Faraday's Law and inductors

1. A sliding rod and rails make a conducting path with resistance $R = 1\,k\Omega$. The distance between rails (length of the rod) is $l = 10\,cm$, and there is a magnetic field $B = 2\,T$ which points into the page; the rod is moving with speed $v = 10\,m/s$ to the right.

   (a) find $E_{ind}$

   (b) find $I_{ind}$

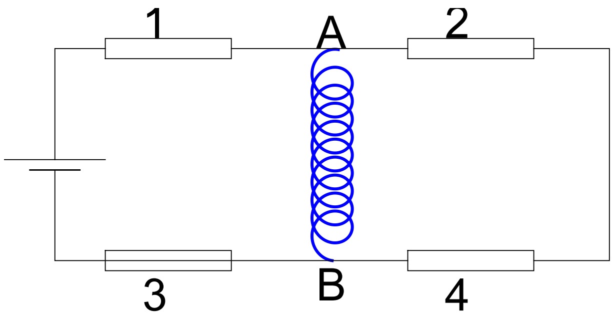
   (c) find the electric power $P$ released in the circuit

   (d) find $\vec{F}_M$ acting on the rod (direction)

   (e) find $\vec{F}_M$ acting on the rod (magnitude)

   (f) find the mechanical power which is required to overcome $F_M$ and compare to $P$

   (g) what would be the direction of the induced current and the magnetic force if the rod would slide left?



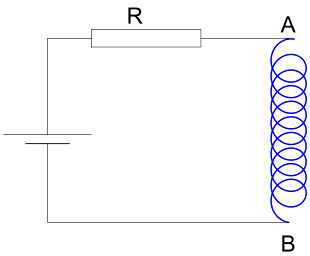

2. In the above circuit $R_1 = 1\,\Omega\,,\ R_2 = 2\,\Omega\,,\ R_3 = 3\,\Omega\,,\ R_4 = 4\,\Omega$ and $E = 12\,V$. The switch (not shown) was closed at $t = 0$.

(a) redraw the circuit and find all currents as $t \to 0$

(b) redraw the circuit and find all currents as $t \to \infty$

(c) the same if the inductor is replaced by a capacitor $C$

(d) for the original circuit with $R_2\,,\ R_4$ removed and $R = R_1 + R_2$, find the induced emf $E_L$ when the current reaches 20% of its maximum value. (*Note.* The actual value of the inductance $L$ does not matter here; you can get the result from the loop equation, or use any value of $L$ in explicit calculations).




(e) find the *time* for the current to reach 50% of its maximum value; use $L = 2\,mH$.

(f) Assume that a long time after the maximum current was reached, the battery is also removed and replace by a wire. At that instant, time is "restarted", i.e. $t = 0$. Plot $i(t)$ and $U_M(t)$; use the attached graphpaper (select a good scale!).