EXAM 3

NAME:

SOLUTIONS

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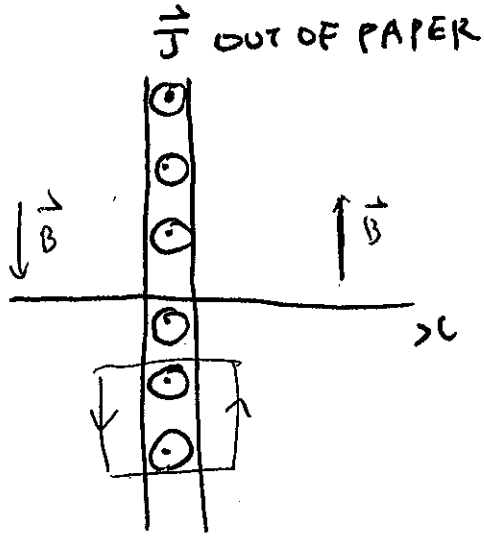
PROBLEM 1 ; a) CALCULATE MAGNETIC FIELD DUE TO AN INFINITE SHEET OF CURRENT LYING IN THE YZ PLANE WITH SURFACE CURRENT DENSITY $\vec{J}$ (A/m).

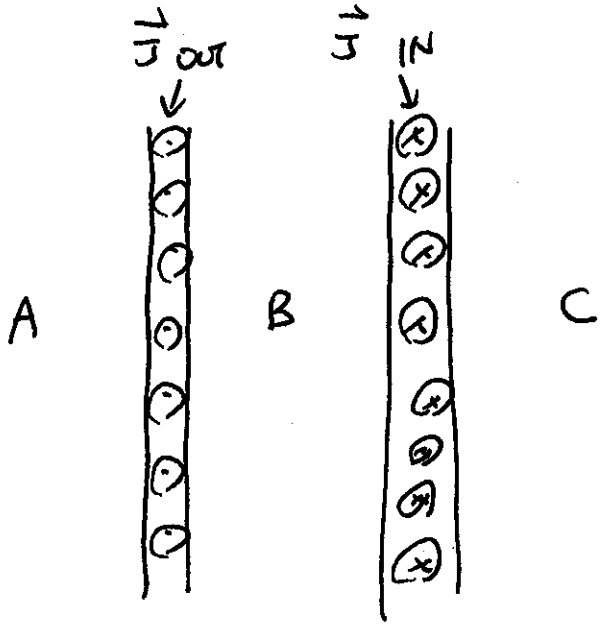
INDICATE DIRECTION OF MAGNETIC FIELDS ON THE LEFT FIGURE.



$$2Bl = \mu_0 \frac{J}{\Sigma} l$$

$$B = \frac{\mu_0 J}{2}$$

PROBLEM 16) CALCULATE MAGNETIC FIELD EVERYWHERE [REGION A, B AND C] FOR THE FOLLOWING GEOMETRY



$A = 0$

$B = \mu_0 J$ ↑

$C = 0$

PROBLEM 2 (BIOT-SAVART LAW)

BIOT-SAVART LAW IS GIVEN BY

$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{s} \times \hat{r}}{r^2}$$

CALCULATE MAGNETIC FIELD AT THE CENTER OF A CURRENT LOOP IF $r = 1m$ $I = 1A$

$$dB = \frac{\mu_0 I}{4\pi} \frac{1}{r^2} ds$$

$$B = \frac{\mu_0 I}{4\pi_2} \frac{2\pi r}{r^2 r}$$

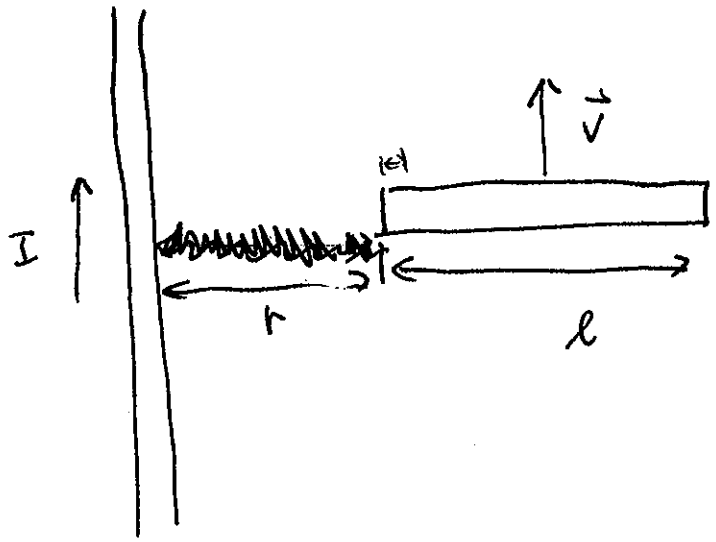
$$B = \frac{\mu_0 I}{2r}$$

$$= \frac{\mu_0}{2} T = 2\pi \times 10^{-7} T$$

PROBLEM 3 (MOTIONAL EMF)

A CONDUCTING ROD OF LENGTH ℓ MOVES WITH VELOCITY $\vec{V}$ PARALLEL TO AN INFINITE WIRE CARRYING A CURRENT I. CALCULATE THE EMF INDUCED IN THE ROD

