13 $E = 7.4\hat{i} + 2.8\hat{j}$ kN/C $B = 15\hat{j} + 36\hat{k}$ mT

$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$

a) $V = 0$ so B field does not initially contribute

$\vec{F} = q\vec{E}$

b) $V = 6.1 \times 10^6 \hat{i}$ note $\hat{i} \times \hat{j} = \hat{k}$ and $\hat{i} \times \hat{k} = -\hat{j}$

15) note that since F_B is always perpindicular to the motion this is much like the centrifugal forces you saw in 2A $V = 15 \times 10^3$ $B = 400 \times 10^{-5}$

$m_p \frac{v^2}{r} = q_p v B$ (the cross product is what told me it was perpindicular)

$r = \frac{m_p V}{q_p B}$ be careful with this ~~rotati~~ accelerating charged particles emit radiation and lose Ke thus this is only valid at $t=0$ after which it will spiral in

(this radiation is called cyclotron radiation)

22) $Ke = \frac{1}{2} m v^2$ $r = \frac{mV}{qB}$ so $r = \frac{\sqrt{2Km}}{qB}$

27) note that $x = 2r = 2\frac{\sqrt{2Km}}{qB}$

remember that the Ke of the particle is equal to the opposite of change in potential it went through (if it starts from rest)

$\Delta P_e = -qV \Rightarrow Ke = qV \Rightarrow x = \frac{2}{B}\frac{\sqrt{2qVm}}{q} = \frac{2}{B}\sqrt{\frac{2V}{q/m}}$

32) $p = V_{\parallel} t_{rot}$ where t_{rot} = time it takes to do one revolution

we can find t_{rot} by noting the one rotation has a length of $2\pi r$ and the proton is moving at speed $V_{\perp} = 40\,Km/s$ remember also that $r = \frac{m_p V_{\perp}}{q_p B}$

$$t_{rot} = \frac{2\pi r}{V_{\perp}} = \frac{2\pi m_p \cancel{V_{\perp}}}{\cancel{V_{\perp}} q_p B}$$ note that $V_{\perp}$ does not matter!

$$V_{\parallel} = P/t_{rot} = \frac{P q_p B}{2\pi m_p}$$

(warning for $V_{\perp}$ that are relativistic, $V_{\perp} > .1C$ it will not drop out)

36) $F = l\vec{I} \times \vec{B} = (\rho \vec{V} \times \vec{B} \cdot \text{volume of wire})$

$I = V/R = 4$ amps in the $-\hat{j}$ direction

$B = -38 \times 10^{-3}T\,\hat{k}$

$\vec{F} = .1m\,(4\,amps)(38 \times 10^{-3}T)(-\hat{j}) \times (-\hat{k}) = 1.52 \times 10^{-2}\,N\,\hat{i}$

note there is a force on the wires that are partially in the field but since current is going in opposite directions in them the forces cancel.

38) A little bit of extra information is needed here the ammount that the bar sags is directly related to the force pushing it down, in this case gravity. the upper position is where the force is reversed.

38 cont

a) as far as magnitudes go this is fairly simple

$|F_o| = |-mg\hat{j}|$

$|F_f| = |\cancel{qv\times B}\ lI\times B - mg\hat{j}|$ note gravity is still there

thus we need $lI\times B = 2mg$ for the net force to be equal and opposite

$$|I| = \frac{2mg}{lB}$$

b) to find the direction we use the right hand rule.

or we note that $lI\times B$ must be in the positive $\hat{j}$ direction and $\hat{B} = -\hat{k}$

$\hat{i}\times(-\hat{k}) = \hat{j}$ so I goes left to right $(\hat{i})$

53) without blowing your mind with quantam statistics (not every spin will flip etc etc)

we note that the energy of dipole in a magnetic field is $-\mu\cdot B$ thus the potential energy is $\mu\cdot B$ when the dipole is antiparrallel and $-\mu\cdot B$ when parallel

the change in energy is of course $2\mu B$

in reality there are also spin spin interactions that will change this based on the orientation of the neighbor