PHYSICS MIDTERM III

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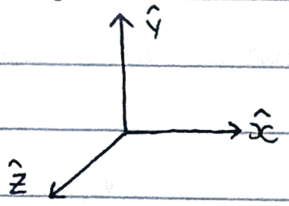
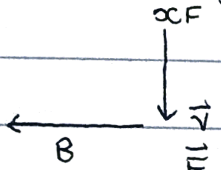
① a)



LORENTZ FORCE $\hat{F} = q\hat{v}\hat{B}$, SO $\hat{v}$, $\hat{B}$, $\hat{F}$ ARE CYCLIC COORDINATES SUCH AS $\hat{x}, \hat{y}, \hat{z}$ AND $\hat{v}, \hat{B}, \hat{F}$ ARE PERPENDICULAR $\rightarrow \hat{B} = \hat{F} \times \hat{v}$

$B = Fv = (-\hat{i} \cdot \hat{j}) = -\hat{k}$ SO, DIRECTION OF B IS $\boxed{\text{INTO THE PAGE}}$

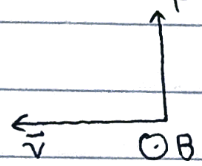
b)



$\hat{F}$ IS INTO THE PAGE, SO $\hat{B} = \hat{F} \cdot \hat{v} = (-\hat{k})(-\hat{j}) \longrightarrow \hat{B} = (-\hat{i})$

SO THE DIRECTION OF B HERE IS TOWARD THE $\boxed{\text{LEFT}}$.

c)



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

FROM THIS, THE DIRECTION OF B IS $\boxed{\text{OUT OF THE PAGE.}}$

② HERE, THE ELECTRIC FORCE AND LORENTZ FORCE BALANCE

FROM THIS, $F_E = F_B \rightarrow qE = qvB\sin\theta$ WHERE $\theta = 90$

SO, $qE = qvB \rightarrow E = vB \therefore \boxed{v = E/B}$

b) HERE, WE HAVE CONSTANT ELECTRIC FIELD SUCH THAT $E = \frac{\partial V}{\partial x} \rightarrow \partial V = E(dx)$

$\Delta V = B(\Delta x)v$ WHERE v = DRIFT VELOCITY.

SO $v_0 = I/nq_E A$, NOW SUB IN v_0

$\Delta V = B(\Delta x) \cdot I/n v_E A \longrightarrow \boxed{\Delta V = \frac{B(\Delta x)I}{nq_E A}}$

FROM THIS, $\Delta V = ((1.33)(2 \cdot 10^{-2})(10)) / ((2 \cdot 10^{28})(1.6 \cdot 10^{-19})(10^{-3})^2)$

$= \boxed{8.31 \cdot 10^{-5} V}$

③ $\tau = NIAB\sin\theta$ WHERE $N = 1$ AND $\theta = 90°$

FIRST FIND AREA OF CIRCLE! $A = \pi r^2 = \pi(0.65 \cdot 10^{-15} m)^2 = 1.33 \cdot 10^{-30} m^2$

FROM EQ1, $\tau = (1)(1.05 \cdot 10^4 A)(1.33 \cdot 10^{-30} m^2)(2.5T)(\sin 90)$

$= \boxed{3.48 \cdot 10^{-26} Nm}$

④ a) $B = \mu_0 n I = (4\pi \cdot 10^{-7})(500)(3) = (1884.9)(10^{-7})T = \boxed{1.88 \cdot 10^{-4} T}$

b) NOW, WE HAVE A METAL PERMEABILITY OF $5000\mu_0$.

$B' = \mu n I = 5000\mu_0 n I = (5000)(1.88 \cdot 10^{-4}) = \boxed{0.94T}$

⑤ AT THE TOP-LEFT REGION, ELECTRIC FIELD IS UPWARD IN DIRECTION, WHILE MAGNETIC FIELD (B) = OUT OF THE PAGE, AND v = RIGHTWARD.

$F_{ELECTRIC} + F_{MAGMETIC} = 0$

$F_{ELECTRIC} = q(\vec{v} \cdot \vec{B})$, WHILE $F_{TOTAL} = F_{ELECTRIC} + F_{MAGNETIC} = 0$

$q(\vec{E} + \vec{v}\vec{B}) = 0$ $\quad$ ($\tilde{v} \times \hat{B}$ IS DOWN, AND OPPOSING $\vec{E}$).

$|F_{TOTAL}| = q(E - vB) = 0 \longrightarrow E = vB \longrightarrow v = E/B$ FOR $F_{NET} = 0$

SO, THE PARTICLE COMES IN ON THE RIGHT, AND ONLY FEELS MAGNETIC FORCE (LORENTZ).

