SOLUTIONS- 7

FORMLAE RC circuit

charging $i = i_0 e^{-t/RC}$, $i_0 = \frac{\mathcal{E}}{R}$

$$q = C\mathcal{E}\left[1 - e^{-t/RC}\right]$$

$$v_c = q/c$$

Discharging $i = i_0 e^{-t/RC}$

$$q = C\mathcal{E}e^{-t/RC}$$

FORCE IN $\underline{B}$-field.

on Moving Charge

$\vec{F}_B = q[\vec{v} \times \vec{B}]$

Right hand. → $q\vec{v}$ ∥ Thumb, $\vec{B}$ ∥ Fingers, $\vec{F}_B \perp$ PALM

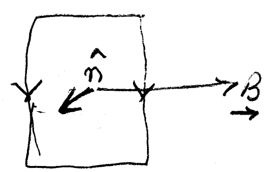
$F_B = qvB\sin(\vec{v}, \vec{B})$

Current $\vec{F}_I = I[\Delta\vec{l} \times \vec{B}]$

$$F_I = I\Delta l B\sin(\Delta\vec{l}, \vec{B})$$

Torque on loop

$$\vec{\tau} = NIA[\hat{n} \times \vec{B}]$$



Magnetic moment

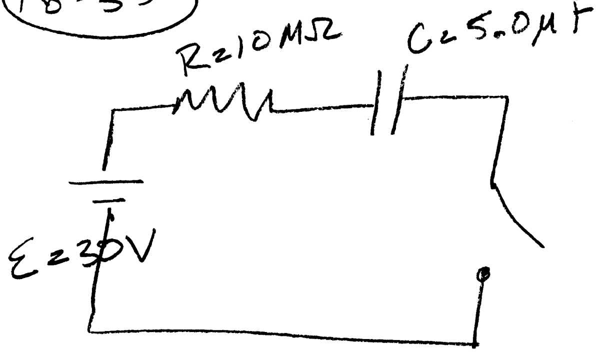
$$\vec{\mu} = NIA\hat{n}$$

Homework Solutions

10/20/08

Ch. 18

18-33



$q(t) = Q_{max}\left(1 - e^{-t/\tau}\right)$ → charge on the capacitor as a function of time.

$Q_{max} = C\varepsilon = (5.0 \times 10^{-6}\,F)(30\,V) = 1.5\times10^{-4}\,C$

$\tau = RC = (10\times10^{6}\,\Omega)(5\times10^{-6}\,F) = 5.0\,s$

So,

$q(10\,s) = (1.5\times10^{-4}\,C)\left(1 - e^{-10s/5.0s}\right)$

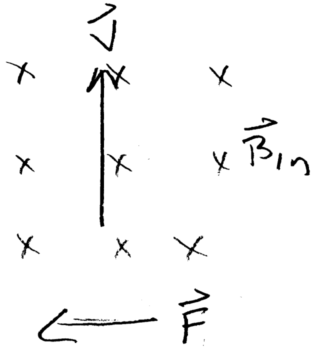
$= \boxed{1.3\times10^{-4}\,C}$

Ch. 19

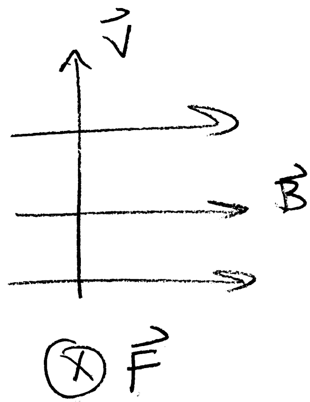
19-2

⊕-charge moving through Magnetic Fields
→ use the right hand rule

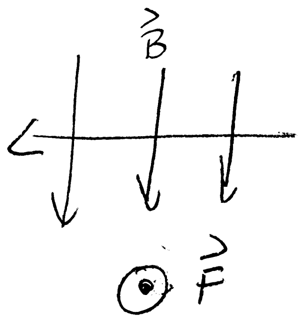
(a)



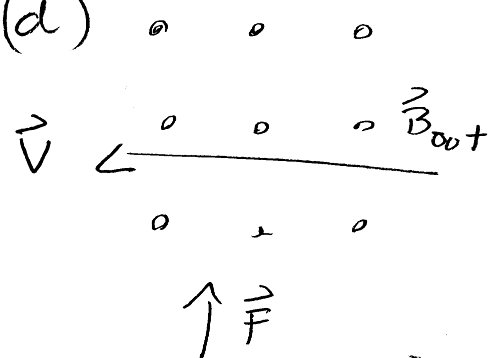
(b)



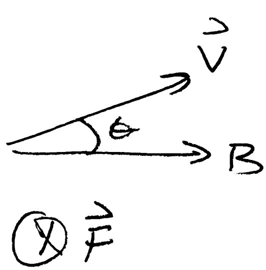
(c)



