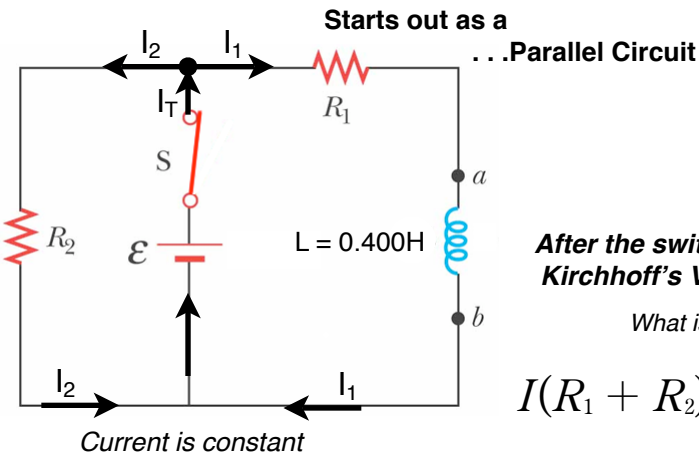


Physics 196 Chapter 32 Problem 71

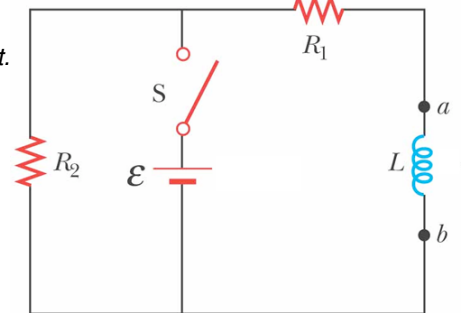
The emf = 14.0 V, $R_1 = 2.80$ kohms, and $R_2 = 5.00$ kohms. The switch is closed for $t < 0$, and steady-state conditions are established. The switch is now thrown open at $t = 0$. (a) Find the initial voltage emf_0 across L just after $t = 0$. Which end of the coil is at the higher potential: a or b? (b) Make freehand graphs of the currents in R_1 and in R_2 as a function of time. Show values before and after $t = 0$. (c) How long after $t = 0$ does the current in R_2 have the value 2.00 mA? (30 points)



... then ends as a

Show which end of the inductor is at a higher potential. 4 pts

Show the initial direction of the current.



Is the initial current increasing or decreasing? 3 pts

After the switch is opened use Kirchhoff's Voltage Sum Rule

What is the induced emf over the inductor?

$$I(R_1 + R_2) + \boxed{} = 0$$

Derive the current wrt time when the switch is closed.

symbolically 6 pts

a. The switch is closed for a long time so the current in both branches has reached a constant value.

b. The voltage over the inductor is zero because the current has stopped changing. No change in current no 'back emf'.

c. A constant Magnetic Field has been established in the coil.

Find the steady state current for the left and right loops when the switch is closed using Kirchhoff's Current Sum Rule.

$$I_T = I_1 + I_2$$

$$I_T = \frac{\mathcal{E}}{R_1} (1 - e^{-\frac{R_2 t}{L}}) + \frac{\mathcal{E}}{R_2}$$

Find the Steady-state current in the left and right loop

plug in values 4 pts

$$I = \frac{\mathcal{E}}{R_2 + R_1} (e^{-\frac{(R_2 + R_1)t}{L}})$$

$$I_f = I_0 e^{-\frac{(R_2 + R_1)t}{L}}$$

a. The power source is disconnected. Initially the current is CW / CCW thru the inductor.
 b. Because the current is _____ the coil reacts by inducing a _____ emf.
 c. The current through the inductor will begin to _____ in magnitude but continue in the _____ direction. The current in the left loop _____ direction.
 d. _____ is at a higher potential because the coil is trying to keep the current from falling to zero.

Find the initial emf over the Inductor when the switch is opened? Use Kirchhoff's Voltage Sum Rule. 2 pts

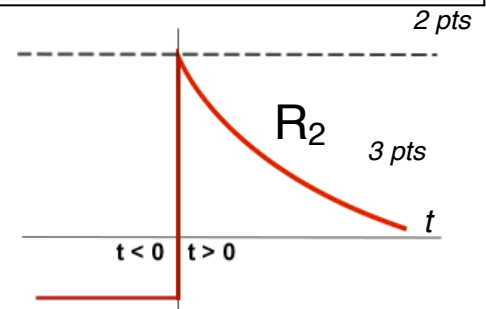
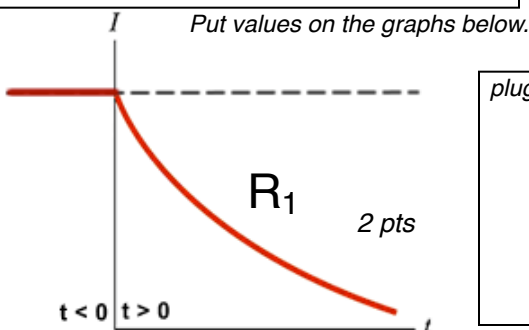
symbolically

plug in values

What is the time required for current to fall to 2.00mA?

