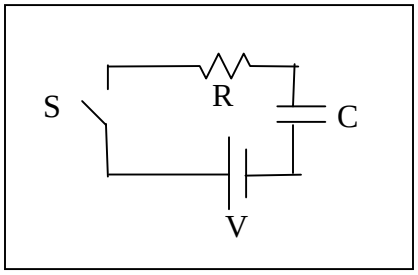
Physics 206b

Homework Assignment VIII

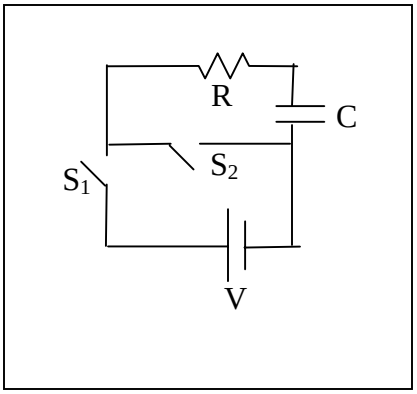
Due October 8, 2007

Note that the due date is a Monday so as not to interfere with your preparation for the exam on Friday, October 5.

1. In the circuit below, the resistance is $37k\Omega$ and the capacitor is 14 nF. After switch S is closed, how long will it be before the voltage difference across the capacitor is ½ V?



2. Now consider the circuit below. Initially, S_1 is closed and S_2 is left open. After a long time, S_1 is opened and S_2 is immediately closed. (This is usually accomplished by a single switch just "shunting" to a different path.) Make a sketch of the charge held by the capacitor as a function of time after S_2 is closed. Use the values for R and C from the previous problem. Be sure to indicate on your sketch the time at which the charge will be at the $\frac{1}{e}$ level. If $V = 3V$, after 300 microseconds, what will be the charge remaining on the capacitor (this will be an actual value, not just a fraction)?

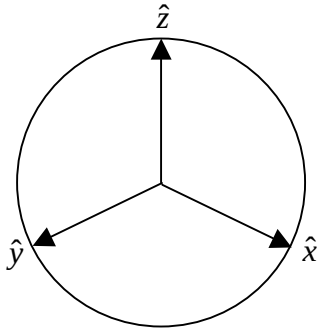


3. Write down, in words, Ampere's Law.

Below is a set of math problems provided to give you practice with a new skill set. These problems will not be graded. However, I urge you to approach them with the same level of seriousness that you bring to the other problems you are assigned! The skills represented in these problems will be essential to solving the problems you will see in future assignments.

Some important properties of the cross product:

$\vec{a}\times\vec{b} = -\vec{b}\times\vec{a}$
$\vec{a}\times\vec{a} = 0$
$\hat{x}\times\hat{y} = \hat{z}$
$\hat{y}\times\hat{z} = \hat{x}$
$\hat{z}\times\hat{x} = \hat{y}$



4. Using the right hand rule (RHR), what is size and direction of $\vec{a}\times\vec{b}$ if $\vec{a}$ is a vector of length 2 pointed in the $\hat{x}$ direction and $\vec{b}$ is a vector of length 5 making an angle of 20° with $\vec{a}$ in the *x*-*y* plane?
5. Now, use the two vectors above to perform the same calculation algebraically.
6. Perform the following cross products:
   a. $(27\hat{x}+3\hat{y})\times(9\hat{x}+1\hat{y})$
   b. $(27\hat{x}+3\hat{y})\times(9\hat{x}-1\hat{y})$
   c. $(3\hat{x}+5\hat{y}+7\hat{z})\times(11\hat{x}-13\hat{y}+6\hat{z})$
7. By directly performing the following cross products in two different orders, show that, in general $(\vec{a}\times\vec{b})\times\vec{c} \neq \vec{a}\times(\vec{b}\times\vec{c})$
   a. $5\hat{x}\times 3\hat{z}\times 9\hat{z}$
   b. $(2\hat{x}+5\hat{y}+8\hat{z})\times(9\hat{x}-13\hat{y}+11\hat{z})\times(-6\hat{x}+7\hat{y}+17\hat{z})$
8. Taking $\vec{\tau} = \vec{d}\times\vec{F}$, find $\vec{\tau}$ when
   a. $\vec{F} = 80\,N$ in the $-\hat{y}$ direction and $\vec{d} = 1m$ at an angle of 17° relative to the *x* axis in the *x*-*y* plane. Sketch the force, the moment arm (*d*), and the torque ($\vec{\tau}$).
   b. $\vec{F} = 12N\,\hat{x} - 3N\,\hat{y} + 5N\,\hat{z}$ and $\vec{d}$ is 4 meters long and makes a 45° angle with all three of the Cartesian axes (i.e., it points out of the corner of the cube formed of *x*, *y*, and *z*.)