28.3

a) $\bar{F} = q\bar{V} \times \bar{B}$

$= (-e)\left(2\times10^6 \frac{m}{s}\hat{i} + 3.0\times10^6 \frac{m}{s}\hat{j}\right) \times (.03T\hat{i} - .15T\hat{j})$

$= -e\left(-2\times10^6 \frac{m}{s}\cdot .15T - 3.0\times10^6 \frac{m}{s}\cdot .03T\right)\hat{k}$

$= +1.602\times10^{-19}C\left(3\times10^5 \frac{N}{C} + 9\times10^4 \frac{N}{C}\right)\hat{k}$

$= 6.25\times10^{-14}\,N\,\hat{k}$

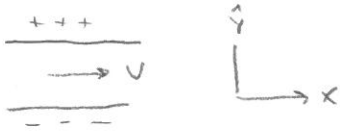
b) For the proton the sign changes

$F = -6.25\times10^{-14}\,N\,\hat{k}$

28.9

$\frac{1}{2}m_e v^2 = q_e \bar{V}_1$

$v = \left(\frac{2q_e\bar{V}}{m_e}\right)^{1/2}$



$\bar{F}_m = q_e \bar{V} \times \bar{B}$

$\bar{F}_e = q_e \bar{E} = q_e \frac{V_2}{d}\hat{y}$

To cancel the electric force $\bar{B}$ must be in the $\hat{z}$ direction

$q_e v B = q_e \frac{V_2}{d}$

$B = \frac{\bar{V}_2}{d}\cdot\frac{1}{V} = \frac{\bar{V}_2}{d}\left(\frac{m_e}{2q_e\bar{V}_1}\right)^{1/2}$

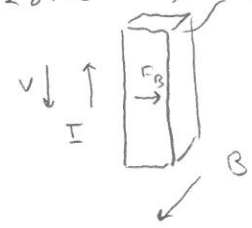
$= \left(\frac{100V}{.02m}\right)\left(\frac{9.1\times10^{-31}}{2\cdot1.602\times10^{-19}\cdot10^3 V}\right)$

$= 2.66\times10^{-4}\,T$

4.35×10^{-8}

Note $v = 1.86\times10^7 < 3.0\times10^8$ (speed of light – non-relativistic KE OK)

28.13



$4.5 \times 10^{-3}\ m = d$

$150 \times 10^{-6}\ m = w$

$\bar{B} = .65\ T$

$I = 23\ A$

$n = 8.47 \times 10^{28}\ /m^3$

$$J = \frac{I}{A} = enV_e \Rightarrow V_e = \frac{I}{Aen}$$

$$F_B = q_e V_e B = q_e E = q_e \frac{V_n}{d} \qquad A = dw$$

$$V_n = dV_e B = d\left(\frac{I}{Aen}\right)B = d\,\frac{I}{dwen}\,B$$

$$= \frac{IB}{wen} = \frac{(23A)(.65T)}{(150\times10^{-6})(1.602\times10^{-19})(8.47\times10^{28}\,/m^3)}$$

$$= 7.34 \times 10^{-6}\ \text{Volts}$$

28.14

$\bar{B} = 1.2 \times 10^{-3}\ T$ $\quad \bar{V}_n = 3.90 \times 10^{-6}\ V$

$d = .85 \times 10^{-2}\ m$, $.76 \times 10^{-3}\ m = w$

using $\quad qvB = qE = q\frac{\bar{V}}{d}$

$$v = \frac{\bar{V}}{dB} = \frac{3.90\times10^{-6}\ V}{.85\times10^{-2}\cdot 1.2\times10^{-3}\ T} = 3.7\times10^{-4}\ \frac{m}{s}$$

28.25)

$$qV_\perp B = mV_\perp^2/R$$

$$V_\perp = R\omega$$

$$qR\omega B = mR^2\omega^2/R = mR\omega^2$$

$$qB = m\omega$$

$$\omega = 2\pi f = \frac{qB}{m}$$

a) $$f = \frac{qB}{2\pi m} = \frac{(1.602\times10^{-19}\,C)(35\times10^{-6}\,T)}{(2\pi \times 9.1\times10^{-31}\,kg)} = 9.8\times10^{5}\,s^{-1}$$

b) $$\mathcal{E} = \tfrac{1}{2}m_e v^2 \qquad v = \left(\frac{2\mathcal{E}}{m_e}\right)^{1/2}$$

$$R = \frac{v}{\omega} = \left(\frac{2\mathcal{E}}{m_e}\right)^{1/2}\cdot\left(\frac{m_e}{qB}\right) = (2\mathcal{E}m_e)^{1/2}\frac{1}{qB}$$

$$= \frac{(2\times100\,V\times9.1\times10^{-31}\,kg)^{1/2}}{(1.602\times10^{-19}\,C)(35\times10^{-6}\,T)} = .96\,m$$

28.34)

$$\bar{B} = (2\times10^{-2}\,\hat{i} - 5\times10^{-2}\,\hat{j} - 3\times10^{-2}\,\hat{k})\,T$$

$$\bar{v} = (2\times10^{1}\,\hat{i} - 3\times10^{1}\,\hat{i} + 5\times10^{1}\,\hat{k})\,\frac{m}{s}$$

$$\bar{B}\cdot\bar{v} = |B||v|\cos\theta = 4\times10^{-1}\,T\,m/s$$

$$|\bar{B}| = 6.1644\times10^{-2}\,T$$

$$|\bar{v}| = 6.1644\times10^{1}\,\frac{m}{s}$$

a) $$\cos\theta = \frac{\bar{B}\cdot\bar{v}}{|B||v|} = \frac{4\times10^{-1}\,T\,m/s}{(6.1644)^2\times10^{-1}\,m/s} = .105$$

$$\theta = \cos^{-1}(.105) = 83.9^\circ$$

b) the speed does not change — the direction of $V_\perp$ does

c) since $|B|$ $|\bar{v}|$ $\bar{B}\cdot\bar{v}$ does not change — so θ does not change

d) $qV_\perp B = m\frac{V_\perp^2}{R}$

$$R = \frac{mV_\perp}{qB} = \frac{mv}{qB}\sin\theta$$

$$= \frac{(9.1\times10^{-31})(61.644\ \frac{m}{s})(.9944)}{1.602\times10^{-19}\cdot 6.16\times10^{-2}}$$

$$= 5.6\times10^{-9}\ m$$

28.35) $V = 200\ V$

a) $\Delta KE = qV$

$$= (1.602\times10^{-19}\ C)(200\ V)$$

$$= (3.204\times10^{-17})\ J$$

b) $KE = 100\ \Delta KE = 3.204\times10^{-15}\ J$

c) $V = R\omega$

in this case ω is a constant

$\Delta V = \Delta R\ \omega$ $\quad\quad$ $\frac{1}{2}mv^2 = \varepsilon$

$\frac{\Delta R}{R} = \frac{\Delta V}{V}$ $\quad\quad$ $mv\Delta V = \Delta\varepsilon$

$\Delta V = \frac{\Delta\varepsilon}{mv}$

$$\frac{\Delta R}{R} = \frac{\Delta\varepsilon}{mv^2} = \frac{1}{2}\frac{\Delta\varepsilon}{\frac{1}{2}mv^2} = \frac{1}{2}\frac{\Delta\varepsilon}{\varepsilon} = \frac{1}{2}\frac{3.204\times10^{-17}}{3.204\times10^{-15}}$$

$$= .5\times10^{-2} \Rightarrow .5\%$$