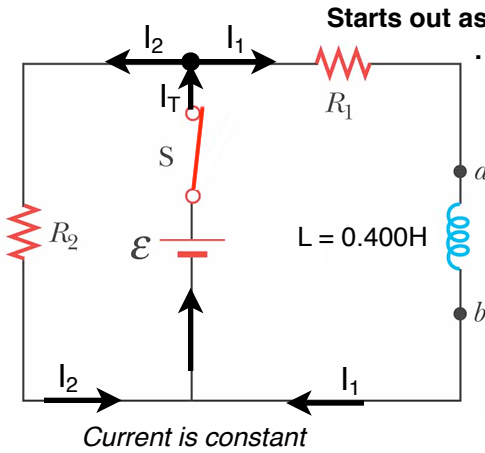
plug in values 2 pts

Put values on the graphs below.

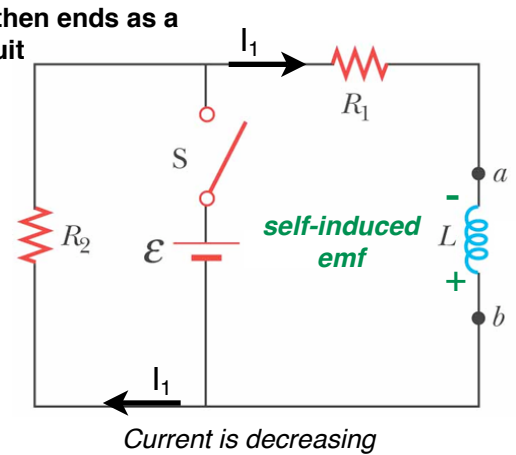


Physics 196 Chapter 32 Problem 71

The emf = 14.0 V, $R_1 = 2.80$ kohms, and $R_2 = 5.00$ kohms. The switch is closed for $t < 0$, and steady-state conditions are established. The switch is now thrown open at $t = 0$. (a) Find the initial voltage emf₀ across L just after $t = 0$. Which end of the coil is at the higher potential: a or b? (b) Make freehand graphs of the currents in R_1 and in R_2 as a function of time. Show values before and after $t = 0$. (c) How long after $t = 0$ does the current in R_2 have the value 2.00 mA?



Starts out as a ... Parallel Circuit
 Closed switch. . . . Open Switch
 After the switch is opened use Kirchhoff's Voltage Sum Rule



a. The switch is closed for a long time so the current in both branches has reached a constant value.

b. The voltage over the inductor is zero because the current has stopped changing. No change in current no 'back emf'.

c. A constant Magnetic Field has been established in the coil.

Find the steady state current when the switch is closed using Kirchhoff's Current Sum Rule

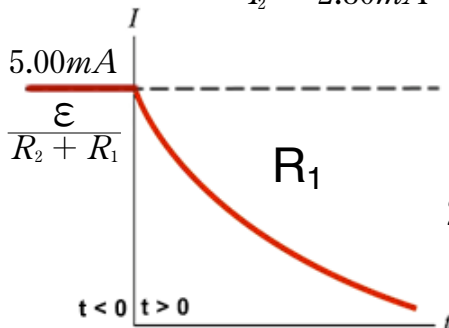
$$I_T = I_1 + I_2$$

$$I_T = \frac{\epsilon}{R_1} (1 - e^{-\frac{R_2 t}{L}}) + \frac{\epsilon}{R_2}$$

Steady-state current ($t \rightarrow \infty$) in the left and right loop

$$I_T = \frac{14.0 \text{ V}}{2800} + \frac{14.0 \text{ V}}{5000} = 7.80 \text{ mA}$$

$$I_1 = 5.00 \text{ mA} \quad I_2 = 2.80 \text{ mA}$$



$$I(R_1 + R_2) + L \frac{dI}{dt} = 0$$

$$\frac{dI}{dt} = -\frac{I(R_2 + R_1)}{L}$$

$$\frac{dI}{I} = -\frac{(R_2 + R_1) dt}{L}$$

$$\int_0^I \frac{dI}{I} = \int_0^t -\frac{(R_2 + R_1) dt}{L}$$

$$I = \frac{\epsilon}{R_2 + R_1} (e^{-\frac{(R_2 + R_1)t}{L}})$$

$$I_f = I_0 e^{-\frac{(R_2 + R_1)t}{L}}$$

Time required for current to fall to 2.00mA.

$$2.00 \text{ mA} = 5.00 \text{ mA} (e^{-\frac{(5000 + 2800)t}{0.400 \text{ H}}})$$

$$t = 4.70 \times 10^{-5} \text{ s} = 47.0 \mu\text{s}$$

a. The power source is disconnected. Initially the current is CW through the inductor.

b. Because the current is changing (decreasing) the coil reacts by inducing a forward emf (CW).

c. The current through the inductor will begin to decrease in magnitude but continue in the same direction. The current in the left loop changes direction.

d. Point b is at a higher potential because the coil is trying to keep the current from falling to zero.

Find the initial forward emf over the Inductor when the switch is opened using Kirchhoff's Voltage Sum Rule in the outer loop

$$\epsilon_{ind} - (R_2 + R_1) I_0 = 0$$

Initial Forward emf

$$\epsilon = (5000 + 2800) 5.00 \text{ mA} = 39.0 \text{ V}$$