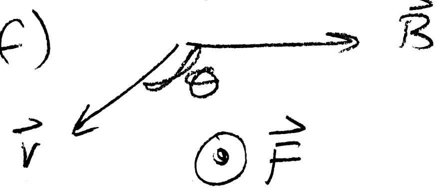
(d)



(e)

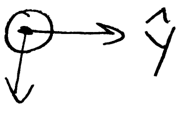


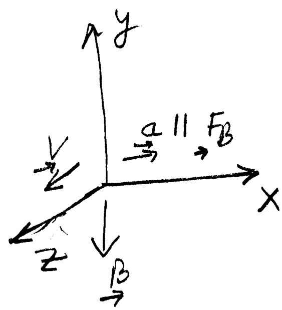
(f)



For a ⊖-charge, all the forces are reversed

(19-9)





e^+ - proton:

⊙ $\vec{v} = 1.0 \times 10^{7}\ m/s\ \hat{z}$

$\vec{a} = 2.0 \times 10^{13}\ m/s^2\ \hat{x}$

Since $\vec{v}$ + $\vec{B}$ are perpendicular and using the right hand rule, we find that $\vec{B}$ points in the $(-\hat{y})$-direction. The magnitude follows from

$$F = Bqv$$

$$\Rightarrow B = \frac{F}{qv} = \frac{ma}{qv} = \frac{(1.67\times10^{-27}\,kg)(2.0\times10^{13}\,m/s)}{(1.60\times10^{-19}\,C)(1.0\times10^{7}\,m/s)}.$$

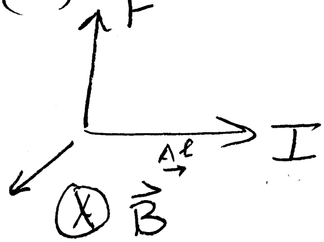
$$= 0.021\ T$$

$$\Rightarrow \boxed{\vec{B} = -0.021\,T\,\hat{y}}$$

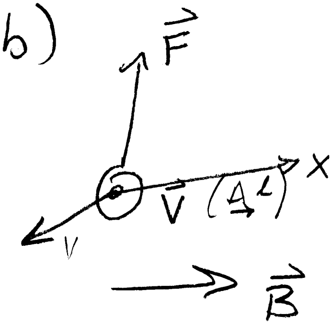
19-13

Use the right hand rule: $\vec{F}_I = I \vec{\Delta l} \times \vec{B}$

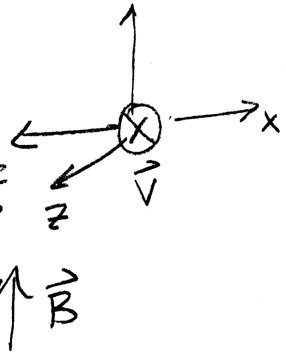
(a)



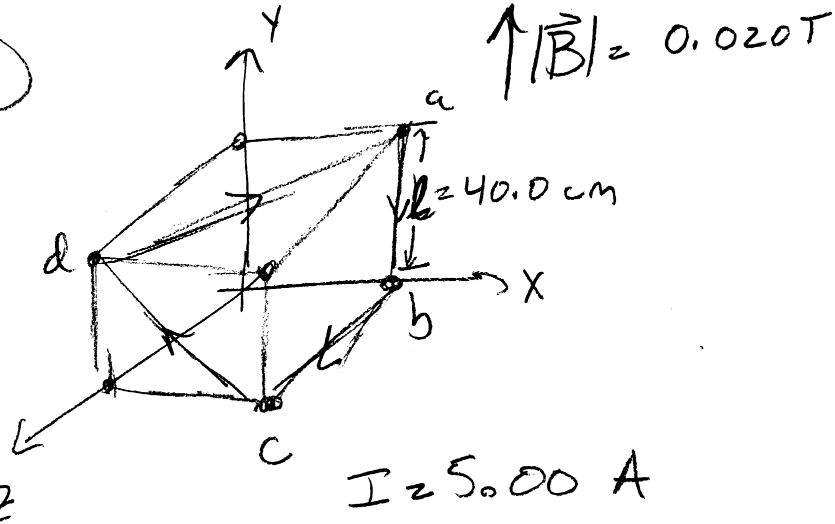
(b)



(c)