$F = qvB$, $\perp$ DIRECTION OF MOTION, $\therefore$ CENTRIPEDAL FORCE, PARTICLE ROTATES IN AN ARC $\rightarrow$ HITS WALL AT $x = 2r$, CENTRIPEDAL FORCE $= mv^2/r$.

$qvB = mv^2/r \longrightarrow r = mv/qB$

$v = \frac{E}{B} \longrightarrow r = \frac{mE/B}{qB} \longrightarrow r = mE/qB^2$

$r = mE/qB^2 = \frac{(16)(1.67 \cdot 10^{-27})(10)}{(1.602 \cdot 10^{-19})(.01)^2} = \boxed{1.67\text{cm}}$

⑥ USE FARADAY'S LAW OF ELECTROMAG. INDUCTION SUCH THAT:

INDUCED EMF $\epsilon = -N\frac{d\phi}{dt}$

\# TURNS $\quad$ RATE OF CHANGE (MAGNETIC FLUX).

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

AREA IS CONSTANT, $\frac{\partial\Phi}{\partial t} = \frac{\partial(BA)}{\partial t} = A\left(\frac{\partial B}{\partial t}\right)$

$\frac{\partial B}{\partial t} = B_0\left[\frac{2}{\pi}\cos(2\pi ft)\, 2\pi f + \frac{2}{3\pi}\cos(6\pi ft) \cdot 2\pi f + \frac{2}{5\pi}\cos(10\pi ft) \cdot \cancel{10}^{2}\pi f\right)\Big]$

$= 2fB_0\left[2\cos(2\pi ft) + \cos(6\pi ft) + \cos(10\pi ft)\right]$

SO FROM THIS, $\frac{\partial\Phi}{\partial t} = 4\pi r^2 fB_0\left[\cos(2\pi ft) + \cos(6\pi ft)\cos(10\pi ft)\right]$

a) $\boxed{\epsilon = -4\pi r^2 fB_0\left[\cos(2\pi ft) + \cos(6\pi ft) + \cos(10\pi ft)\right]}$

b) $B = 0.1T$, $r = 0.1m$, $f = 10^3$ Hz, $t = 0$.

FROM THIS, $\epsilon = -4\pi \cdot 3$

$\boxed{= 12\pi V}$ AT $t = 0s$.

c) FOR $t = 1ms = 10^{-3}s$

$\epsilon = \cancel{4}\pi \cdot 3 = \boxed{12\pi V}$ AT $t = 1ms$. $\quad$ (I CHANGED THIS ONE, IT IS AT THE LAST QUESTION INSTEAD!).

7 L INDUCTANCE = 0.50H

THE INDUCED EMT ACROSS THE INDUCTOR IS GIVEN BY THE EQUATION:

$\varepsilon = -L \, dI/dt$ FROM THIS,

$\frac{\partial I}{\partial t} = \frac{-\varepsilon}{L} = \frac{-0.150V}{0.50H} = -0.3 \, A/s$

MAGNITUDE OF RATE OF Δ OF CURREINT IS = $\left| \frac{\partial I}{\partial t} \right| = \boxed{0.3 A/S}$

8 $\varepsilon = L \cdot \frac{\partial I}{\partial t}$] EXPRESSION OF EMF OF THE COIL IN TERMS OF SELF-INDUCTANCE.

$\partial t = \frac{L}{\varepsilon} dI \rightarrow dt = \frac{2.00mH}{500V} (0.100A)$

$= ((2.0mH)(10^{-3}H)) / 500V \cdot 0.100A = \boxed{4.00 \cdot 10^{-7} s}$

6 INDUCED VOLTAGE IS GIVEN BY

$\epsilon = \frac{d\phi}{\partial t} = d(BA)/dt = A\partial B/dt$

$\therefore \boxed{\epsilon = \pi r^2 \frac{B_0}{T_0} \sin(2\pi 6t)}$

b) THE INDUCED EMF AT $t=0$

$\sin(2\pi f t)$ HERE, $t=0 \therefore \sin(0)=0$

$\therefore$ INDUCED EMF AT $t=0$ $\boxed{=0}$

c) $e = \pi (0.1)^2 \cdot (0.1)/1ms \cdot \sin(2\pi \cdot 10^3 \cdot 0.16 \cdot 10^{-3})$

$= 3.14 \cdot (0.1)^3 / 1ms \, (\sin(.32)\pi)$

$\therefore \boxed{\epsilon = 0.055V}$

d) $I = \varepsilon/R = 0.055V / 5r = \boxed{0.011A}$