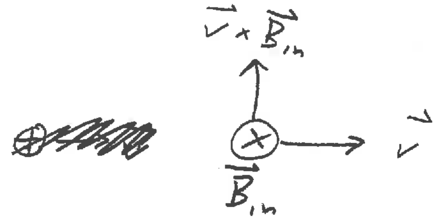
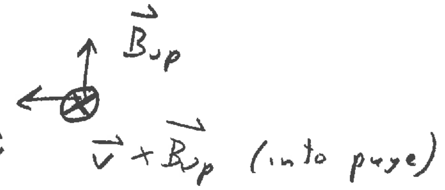
Chpt 29:

1. a) 

$\vec{F} = q\,\vec{v}\times\vec{B}_{in}$

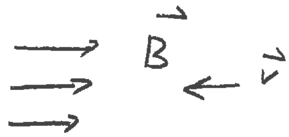
$q>0 \rightarrow \vec{F}$ in same direction as $\vec{v}\times\vec{B}_{in}$

so $\vec{F}$ is $\boxed{\text{Up}}$

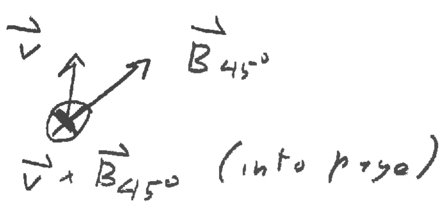
b) 

$q<0$, so $\vec{F}$ is opp $\vec{v}\times\vec{B}_{up}$

so $\boxed{\text{out of page}}$

c) 

, $\vec{B} \parallel \vec{v}$ so $\boxed{\vec{F}=\vec{0}}$

d) 

$q>0$, so $\vec{F}$ is in same direction as $\vec{v}\times\vec{B}_{45°}$

so $\vec{F}$ is $\boxed{\text{into}}$ page

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2. Proton: m, q (proton mass $= 1.67\times10^{-27}$ kg, $q = 1.6\times10^{-19}$ C)

$\vec{v} = (4\hat{i} - 6\hat{j} + \hat{k})$ m/s

$\vec{B} = (\hat{i} + 2\hat{j} - \hat{k})$ T

$\vec{F} = q\,\vec{v}\times\vec{B}$, $\quad \vec{v}\times\vec{B} = (4\hat{i} - 6\hat{j} + \hat{k})\times(\hat{i} + 2\hat{j} - \hat{k})\ \frac{m\,T}{s}$

$= (8\hat{k} + 4\hat{j} + 6\hat{k} + 6\hat{i} + \hat{j} - 2\hat{i})\ \frac{m\cdot T}{s}$

$= (4\hat{i} + 5\hat{j} + 14\hat{k})\ \frac{m\,T}{s}$

$|\vec{v}\times\vec{B}| = \sqrt{4^2+5^2+14^2}\ \frac{m\,T}{s}$

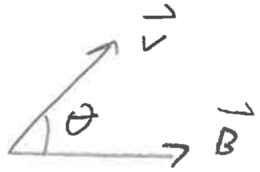
$|\vec{F}| = |q|\,|\vec{v}\times\vec{B}| = 1.6\times10^{-19}\sqrt{4^2+5^2+14^2}$ N

$= \boxed{2.47\times10^{-18}\ \text{N}}$

(3.) proton, $v = 4.90 \times 10^6$ m/s, $\theta = 57°$, $B = 0.240$ T

$q = 1.6 \times 10^{-19}$ C

$m = 1.67 \times 10^{-27}$ kg



a) $F = |q|\,|\vec{v} \times \vec{B}|$

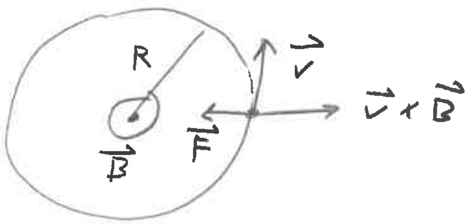
$= |q|\, v B \sin\theta$

$= \boxed{1.58 \times 10^{-13}\ \text{N}}$

b) $F = ma \rightarrow a = \dfrac{F}{m} = \boxed{9.46 \times 10^{13}\ \text{m/s}^2}$

(4.) electron: $m = 9.11 \times 10^{-31}$ kg

$q = -1.6 \times 10^{-19}$ C



($\vec{F} = q\,\vec{v} \times \vec{B}$ is directed opposite to $\vec{v} \times \vec{B}$ since $q < 0$)

$B = 2.17$ mT

$v = 1.35 \times 10^7$ m/s

a) $F = \dfrac{mv^2}{R} = |q|\, vB$ (since $\vec{v} \perp \vec{B}$ are $\perp$)

Thus, $R = \dfrac{mv}{|q|B} = \boxed{3.5\ \text{cm}}$

b) Time interval for one revolution

$v = \dfrac{2\pi R}{T} \rightarrow T = \dfrac{2\pi R}{v} = \dfrac{2\pi}{v} \dfrac{mv}{|q|B} = \dfrac{2\pi m}{|q|B}$

