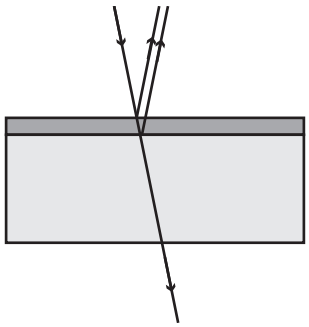
Activity ID:_____

1. An optical filter is a device which preferentially transmits desired wavelengths of light while reflecting others. A simple optical filter can be constructed from a thin film of titanium dioxide ($n_f = 2.68$) deposited on optical glass ($n_g = 1.53$), as shown in the diagram. You may treat the layer of glass as being much thicker than the layer of TiO_2 and assume normal incidence for the light rays. The spectrum of visible light ranges from 390–700 nm.

   (a) If three of the wavelengths of electromagnetic radiation maximally reflected by the filter are $\lambda_1 = 2070$ nm (infrared), $\lambda_2 = 690$ nm (red light), and $\lambda_3 = 414$ nm (violet light), what is the thickness of the thin film?

   (b) What wavelength of visible light is preferentially transmitted by this optical filter? (Hint: if an incident wave is preferentially transmitted, what must be true of its reflected waves?) If you are unable to determine the actual film thickness in part (a) you can use $t = 250$nm. NOTE–THIS IS NOT THE CORRECT ANSWER.



Activity ID:_____

2. Consider the circuit on the left with $R_1 = 1\ \Omega$, $R_2 = 2\ \Omega$, $R_3 = 3\ \Omega$, $C_2 = 2\mu$F, and $C_3 = 3\mu$F. Both capacitors are initially uncharged when the switch S_1 is closed at $t = 0$.

(a) Write an equation for the current, $i_1(t)$, passing through R_1 using the numerical values provided.

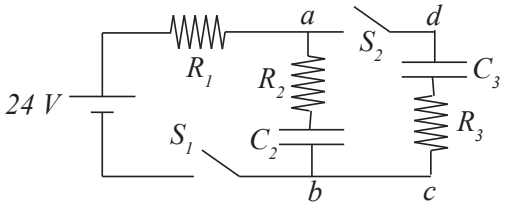
(b) What is the final charge on C_2, a long time after the switch S_1 is closed?

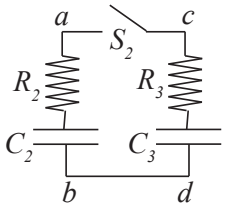
(c) Next we also close switch S_2. What are the final charges on the capacitors, Q_2 and Q_3, a long time after the switch S_2 is closed?

A Physics 158 student forgets to discharge these two capacitors before disconnecting them. The next day another P158 student reconnects them with reverse polarity as shown in the figure on the right.

(d) Calculate $|\ V_{ab}\ |$ and $|\ V_{cd}\ |$ a long time after the switch S_2 is closed.

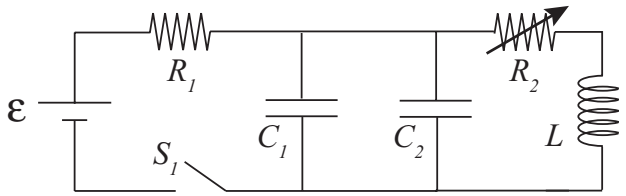
(e) How much charge flows through the switch S_2?

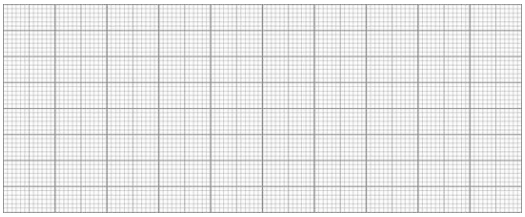




Activity ID:_____

3. Consider the LRC circuit shown below. Use $\varepsilon = 10\text{V}$, $\text{R}_1 = 2\Omega$, R_2 is a variable resistor initially set to 5Ω, $\text{C}_1 = 3\text{F}$, $\text{C}_2 = 5\text{F}$, and $L = 10\text{H}$. At $t = 0$ the switch S_1 is closed.





(a) What is the voltage drop across the inductor L at $t = 0$?

(b) What is the current provided by the battery at $t = 0$?

(c) What is the charge on capacitor C_1 after a long time?

Now suppose that the variable resistance R_2 is reduced to zero. After waiting for the system to reach a new steady state, we open the switch S_1. We redefine this new time to be $t' = 0$.

(d) Sketch on the graph paper above the total charge $Q(t')$ on the top capacitor plates.

(e) What is the maximum energy stored in the capacitors?

(f) When does the **magnitude** of the capacitor charge first reach its maximum value?