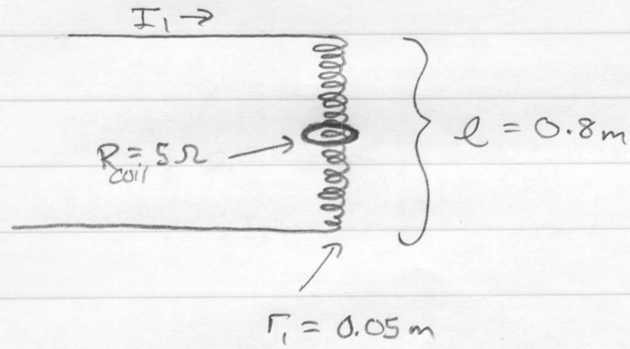
Physics 2b Quiz 8 Solutions #1

$L = 18\,mH$, $l = 0.8\,m$, $r_1 = 0.05\,m$

$R_{coil} = 5\,\Omega$, $M = 60\,\mu H$, $I_1 = 300\,mA$, $\frac{dI_1}{dt} = -2.5\,A/s$



What is I_{coil} when $dI_1/dt = -2.5A$?

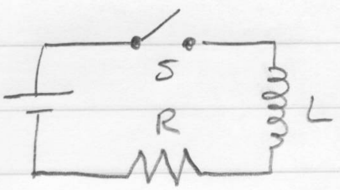
$$\mathcal{E}_{coil} = -M\frac{dI_1}{dt} = -60\,\mu H\,(-2.5\,A/s) = 1.5\times10^{-4}\,V$$

$$\text{Ohm's law} \Rightarrow I = \frac{\mathcal{E}_{coil}}{R_{coil}} = \frac{1.5\times10^{-4}\,V}{5\,\Omega} = \boxed{30\,\mu A}$$

#2

$\mathcal{E} = 60V$, $L = 30H$, $R = 12\Omega$

What is I when $t = 3.5s$? (t measured after switch closes)



$$I(t) = I_0\left(1 - e^{-R/L\,t}\right)$$

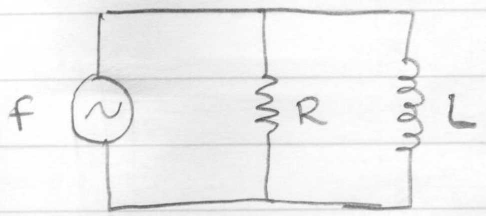
$$= \frac{\mathcal{E}_0}{R}\left(1 - e^{-R/L\,t}\right)$$

$$= \frac{60V}{12\Omega}\left(1 - e^{-\frac{12\Omega}{30H}(3.5s)}\right)$$

$$= 3.76A \Rightarrow \boxed{3.8A}$$

Physics 2b Quiz 8 Solutions # 3

$R = 300\,\Omega$, $L = 250\,mH$, $f = 100\,Hz$, $I_{rms,L} = 0.5A$



What is $I_{rms,R}$?

Because we have an AC source, we can assume a voltage of the form $V(t) = V_p \sin(\omega t)$ where $\omega = 2\pi f$. Notice that R and L are in parallel with the AC source, so the voltage across both R and L is equal to the source voltage at all times. Since we are looking for a time averaged quantity, $I_{rms,R}$, we can treat L as a resistor with resistance $X_L = \omega L$ in this simple case.

Ohm's law $\Rightarrow$ $V_{rms,L} = I_{rms,L} X_L$

$= (0.5A)(2\pi(100Hz))(250mH)$

$= 78.54V$

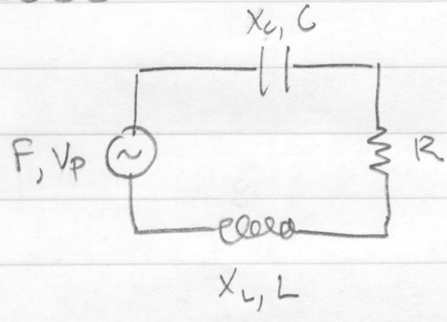
From above, $V_{rms,L} = V_{rms,R}$

Ohm's law $\Rightarrow$ $I_{rms,R} = \dfrac{V_{rms,R}}{R} = \dfrac{78.54V}{300\Omega} = \boxed{0.26A}$

Physics 2b Quiz 8 Solutions #4

$F = 60\,Hz$, $V_p = 120\,V$, $X_C = 900\,\Omega$, $X_L = 300\,\Omega$

$R = 400\,\Omega$



What is L?

$$X_L = \omega L \Rightarrow L = \frac{X_L}{\omega} = \frac{X_L}{2\pi f} = \frac{300\,\Omega}{2\pi(60\,Hz)} = .796\,H$$

$$\Rightarrow \boxed{800\,mH}$$

#5

This is an extension of the analogy presented in class and detailed in Table 33-3.

The key to this question is to realize that q and x are analogous, therefore $\dot{q} = I$ and $\dot{x} = v$ are also analagous. Kinetic energy is $\frac{1}{2}mv^2$ so you should look for an energy with I^2, which is $U = \frac{1}{2}LI^2$, the magnetic energy stored in the inductor.