19-21



$|\vec{F}| = BIL\sin\theta$

θ = angle between I & B

$\Rightarrow$ direction given by right hand rule

ab: $\theta = 180^\circ$ $\quad |\vec{F}| \propto \sin(180^\circ) = \boxed{0}$

bc: $F = (0.020\,T)(5.00\,A)(40.0\,cm)\sin 90^\circ$

$= 0.040\,N$

$\Rightarrow \boxed{\vec{F} = -0.040\,N\,\hat{x}}$

cd: $F = BIL\sin\theta$

$= (0.20\,T)(5.00\,A)(0.400\sqrt{2}\,m)\sin 45^\circ$

$= 0.040\,N$

$\boxed{\vec{F} = 0.040\,N\,\hat{z}}$

da: $F = BIL\sin\theta$

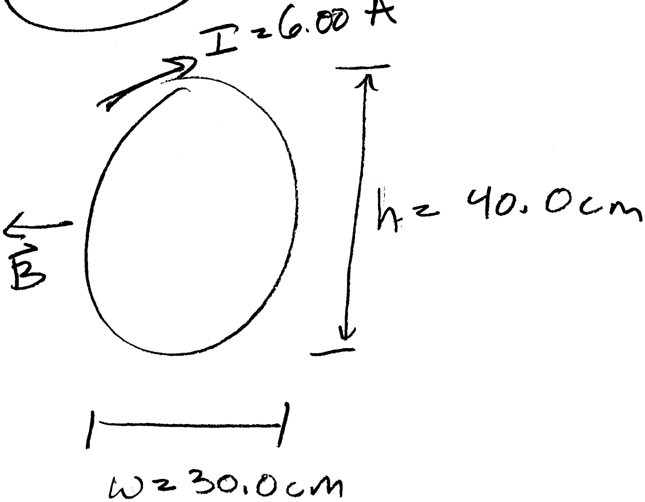
$= (0.20\,T)(5.00\,A)(0.400\sqrt{2}\,m)(\sin 90^\circ)$

$= 0.057\,N$

$\vec{F} = 0.057\,N\left(\cos 45^\circ\,\hat{x} + \sin 45^\circ\,\hat{y}\right)$

19-23

$|\vec{B}| = 2.00 \times 10^{-4}\ T$



τ = torque = $NBIA \sin\theta$

N = # of turns

$A = \text{area} = \pi ab = \pi (20.0\ cm)(15.0\ cm)$

$= 0.0942\ m^2$

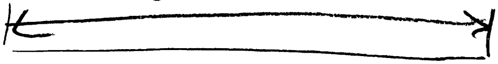
θ = angle between $\vec{B}$ + the unit normal vector = 90°

$\tau = 8(2.00 \times 10^{-4}\ T)(6.00\ A)(0.0942\ m^2) \sin 90^\circ$

$= \boxed{9.05 \times 10^{-4}\ Nm}$

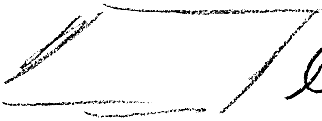
(19.25)

$L = 4.00\,m$



$m = 0.100\,kg$

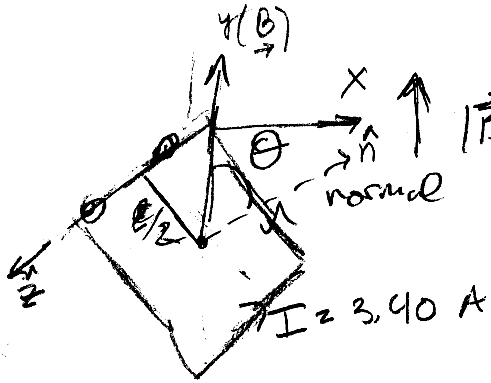
↳ wrap into a coil



$\ell = 0.100\,m$

$N = \frac{L}{4\ell} = \frac{4.00\,m}{4(0.100\,m)} = 10$

Attach one side to a hinge



$|\vec{B}| = 0.010\,T$

$\vec{\tau}_B = -NBIA\sin\theta\,\hat{z}$

$\vec{\tau}_g$ = torque due to gravity $= +mg\left(\frac{\ell}{2}\cos\theta\right)\hat{z}$

In equilibrium: $\vec{\tau}_B + \vec{\tau}_g = 0$

$$NBIA\sin\theta = mg\left(\frac{l}{2}\cos\theta\right)$$

$$\tan\theta = \frac{mgl}{2NBIA}$$

$$\theta = \text{Arctan}\left(\frac{mgl}{2NBIA}\right)$$

$$= \text{Arc tan}\left(\frac{(0.100\,kg)(9.8\,m/s^2)(0.100\,m)}{2(10)(0.010T)(3.40A)(0.100\,m)^2}\right)$$

$$\boxed{\theta = 86.0^\circ}$$

(b) $$\vec{\tau}_B = NBIA\sin\theta\,\hat{z}$$

$$= 10(0.010T)(3.40A)(0.100m)^2 \sin 86^\circ\,\hat{z}$$

$$= \boxed{3.39\times10^{-3}\ Nm\,\hat{z}}$$