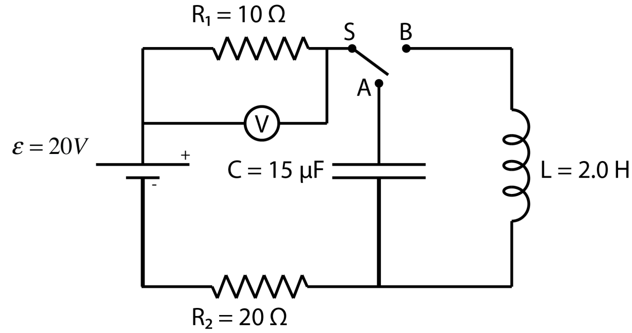
Flipping Physics Lecture Notes:
Electricity and Magnetism Free Response Question #2 Solutions
AP Physics C 1998 Released Exam from the College Board



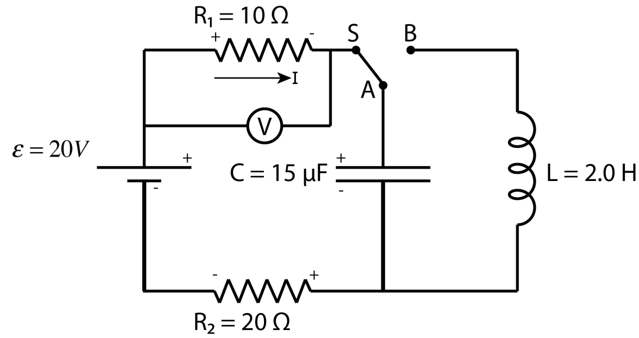
Part (a): The voltmeter needs be placed in parallel with R_1, like this:

Part (b): The capacitor, C, is initially uncharged so when the switch is closed to position A, the capacitor has zero potential difference across it and therefore the equivalent resistance of the circuit is:

$R_{eq} = R_1 + R_2 = 10 + 20 = 30\Omega$ and

$$\Delta V = IR \Rightarrow I = \frac{\Delta V}{R} \Rightarrow I_t = \frac{\varepsilon}{R_{eq}} = \frac{20}{30} = \frac{2}{3}A = I_1 = I_2$$

and $\Delta V_1 = I_1 R_1 = \left(\frac{2}{3}\right)(10) = \frac{20}{3} = 6.\overline{6} \approx \boxed{6.67V}$



Part (c i): "After a long time" the capacitor will be fully charged and there will be zero current through the circuit. This means that the potential difference across R_1 will be zero and …

Part (c ii): the potential difference across the capacitor will be the same as the emf of the battery.

$\varepsilon = \Delta V_c = 20V$ and $C = \frac{Q_c}{\Delta V_c} \Rightarrow Q_c = (\Delta V_c)(C) = (20)(15 \times 10^{-6}) = \boxed{3.00 \times 10^{-4} C}$

Part (d): The switch is moved to position B at t = T. The charge will remain @ 300 μC in the capacitor and will not be discharged because the capacitor needs both plates attached to a closed loop to discharge through. The inductor resists a change in the current and right before t = T there is no current in the inductor, therefore there will be no current in the inductor or either resistor at t = T. Therefore $\boxed{\Delta V_1 = 0.}$

Part (e i) "A long time after t = T" means the current has reached a constant, maximum value. Therefore the change in the current with respect to time is zero or $\frac{dI}{dt} = 0$. Therefore the potential difference across the inductor is also zero: $\varepsilon_L = -L\frac{dI}{dt} = -L(0) = 0$. This works out to be exactly like part, however, instead of having the potential difference across the capacitor be zero, the potential difference across the inductor is zero. The equations work out the same and $I_t = \frac{\varepsilon}{R_{eq}} = \frac{20}{30} = \frac{2}{3}A = I_1 \approx \boxed{0.667A}$

Part (e ii): The current through the inductor is the same as through R_1 so:

$$U_L = \frac{1}{2}LI^2 = \frac{1}{2}(2)\left(\frac{2}{3}\right)^2 = 0.\overline{4} \approx \boxed{0.444J}$$

Part (f): Start by writing the equation for the potential difference around a loop:

$$\varepsilon - \Delta V_{R_1} - \Delta V_L - \Delta V_{R_2} = 0 \Rightarrow \varepsilon - I_1 R_1 - L\frac{dI}{dt} - I_2 R_2 = 0 \Rightarrow \boxed{\varepsilon - I_t(R_1 + R_2) - L\frac{dI}{dt} = 0}$$

It's hard to know where to stop on problems where you are asked to "write, but do not solve". Generally you don't need to plug in numbers or even begin solving the equation.