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$\vec{E} = 7.4\hat{\imath} + 2.8\hat{\jmath}$ kN/C

$\vec{B} = 15\hat{\jmath} + 36\hat{k}$ mT

(a) What is the force on a stationary proton?

The Lorentz force law, $\vec{F} = q\vec{v}\times\vec{B}$, tells you that there is no magnetic force on a stationary ($\vec{v}=0$) particle. So, we just have the Coulomb force:

$$\vec{F} = q\vec{E} = (1.6\times10^{-19}\,C)(7.4\,\hat{\imath} + 2.8\,\hat{\jmath}\ kN/C)$$

$$= \boxed{1.18\times10^{-15}\,\hat{\imath} + 4.48\times10^{-16}\,\hat{\jmath}\ N}$$

(b) What is the force on an e^- moving w/ $\vec{v} = 6.1\hat{\imath}$ Mm/s?

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

$$\vec{F}_E = q\vec{E} = -1.18\times10^{-15}\hat{\imath} + -4.48\times10^{-16}\hat{\jmath}\ N \quad \text{(opposite of above)}$$

$$\vec{F}_B = q\vec{V}\times\vec{B}$$

$$\vec{V}\times\vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 6.1\,Mm/s & 0 & 0 \\ 0 & 15mT & 36mT \end{vmatrix} = \hat{\imath}\,(0-0) - \hat{\jmath}\,(6.1\times10^{6}\,m/s\cdot 36\times10^{-3}\,T - 0) + \hat{k}\,(6.1\times10^{6}\,m/s\cdot 15\times10^{-3}\,T - 0)$$

If you don't understand what is above, review how to take cross products.

$$\vec{F}_B = q\vec{V}\times\vec{B} = (-1.6\times10^{-19}\,C)(-219.6\,\tfrac{KTm}{s}\hat{\jmath} + 91.5\,\tfrac{KTm}{s}\hat{k})$$

$$= 3.51\times10^{-14}\,N\,\hat{\jmath} - 1.46\times10^{-14}\,N\,\hat{k}$$

$$\vec{F} = \vec{F}_E + \vec{F}_B = \boxed{-1.18\times10^{-15}\,\hat{\imath} + 3.46\times10^{-14}\,\hat{\jmath} - 1.46\times10^{-14}\,\hat{k}\ N}$$

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What is r for a p w/ $\vec{v} = 15\ \text{km/s}$ in $\perp$ $\vec{B} = 400G$

Note: Gauss $= 10^{-4}T$ is not the SI unit, convert.

$$\vec{B} = \frac{400\ G}{} \left| \frac{10^{-4}\ T}{G} \right| \left| 0.04T \right.$$

$$F_{centripital} = F_B$$

$$m\frac{v^2}{r} = qvB$$ (here $\vec{B}$ is perpendicular to $\vec{v}$ and $\theta = 90° \Rightarrow \sin\theta = 1$)

$$\Rightarrow r = \frac{mv^2}{qvB} = \frac{(1.67\times10^{-27}\ kg)(15\times10^3\ m/s)^2}{(1.6\times10^{-19}C)(15\times10^3\ m/s)(0.04T)}$$

$$= \boxed{3.91\times10^{-3}\ m}$$ (note you can cancel one v)

#22

Show that $r = \frac{\sqrt{2Km}}{qB}$.

We have, from above: $r = \frac{mv^2}{qvB} = \frac{mv}{qB}$

and we know $K = \frac{1}{2}mv^2 \Rightarrow mv = \sqrt{2Km}$

$$\boxed{r = \frac{\sqrt{2Km}}{qB}}$$

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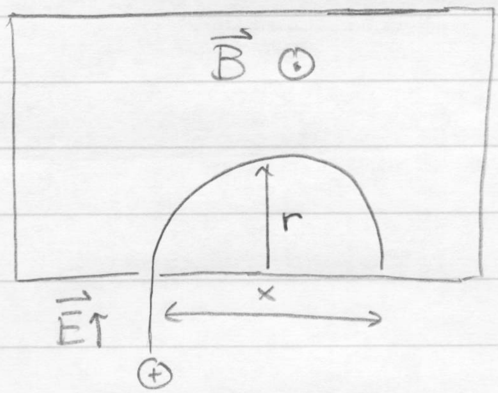

Show $x = \dfrac{2}{B}\sqrt{\dfrac{2V}{(q/m)}}$

From #22 we have $r = \dfrac{\sqrt{2Km}}{qB} = \frac{1}{2}x$ (above)

K when q enters $\vec{B}$ is given by qV by energy conservation.

$$x = 2r = \frac{2\sqrt{2(qV)m}}{qB} = \boxed{\frac{2}{B}\sqrt{\frac{2V}{q/m}}}$$

#32

$$\vec{B} = 15\text{ mG} = \frac{15\times10^{-3}\text{ G}}{} \left| \frac{10^{-4}\text{ T}}{\text{G}} \right| \frac{15\times10^{-7}\text{ T}}{}$$

$V_c = 40\times10^{3}$ m/s , $p = 8.7\times10^{3}$ m

what is the velocity parallel to the field?

