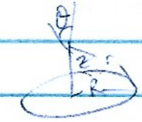


symmetry, horiz. components cancel out

$B\sin\theta$ survives $\sin\theta = \frac{z}{r}$

$B = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{r}}{r^2} \cdot \sin\theta$

$B = \frac{z}{r} \cdot \frac{\mu_0}{4\pi} I \cdot \int \frac{d\vec{l} \times \hat{r}}{r^2}$



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

$d\vec{l} \times \hat{r} = dl$

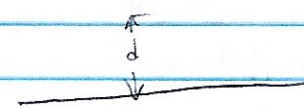
θ & r are the same for the whole ring

$B = \frac{\mu_0}{4\pi} \cdot \frac{I}{r^2} \cos\theta \int dl\,\hat{k}$

$= \frac{\mu_0}{4\pi} \cdot \frac{I}{\sqrt{(R^2+z^2)}} \cdot \frac{R}{(R^2+z^2)} \cdot 2\pi R$

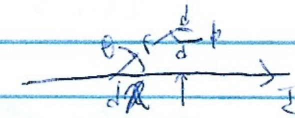
$= \frac{\mu_0 I R^2}{2(R^2+z^2)^{3/2}}$

11)



a) $B = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{r}}{r^2}$ $\sin\theta = 1$

$= \frac{\mu_0}{4\pi} I \int$



$d\vec{l} \times \hat{r} = dx\,\hat{i} \times (\cos\theta\,\hat{i} + \sin\theta\,\hat{j})$

$= dx\sin\theta\,\hat{k}$

$B = \frac{\mu_0}{4\pi} I \int \frac{dx\sin\theta}{r^2}$

$\sin\theta = \frac{d}{r} = \frac{d}{\sqrt{(d^2+x^2)}}$

$B = \frac{\mu_0}{4\pi} 2\int \frac{dx \cdot d}{(d^2+x^2)^{3/2}}$

$= \frac{2\mu_0 I d}{4\pi}\int_0^{\infty} \frac{dx}{(d^2+x^2)^{3/2}}$

$x = d\tan\phi \qquad dx = d\sec^2\phi\, d\phi$

$(d^2+x^2)^{3/2} = (d^2+d^2\tan^2\phi)^{3/2}$

$= (d^2(1+\tan^2\phi))^{3/2}$

$= (d^2\sec^2\phi)^{3/2}$

$= d^3\sec^3\phi$

$B = \frac{\mu_0 2 I d}{4\pi}\int_{0^\circ}^{90^\circ}\frac{d\sec^2\phi\, d\phi}{d^3\sec^3\phi}$

$= \frac{\mu_0 2I}{4\pi d}\int_0^{90}\cos\phi\, d\phi$

$= \frac{\mu_0 I}{2\pi d}\sin\phi\Big|_0^{90}$

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

b) $\cancel{d = \frac{2\pi B}{\mu_0 I} = \frac{2\pi(1\times10^{-4}\,T)}{(4\pi\times10^{-7}\,H/m)(15A)} = 33.3\,m}$

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

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

$\cancel{33.3}$

$= \frac{(4\pi\times10^{-7})(15A)}{2\pi(1\times10^{-4}T)} = \boxed{0.03\,m}$

12) $\oint B\cdot dr = \mu_0 I$

constant B at that distance

$B\oint dr = \mu_0 I$

$\oint dr \Rightarrow$ circumference

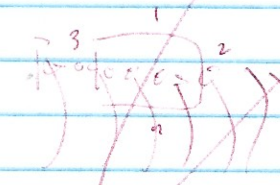
$B(2\pi d) = \mu_0 I$

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

13) $\oint B\cdot dr = \mu_0 I$

$\int_{seg.1}\vec{B}\cdot d\vec{r} = \int_{seg.1} B\,dr\cos\theta \qquad \theta = 0$

$= \int_{seg.1} B\,dr = Bl$



$\int_{seg.3} B\cdot dr = -Bl$

Seg-2 & 4 = 0

$\oint_{closed\ path} B\cdot dr = \mu_0 I$

$Bl = \mu_0 n l I$

$B = \mu_0 n I$

14) $\oint B\cdot dr = \oint B\,dr\cos\theta \qquad \theta = 0$

$= B\,2\pi r$

$B\cdot 2\pi r = \mu_0 N I$

$B = \frac{\mu_0 N I}{2\pi r} \qquad \frac{N}{2\pi r} \sim n$

$B = \mu_0 n I$