$\boxed{T = 1.6 \times 10^{-8}\ \text{s}}$

(5.) Proton: $m = m_p$, $q = e$

Deuteron: $m = 2 \times m_p$, $q = e = q_p$

α particle: $m = 4 \times m_p$, $q = 2e = 2 \times q_p$

Potential difference ΔV

$$\Delta U = |q| \Delta V = \Delta K = \frac{1}{2} m v^2$$

Thus, $v = \sqrt{\dfrac{2|q|\Delta V}{m}}$ (after being accelerated by ΔV

In magnetic field: (unif. circular motion)

$$R = \frac{mv}{|q| B} = \frac{m}{|q| B}\sqrt{\frac{2|q|\Delta V}{m}} = \frac{1}{B}\sqrt{2\Delta V}\sqrt{\frac{m}{|q|}}$$

Let r_p = radius for proton $= \dfrac{1}{B}\sqrt{2\Delta V}\sqrt{\dfrac{m_p}{q_p}}$

a) r_d = radius for deuteron $= \dfrac{1}{B}\sqrt{2\Delta V}\sqrt{\dfrac{m_d}{q_d}}$

$$= \frac{1}{B}\sqrt{2\Delta V}\sqrt{\frac{2 m_p}{q_p}}$$

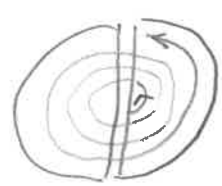
$$= \boxed{\sqrt{2}\, r_p}$$

b) r_α = radius for alpha particle $= \dfrac{1}{B}\sqrt{2\Delta V}\sqrt{\dfrac{m_\alpha}{q_\alpha}}$

$$= \frac{1}{B}\sqrt{2\Delta V}\sqrt{\frac{4 m_p}{2 q_p}}$$

$$= \boxed{\sqrt{2}\, r_p}$$

(6.)



$R = 1.6\ m$, $B = 0.330\ T$, proton: $m = 1.67 \times 10^{-27}$ kg, $q = 1.6 \times 10^{-19}$ C

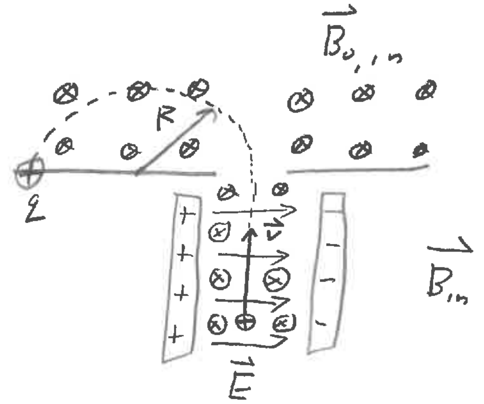
a) cyclotron Freq: $T = \dfrac{2\pi m}{|q| B}$ (from problem 4)

$$\omega = \frac{2\pi}{T} = \frac{|q| B}{m} = \boxed{3.17 \times 10^7 \ \frac{rad}{s}}$$

b) max speed: $v_{max} = \dfrac{2\pi R}{T} = \dfrac{2\pi R}{2\pi m}|q| B = \dfrac{|q| B R}{m}$

$$= \boxed{5.07 \times 10^7 \ \frac{m}{s}}$$

(7)



$E = 2.9 \times 10^3 \ \frac{V}{m}$
$B = 0.045 T$ (For both $\vec{B}_{in}, \vec{B}_{o,in}$)
$m = 1.8 \times 10^{-26}$ kg
$q = 1.6 \times 10^{-19}$ C

For $\vec{v}$ = const between the plates:

$\vec{F}_E = q\vec{E}$ should equal $\vec{F}_B = q\,\vec{v} \times \vec{B}_{in}$

$qE = qvB_{in}$ (for $\vec{v} \perp \vec{B}$)

$E = vB_{in}$

$\rightarrow v = E/B_{in}$

Then in the deflection chamber:

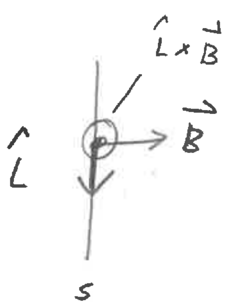
$$\frac{mv^2}{R} = qvB_o$$

$$\rightarrow R = \frac{mv}{|q| B_{o,in}}$$

Thus, $R = \dfrac{mv}{|q| B_{o,in}} = \dfrac{mE}{|q| B_{o,in} B_{in}} = \boxed{0.16 \text{ m}}$

(8.) $\vec{F} = I\vec{L} \times \vec{B} \rightarrow \dfrac{\vec{F}}{L} = I\hat{L} \times \vec{B}$

$\frac{m}{L} = 0.52 \frac{g}{cm} \times \left(\frac{1 kg}{1000 g}\right)$
$= 0.052 \frac{kg}{m} \times \left(\frac{100 cm}{m}\right)$



