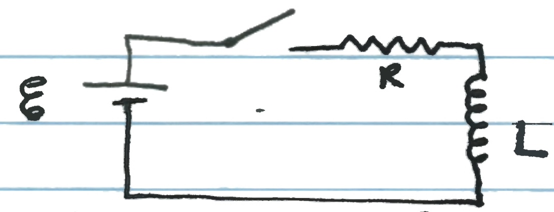
30.23 • A 35.0 V battery with negligible internal resistance, a 50.0 Ω resistor, and a 1.25 mH inductor with negligible resistance are all connected in series with an open switch. The switch is suddenly closed. (a) How long after closing the switch will the current through the inductor reach one-half of its maximum value? (b) How long after closing the switch will the energy stored in the inductor reach one-half of its maximum value?

Phys 132 HW #9

$\boxed{30.21}$



$\mathcal{E} = 35\,V$

$R = 50\,\Omega$

$L = 1.25\,mH$

A. $\tau = L/R = 2.5 \times 10^{-5}\,s$

$t_{1/2} = \tau \ln 2 = 1.73 \times 10^{-5}\,s$

B. $U = \frac{1}{2} L i^2$ $\qquad i = i_0(1 - e^{-t/\tau})$

$U_0 = \frac{1}{2} L i_0^2$

when is $U = \frac{1}{2} U_0$.

$\frac{1}{2} L i^2 = \frac{1}{2}\left[\frac{1}{2} L i_0^2\right]$

$i^2 = \frac{1}{2} i_0^2$

$i_0^2 (1 - e^{-t/\tau})^2 = \frac{1}{2} i_0^2$

$1 - e^{-t/\tau} = 1/\sqrt{2}$

$e^{-t/\tau} = 1 - 1/\sqrt{2}$

$\ln e^{-t/\tau} = \ln(1 - 1/\sqrt{2})$

$-t/\tau = \ln(1 - 1/\sqrt{2})$

$t = -\tau \ln(1 - 1/\sqrt{2}) = -(\cancel{1.73 \times 10^{-5}}\ 2.5 \times 10^{-5}\,s)(-1.2279)$

$\boxed{t = 3.07 \times 10^{-5}\,s}$

$\boxed{30.32}$ $\quad C = 3.23\,\mu F \qquad L = 89\,mH$

$i_{MAX} = 0.849\,mA$

A Consider energy: $U_L = \frac{1}{2} L i^2 \qquad U_C = \frac{1}{2C} Q^2$

$\therefore \frac{1}{2} L i_{MAX}^2 = \frac{1}{2C} q_{max}^2$

$q_{max} = \sqrt{LC}\, i_{MAX} = \boxed{4.55 \times 10^{-4}\,C}$