$r = \ell$ FOR THIS PROBLEM



$$\mathcal{E} = \oint \vec{V} \times \vec{B}$$

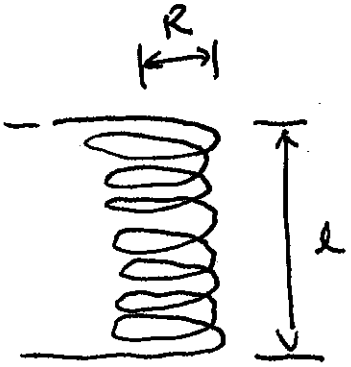
$$E = VB$$

$$\mathcal{E} = VB$$

$$B(r) = \frac{\mu_0 I}{2\pi r} \qquad E(r) = \frac{\mu_0 I}{2\pi r} V$$

$$\int_r^{2r} \frac{\mu_0 I V}{2\pi r} = \frac{\mu_0 I}{2\pi} V \ln 2 = \mathcal{E}$$

PROBLEM 4

a) 

SOLENOID HAS 100 COILS AND LENGTH OF 1 m. CALCULATE ITS SELF-INDUCTANCE L IF ITS CROSS SECTIONAL AREA, πR^2, IS $1\,m^2$. $\mu_0 = 4\pi \times 10^{-7}\ T/Am$

$$B = \mu_0 n I = \frac{\mu_0 N I}{\ell} \qquad -N\frac{d\Phi}{dt} = -L\frac{dI}{dt}$$

$$\Phi = \frac{\mu_0 N I}{\ell}\cdot \pi R^2 \qquad L = \frac{\mu_0 N^2}{\ell}\pi R^2$$

ℓ: 1 m, πR^2: 1 m

$0.012566\,H$

$$L = 100^2 \mu_0$$

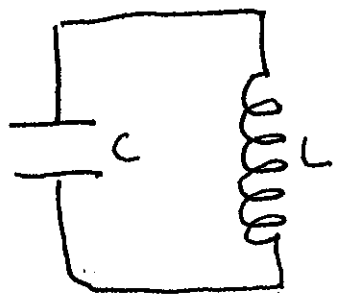
$$\boxed{L = 4\pi \times 10^{-4}\,H}$$

b) FOR THE ABOVE SOLENOID WHAT IS THE STORED ENERGY IF I = 100A.

$$\frac{1}{2}LI^2 = E = \frac{1}{2}\,4\pi \times 10^{-4} \cdot 10^4$$

$$= \boxed{6.28\ J} \qquad \boxed{62.8\,J}$$

c) CALCULATE OSCILLATION FREQUENCY OF THE CIRCUIT DEPICTED BELOW.



$L = 100\ mH$

$C = 100\ mF$

$$\frac{Q}{C} + L\frac{dI}{dt} = 0 \qquad \frac{Q}{C} + L\frac{d^2I}{d}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \qquad f_0 = \frac{1}{2\pi\sqrt{2C}}$$

$$\frac{2\pi}{\omega} = T \Rightarrow \frac{1}{f} \qquad \int \quad =$$

$$f = \frac{\omega}{2\pi}$$

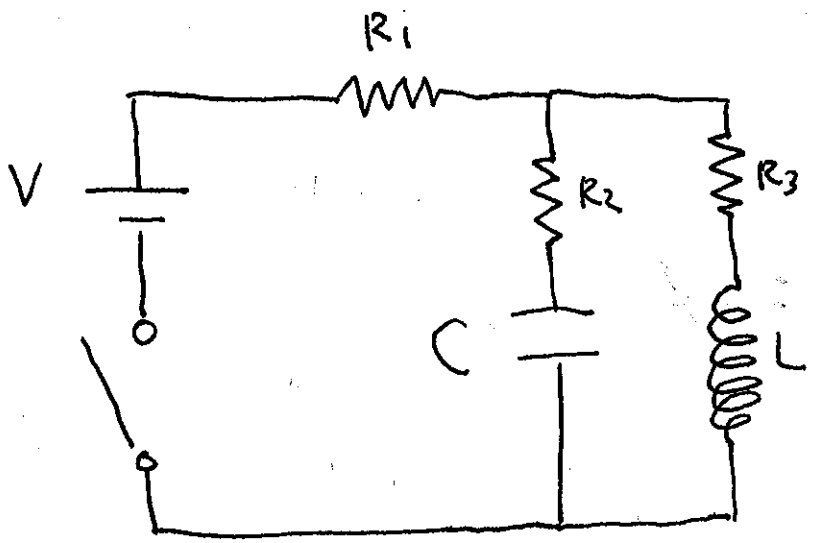
$$f_0 = \frac{1}{2\pi\sqrt{100\times10^{-3}\times100\times10^{-3}}}$$

$$= \frac{1}{2\pi \times 100\times10^{-3}} = \frac{1}{2\pi}\ \frac{5}{10}$$

$$= \frac{5}{\pi}\ Hz$$

1,59Hz

PROBLEM 5



AT $t=0$ THE SWITCH IS CLOSED.

a) WHAT IS THE CURRENT SOURCED BY THE BATTERY AT $t=0$.

b) WHAT IS THE CURRENT SOURCED BY THE BATTERY AT $t=\infty$

a) $\dfrac{V}{R_1+R_2}$

b) $\dfrac{V}{R_1+R_3}$