Andrea Acosta
20607848

Chapter 11: MAGNETIC FORCES AND FIELDS

① (a) $\hat{B} = \hat{F} \times \hat{V} = (-\hat{i} \times \hat{j}) = -\hat{k}$

$\therefore$ direction of B-field is $\boxed{\text{into the page}}$

(b) $\hat{B} = \hat{F} \times \hat{V} = (-\hat{k}) \times (-\hat{j}) = -\hat{i}$

$\therefore$ direction of B-field is $\boxed{\text{along left side (towards left)}}$

(c) $\hat{B} = \hat{F} \times \hat{V} = \hat{j} \times (-\hat{i}) = \hat{k}$

$\therefore$ direction of B-field is $\boxed{\text{out of the page}}$

② (a) $\vec{F} = q\vec{E} + q(\vec{V} \times \vec{B})$

$\Rightarrow \vec{F} = q\vec{E} - q(B \times \vec{V})$ $\quad q = e^-$ $\quad \Rightarrow 0 = eE - e(B \times V)$

$eE = e(B \times V) \Rightarrow V = E/B$

$F_c = F_B \Rightarrow qE = qv\sin\theta$ where $\theta = 90° \therefore \sin 90 = 1$

$\therefore qE = qVB$

$\Rightarrow E = VB$

$\therefore \Rightarrow \boxed{V = \frac{E}{B}}$

(b) $E = \frac{\Delta V}{\Delta X} \Rightarrow \Delta V = E\Delta X$ if $E = VB$ above

$\Delta V = (VB)\Delta X$

$\Delta V = B(\Delta X)V \rightarrow V = V_d = \frac{I}{nq_e A}$

$\Delta V = B(\Delta X) \cdot \frac{I}{nq_e A} \Rightarrow \boxed{\Delta V = \frac{B\Delta X I}{nq_e A}}$

$B = 1.33T$
$\Delta x = 2\,cm$
$I = 10\,A$
$n = 2 \times 10^{28}\,m^{-3}$
$A = 1\,mm^2$
$q_e = 1.603 \times 10^{-19}\,C$

$$\Delta V = \frac{(1.33T)(2 \times 10^{-2}\,m)(10A)}{(2 \times 10^{28}\,m^{-3})(1.603 \times 10^{-19}\,c)(1 \times 10^{-3}\,m)^2}$$

$\boxed{\Delta V = 8.297 \times 10^{-5}\,v}$

③ $\vec{\tau} = \vec{M} \times \vec{B}$

$|\vec{\tau}| = MB\sin\theta$ $\quad$ max torque when $\theta = 90°$ $\sin 90 = 1$ $\rightarrow \therefore |\vec{\tau}|_{max} = MB$ $\quad M = IA$, $A = \pi R^2$

$R = 0.65 \times 10^{-15}\,M$
$I = 1.05 \times 10^4\,A$
$B = 2.5\,T$

$\therefore |\vec{\tau}|_{max} = (I)(\pi R^2)(B)$

$= (1.05 \times 10^4\,A)(\pi(0.65 \times 10^{-15}\,m)^2(2.5T) = \boxed{|\vec{\tau}|_{max} = 3.48 \times 10^{-26}\,N\text{-}m}$

CHAPTER 12 : SOURCES OF MAGNETIC FIELDS

① (a) $n = 500$ turns / meter

$I = 0.3A$

$B = \mu_0 n I = (4\pi \times 10^{-7}\ T\text{-}m/A) \times (500\ m^{-1}) \times (0.3A) = \boxed{1.885 \times 10^{-4}\ T}$

(b) $B = 5000\, \mu_0 n I$

$= 5000\,(4\pi \times 10^{-7}\ T\text{-}m/A) \times (500 m^{-1})(0.3\ A) = \boxed{0.942\ T}$