Parallel to the field, the particle executes uniform rectilinear motion (goes straight with constant velocity). Perpendicular to the field it goes in a circle : $t = \dfrac{\text{distance}}{\text{velocity}} = \dfrac{2\pi\left(\frac{m\cancel{V_c}}{qB}\right)}{\cancel{V_c}} = 0.04\text{s}$

r from #15

Parallel to the field, velocity $= \dfrac{\text{distance}}{\text{time}} = \dfrac{8.7\times10^{3}\text{m}}{0.04\text{s}} = \boxed{1.99\times10^{5}\text{ m/s}}$

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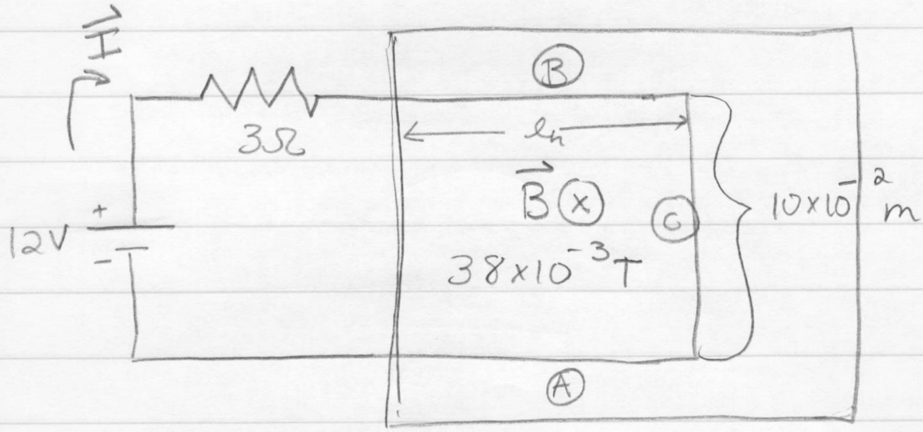

What is the magnitude and direction of the force on the circuit?

$\vec{F} = \vec{I}\, l \times B$ will apply to all segments of the circuit:

Notice that the force on the bottom segment Ⓐ will be $\vec{F}_{A} = \vec{I}\, l_n \times \vec{B}$, which points down (right hand rule).
Likewise $\vec{F}_{B} = \vec{I}\, l_n \times \vec{B}$, pointing up ($\vec{I}$ changes direction)
so $\vec{F}_{A} = -\vec{F}_{B}$ and they cancel.

Finally, $\vec{F}_{C} = \vec{I}\, l \times \vec{B} = IlB$ ($\vec{I}$ is perpendicular to $\vec{B}$)
$= \left(\frac{12V}{3\Omega}\right)(10\times10^{-2}\,m)(38\times10^{-3}\,T) = \boxed{1.52\times10^{-2}\,N}$

The direction is to the $\boxed{\text{right}}$ by the right hand rule.

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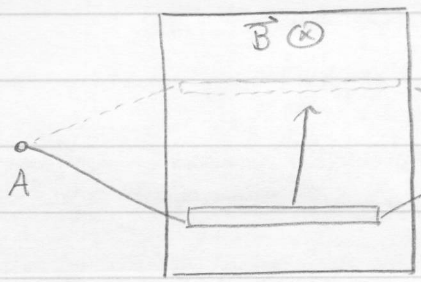
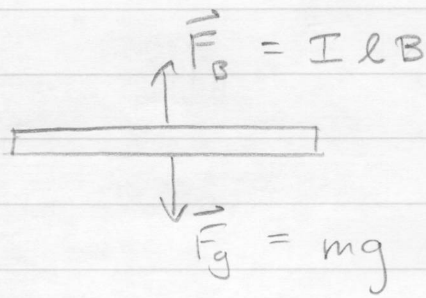


(a) What is $\vec{I}$ to get bar to upper position?
We will have to balance gravity to levitate the bar.



$$\Rightarrow I\ell B = mg \Rightarrow I = \frac{mg}{\ell B} = \frac{(18\times10^{-3}\,kg)(9.8\,m/s^2)}{(20\times10^{-2}\,m)(0.15\,T)}$$

$$= \boxed{5.88\,A}$$

(b) Which direction should $\vec{I}$ go?
Use right hand rule $\Rightarrow \boxed{A \to B}$.

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$$\vec{B} = 7.0\,T, \quad \mu = 1.41 \times 10^{-26}\,Am^2$$

$$\vec{B}$$
$$\longrightarrow$$

$$\longrightarrow \vec{\mu} \text{ (parallel)}$$

$$U_i = -\vec{\mu} \cdot \vec{B} = -\mu B \quad (\vec{\mu} \parallel \vec{B})$$

$$\longleftarrow \vec{\mu} \text{ (anti parallel)}$$

$$U_F = -\vec{\mu} \cdot \vec{B} = \mu B \quad (\vec{\mu} \text{ anti} \parallel \vec{B})$$

$$\Delta U = U_F - U_i = 2\mu B = 2(1.41 \times 10^{-26}\,Am^2)(7.0\,T)$$
$$= \boxed{1.97 \times 10^{-25}\,J}$$