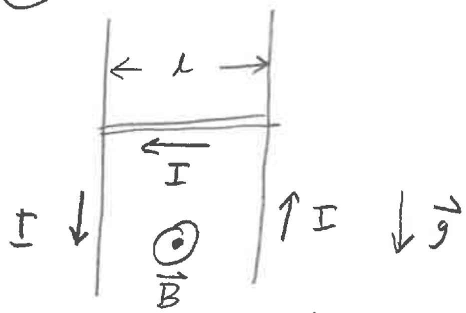
To lift wire need $\vec{F} = m\vec{g}$

$|\vec{F}| = ILB = mg$

$\rightarrow B = \dfrac{m}{L}\dfrac{g}{I}$, $I = 1.60$ A, $g = 9.8$ m/s^2

$= \boxed{0.319 \text{ Tesla}}$

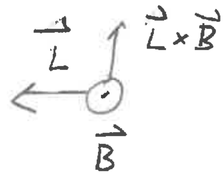
9.



(out of page)
(i.e., horizontal)

$l = 14.4\,cm = 14.4 \times 10^{-2}\,m$

$m = 15.8\,gm = 15.8 \times 10^{-3}\,kg$



$\vec{F}_B = I\vec{L} \times \vec{B}$,

$\vec{F}_g = m\vec{g}$, $g = 9.8\,\frac{m}{s^2}$

$I = 4.75\,A$

a) magnetic and gravitational forces

b) when $\vec{F}_B$ is equal and opposite $\vec{F}_g$ (see below)

c) $\vec{B}$ must be out of page (horizontal)

$$I l B = mg$$

$$B = \frac{mg}{Il} = \boxed{0.226 \text{ Tesla}}$$

d) If $\vec{B}$ is larger than the value in part (c), the horizontal wire will accelerate vertically upward since $\vec{F}_{net} = \vec{F}_B + \vec{F}_g$ will be directed upward

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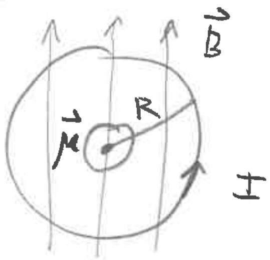
10.



$I = 12\,mA$

$C = 3.20\,m$

$C = 2\pi R \rightarrow R = \frac{C}{2\pi}$

$B = 0.67\,T$

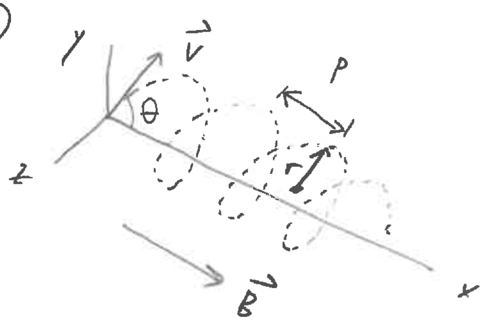
a) $\vec{\mu}$ = magnetic moment (point out of page)

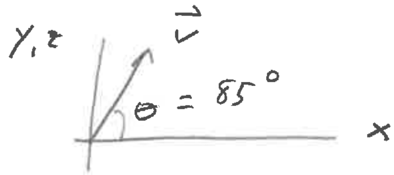
$$\mu = IA = I \cdot \pi R^2 = \boxed{9.78\,mA \cdot m^2}$$

b) $\vec{\tau} = \vec{\mu} \times \vec{B} \rightarrow \tau = \mu B$ (since $\vec{\mu} \perp \vec{B}$)

$$= \boxed{6.55\,mN \cdot m}$$

(11)





$v_x = v\cos\theta$

$v_\perp = v\sin\theta$ ($\perp$ to x-axis)

$v = 4.75 \times 10^6$ m/s , $B = 0.139$ T

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

unit vector $\perp$ to x-axis (in y-z plane)

$= q\left(v_x \hat{i} + v_\perp \hat{n}\right) \times B\hat{i}$

$= q\, v_\perp B\, \hat{n} \times \hat{i}$

$= q\, v_\perp B\, \hat{m}$ (where $\hat{m} = \hat{n} \times \hat{i}$ is also $\perp$ to x-axis)

This Force gives rise to Uniform circular motion in yz plane.

Positron moves with constant velocity in x-direction

$|q| v_\perp B = \dfrac{m v_\perp^2}{r} \quad \rightarrow \quad r = \dfrac{m v_\perp}{|q| B} = \dfrac{m v \sin\theta}{|q| B}$

$= \boxed{1.94 \times 10^{-4}\ \text{m}}$ (b)

pitch: $p = v_x T$ where T = period for One revolution

$= \dfrac{2\pi m}{|q| B}$ (indep of $v_\perp$)

$\rightarrow \quad p = \dfrac{2\pi m}{|q| B} v\cos\theta = \boxed{1.06 \times 10^{-4}\ \text{m}}$ (a)