*② (a) $F_{net} = 0 \Rightarrow F_e + F_m = 0$

$\vec{F_e} = \vec{F_m}$

$q\vec{E} = q(\vec{V} \times \vec{B}) \quad \theta = 90°$

$qE = qvB$

$E = vB$

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

(b) $\frac{mv^2}{r} = Bq\cancel{v}$

$\Rightarrow r = \frac{mv}{Bq} \quad$ if $v = \frac{E}{B}$

$r = \frac{mE}{BqB} \Rightarrow \boxed{r = \frac{mE}{qB^2}}$

$m = 16m,\ E = 10 V/m,\ B = 0.01T,\ q = 1.67 \times 10^{-19} c$

$\downarrow$

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

$r = \frac{(16\,m)E}{qB^2} \Rightarrow = \frac{(16(1.67 \times 10^{-27} kg))(10\ V/m)}{(1.67 \times 10^{-19}\ c)(0.01\ T)^2} = \boxed{r = 0.016\ m}$

CHAPTER 13: electromagnetic induction

① (a) induced EMF $\varepsilon = -N\frac{d\phi}{dt}$

if

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

$$\frac{d\phi}{dt} = \frac{d(BA)}{dt} = A\left(\frac{dB}{dt}\right)$$

$$\therefore \frac{dB(t)}{dt} = B_0\left[0 + \frac{2}{\pi}\times\cos(2\pi f t)\cdot 2\pi f + \frac{2}{3\pi}\cos(6\pi f t)\cdot 6\pi f + \frac{2}{5\pi}\cos(10\pi f t)\cdot 10\pi f\right]$$

$$\Rightarrow \frac{dB(t)}{dt} = B_0\left[4f\cos(2\pi f t) + 4f\cos(6\pi f t) + 4f\cos(10\pi f t)\right]$$

$$\Rightarrow \frac{dB(t)}{dt} = 4B_0 f\left[\cos(2\pi f t) + \cos(6\pi f t) + \cos(10\pi f t)\right]$$

$A = \pi r^2$, $N = 1$

$$\therefore \varepsilon = -\frac{d\phi}{dt} \qquad \phi = NAB(t)$$

$$\Rightarrow \varepsilon = -NA\left(\frac{dB(t)}{dt}\right)$$

$$\because \varepsilon = -NA\times 4B_0 f\left[\cos(2\pi f t) + \cos(6\pi f t) + \cos(10\pi f t)\right]$$

$$\boxed{\therefore \varepsilon = -4\pi r^2 B_0 f\left[\cos(2\pi f t) + \cos(6\pi f t) + \cos(10\pi f t)\right]}$$

(b) $\varepsilon(0) = -4\pi(0.1\,m)^2(0.1T)(10^3Hz)[\cos(0) + \cos(0) + \cos(0)]$

$= -4\pi(0.1m)^2(0.1T)(10^3Hz)(3) = -37.7V \Rightarrow |\varepsilon(0)| = \boxed{37.7\,V = \varepsilon(0)}$

(c) $|\varepsilon| = 4\pi\times(0.1m)^2(0.1T)(10^3Hz)[\cos(2\pi\,10^3Hz\cdot10^{-3}s) + \cos(6\pi\,10^3Hz\cdot10^{-3}s) + \cos(10\pi\,10^3Hz\cdot10^{-3}s)]$

$|\varepsilon| = 4\pi\times(0.1\,m)^2(0.1T)(10^3Hz)[\cos(2\pi) + \cos(6\pi) + \cos(10\pi)]$

$= 4\pi\times 0.1m^2\times 0.1T\times 10^3Hz\times 3$

$= 37.70V$

induced current $I = \frac{|\varepsilon|}{R} = \frac{37.70V}{5.0\Omega} = \boxed{7.54\,A}$

Chapter 14: Inductance

*① $L = 0.50\ H$

$E = 0.150\ V$

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

$\Rightarrow \frac{dI}{dt} = \frac{-\mathcal{E}}{L} = \frac{-0.150V}{0.50H} = -0.3\ A/s \quad \left|\frac{dI}{dt}\right| = 0.3\ A/s$

② $\mathcal{E} = -L\frac{dI}{dt}$

$|\mathcal{E}| = L\frac{dI}{dt}$

$500\ V = (2.00 \times 10^{-3} H)\frac{dI}{dt}$

$\frac{dI}{dt} = 2.5 \times 10^5$

$dI = 2.5 \times 10^5\ dt$

$\int dI = \int 2.5 \times 10^5 dt$

$I = 2.5 \times 10^5 t$

$t = \frac{I}{2.5 \times 10^5}$

$t = \frac{0.100A}{2.5 \times 10^5}$

$\boxed{t = 4 \times 10^{-7} sec}$