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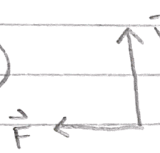
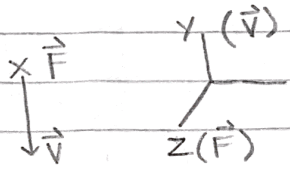
Midterm 3

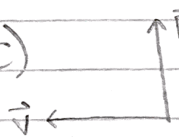
① a) 

Direction: Into the Page

b) 

Direction: To the left

Right hand rule

c) 

Direction: Out of the page

② a) E-field force = Lorentz F

$$\frac{Eq}{q} = \frac{qvB}{q}$$

$$\frac{E}{B} = \frac{vB}{B}$$

$$v = \frac{E}{B}$$

b) $I = nq_e v_d A$

$$I = nq_e\left(\frac{E}{B}\right)A$$

$$I = nq_e\left(\frac{\frac{\Delta V}{\Delta x}}{B}\right)A$$

$$I = nq_e\left(\frac{\Delta V}{\Delta x \cdot B}\right)A$$

$$\frac{I\Delta x B}{nA} = \frac{nq_e \Delta V A}{nq_e A}$$

$$\Delta V = \frac{I\Delta x B}{nq_e A}$$

$$v = \frac{E}{B}$$

$$E = \frac{\Delta V}{\Delta x}$$

c) $\Delta V = \frac{(10)(0.02)(1.33)}{(2\times10^{28})(1.6\times10^{-19})(1\times10^{-6})}$

$\Delta V = \frac{0.266}{3200} = \boxed{8.31\times10^{-5}\ V}$

③ $\tau = \vec{F}\times\vec{r} \Rightarrow \vec{F} = \underbrace{qv}_{I}\times B \Rightarrow \tau = -IAB$

$A = \pi r^2 = \pi(0.65\times10^{-15})^2 = 4.225\times10^{-31}\pi$

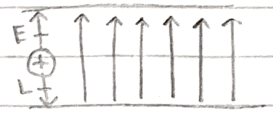
$\tau = -(1.05\times10^{4})(4.225\times10^{-31})(\pi)(2.50) = \boxed{3.48\times10^{-26}\ N/m}$

④ a) $B = \mu_0 nI$

$B = (4\pi \times 10^{-7})(500)(0.3) = \boxed{1.9 \times 10^{-4}\ T}$

b) $B = 5000(\mu_0)nI$

$B = 5000(4\pi \times 10^{-7})(500)(0.3) = \boxed{0.94\ T}$

⑤ a) 

$\frac{Eq}{q} = \frac{qvB}{q}$

$V = \frac{E}{B}$

$\sum F = Eq - qvB$

$\sum F = Eq - q\left(\frac{E}{B}\right)B$

$\sum F = Eq - qE$

$\sum F = 0$

b) $\frac{mv^2}{r} = qvB$

$mv^2 = qvBr$

$m\left(\frac{E}{B}\right) = qBr$

$r = \frac{mE}{qB^2}$

c) $r = \frac{mE}{qB^2}$

$r = \frac{16(1.67 \times 10^{-27})(10)}{(1.6 \times 10^{-19})(0.01)^2} = \boxed{0.0167\ m}$

⑥ a) $\Phi = \frac{AB}{dt} = A \cdot \frac{dB}{dt}$

$B(t) = B_0\left[\frac{1}{2} + \frac{2}{\pi}\sin(2\pi ft) + \frac{2}{3\pi}\sin(6\pi ft) + \frac{2}{5\pi}\sin(10\pi ft)\right]$

$B'(t) = B_0\left[0 + (2\pi f)\left(\frac{2}{\pi}\cos(2\pi ft)\right) + (6\pi f)\left(\frac{2}{3\pi}\right)\cos(6\pi ft) + (10\pi f)\left(\frac{2}{5\pi}\right)\cos(10\pi ft)\right]$

$B'(t) = B_0\left[4f\cos(2\pi ft) + 4f\cos(6\pi ft) + 4f\cos(10\pi ft)\right]$

$\boxed{\Phi = \pi r^2 B_0\left[4f\cos(2\pi ft) + 4f\cos(6\pi ft) + 4f\cos(10\pi ft)\right]}$

b) $B_0 = 0.1\,T$; $r = 0.1\,m$, $f = 10^3\,Hz$, $t = 0$

$$\Phi = \pi(0.1)^2(0.1)\left[4(10^3)\cos(0) + 4(10^3)\cos(0) + 4(10^3)\cos(0)\right]$$

$$\Phi = 0.0031\,(12000) = \boxed{37.7\ V}$$

c) $$\Phi = \pi(0.1)^2(0.1)\,4(10^3)\left[\cos 2\pi 10^3(0.001) + \cos(6\pi 10^3(0.001) + \cos 10\pi 10^3(0.001)\right]$$

$$\Phi = 12.57\,[3] = \boxed{37.7\ V}$$

⑦ 0.50-H and $\mathcal{E} = 0.150\ V$

$$\mathcal{E} = -L\frac{dI}{dt} \Rightarrow \frac{0.150}{-0.50} = -\frac{(0.50)}{-0.50}\frac{dI}{dt} \Rightarrow \boxed{\frac{dI}{dt} = -0.3}$$

⑧ $I = 0.1\ A$
$L = 0.002\ H$
$\mathcal{E} = 500\ V$
$t = ?$

$$\mathcal{E} = -L\frac{dI}{dt} = -L\frac{\Delta I}{\Delta t}$$

$$\mathcal{E}\Delta t = -L\Delta I$$

$$\Delta t = \frac{L\Delta I}{\mathcal{E}}$$

$$\Delta t = \frac{(0.002)(0.1)}{500} = \boxed{4\times10^{-7}\ s}$$