PHYS 230 SOLUTIONS - PROB. SET 11 F04

1. (30-59) **No.** If the entire moving conductor is in <u>uniform</u> $\vec{B}$, then $\frac{d\Phi_B}{dt} = 0$ and $\mathcal{E}_{ind.} = 0$.

2. (30-64) $\vec{E} = \left(270 \frac{kV}{m \cdot s}\right) t \left(\hat{i} - 2\hat{j} + 3\hat{k}\right)$

$$A_1 = \pi (0.65\,m)^2 \quad \hat{n}_1 = \hat{k}$$

$$I_{d_1} = \varepsilon_0 \frac{d\Phi_{E_1}}{dt} = \varepsilon_0 \frac{d}{dt}\left[\pi (0.65\,m)^2 \left(270 \frac{kV}{m \cdot s}\right) t \cdot 3\right]$$

$$= \left(8.85 \times 10^{-12} \frac{C^2}{N \cdot m^2}\right) \pi (0.65\,m)^2 \left(270 \frac{kV}{m \cdot s}\right) \cdot 3$$

$$= \boxed{9.5 \times 10^{-6} A} \quad \text{direction } \boxed{+z}$$

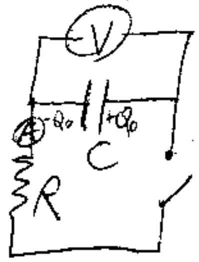
$$I_{d_2} = \varepsilon_0 \frac{d\Phi_{E_2}}{dt} = \varepsilon_0 \frac{d}{dt}\left[(0.50\,m)^2 \left(270 \frac{kV}{m \cdot s}\right) t \cdot 1\right]$$

$$\left(\text{Area } 2 = (0.50\,m)^2 \hat{i}\right)$$

$$I_{d_2} = \boxed{6.0 \times 10^{-7} A} \quad \boxed{\text{direction } +x}$$

PHYS 230-01

3. (31-1)



$V(t=0) = \frac{Q_0}{C}$

$V(t) = \frac{Q_0}{C} e^{-t/RC}$

$= \frac{0.27C}{6.0\times10^{-4}F} e^{-(6.0s)/[(6.7\times10^{3}\Omega)\cdot(6.0\times10^{-4}F)]}$

$= \boxed{100V}$ $I = \frac{\mathcal{E}}{R} = \frac{100V}{6.7k\Omega} = \boxed{15mA}$

4. (31-4) Solenoid: $N = 750$ $l = 2.5$ cm $r = 0.45$ cm

$L = \frac{\mu_0 N^2 A}{l} = \left(4\pi\times10^{-7}\frac{T\cdot m}{A}\right)\frac{(750)^2}{(2.5\times10^{-2}m)}\pi\left(4.5\times10^{-3}m\right)^2$

$= \boxed{1.8\ mH}$

5. (31-6)

$N_p = 100$ $N_s = 500$

$\Delta V_p = (100V)\cos\omega t$

$\Delta V_s = \left(\frac{N_s}{N_p}\right)\Delta V_p = \boxed{(500V)\cos(\omega t)}$

6. (31-7)

Discharging inductor:

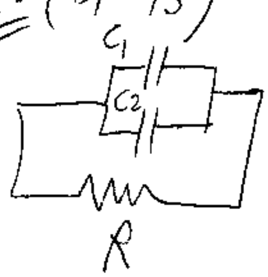
$I = I_0 e^{-t/\tau}$, with $\tau = \frac{L}{R} = \frac{4.0H}{3.0\Omega} = 1.3s$

$I_0 = I e^{t/\tau}$

$= (0.050A)e^{4s/1.33s}$

$= \boxed{1.0A}$

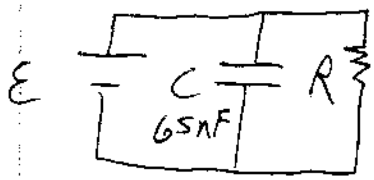
7. (31–15)



$$\tau = RC_p = R(C_1+C_2)$$

$$R = \frac{\tau}{(C_1+C_2)} = \frac{1.0\times10^{-3}\,s}{(16\,\mu F+20\,\mu F)} = \boxed{28\,\Omega}$$

8. (31–18)



Initial charge on capacitor is $Q_0 = \mathcal{E}C$

Initial current after battery removed is

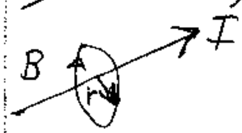
$$I_0 = \frac{\Delta V_c}{R} = \frac{Q_0}{CR} = \frac{\mathcal{E}}{R}$$

Thus $R = \frac{\mathcal{E}}{I_0} = \frac{12V}{0.24A} = \boxed{50\Omega}$

At time $t = 3.0\,\mu s$, $I = I_0 e^{-t/RC}$

$$= \boxed{9.5\times10^{-2}\,A}$$

9. (31–27)



Ampere's Law

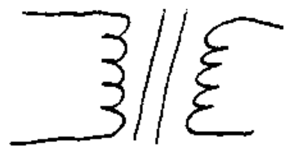
$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{through}$$

$$2\pi rB = \mu_0 I \quad \text{or} \quad B = \frac{\mu_0 I}{2\pi r}$$

$$u_B = \frac{B^2}{2\mu_0} = \frac{\mu_0 I^2}{8\pi^2 r^2}$$

$$= \frac{\left(10^{-7}\,\frac{T\cdot m}{A}\right)\left(8.0\times10^{2}A\right)^2}{2\pi\,(5.0\,m)^2} = \boxed{4.1\times10^{-4}\,J/m^3}$$

10. (31-48)



Want $\frac{V_s}{V_p} = \frac{110V}{33V} = \frac{N_s}{N_p}$

Thus $\frac{N_s}{N_p} = \boxed{\frac{10}{3}}$

(On-line homework looks for

$\frac{N_p}{N_s} = 3/10$).

This could be done with 3 turns on primary and 10 turns on secondary, or with $N_p = 33$ and $N_s = 110$.