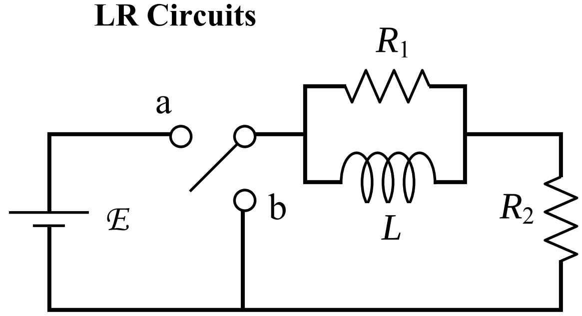
Discussion Question 10A
P212, Week 10
LR Circuits

The diagram shows a classic "LR" circuit, containing both resistors and inductors. The switch shown is initially connected to *neither* terminal, and is then thrown to position "a" at time $t = 0$.



$\mathcal{E} = 10$ V
$L = 15$ mH
$R_1 = 4\ \Omega$
$R_2 = 6\ \Omega$

(a) At $t = 0+$, just after the switch is thrown to position a, what are the currents I_1 and I_2 across the two resistors?

Just after the switch is thrown, what does the inductor 'look like' to the rest of the circuit? What is the current doing? Do inductors *like* that? Once you know what the inductor looks like at this point in time, it is highly advisable to redraw the circuit.

(b) After a very long time, what is the instantaneous power dissipated in the circuit?

After a very long time, what will have happened to the current? Now what will the inductor look like to the rest of the circuit? The circuit now takes on a simple form ... what current is flowing through the resistors?

(c) Sketch the behavior of the energy stored in the inductor as a function of time. What is the final energy stored, after a very long time?

Think about the current through the inductor: what is it at time 0? after a very long time?

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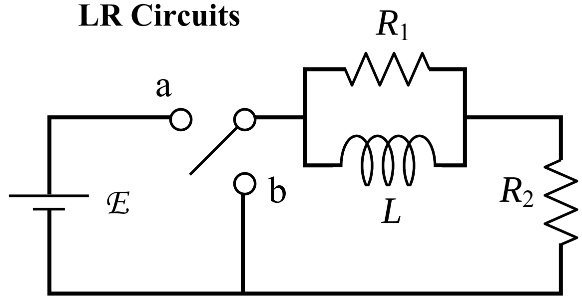
Next, after a very long time, the 'clock' is reset to 0 and the switch is thrown to position b.



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(d) What is the time constant τ describing the change in current through the inductor?

We have a new formula available for time constants in LR circuits: $\tau = L/R$. But the R in the formula refers to the *total resistance in series with the inductor*. Redrawing your circuit will help you to determine this R!

(e) Sketch the time dependence of the current through the inductor.

(f) What is the energy stored in the inductor 8 msec after the switch goes to position b?

First you must write down an equation for the time-dependence of the current. Check that your formula is correct: does it produce the right answer at time 0? What about at $t = \infty$?