# PHY 240: Basic Electronics
# Homework Problem H10

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1. **Capacitor Review Problem.**

   (a) Draw the schematic diagram for a circuit containing a 10 V DC source, a 1.2 kΩ resistor, and a 250 nF capacitor all in series.

   (b) At a particular instant in time that we shall call $t = 0$, the charge on the plate of the capacitor facing the positive side of the 10 V supply is 4 $\mu$C. Of course, this means that the charge on the capacitor plate facing the negative side of the 10 V supply is -4 $\mu$C. Determine the current flowing through the resistor at time $t = 0$. Indicate the direction in which this current is flowing by placing a labeled arrow next to the resistor on your schematic diagram.

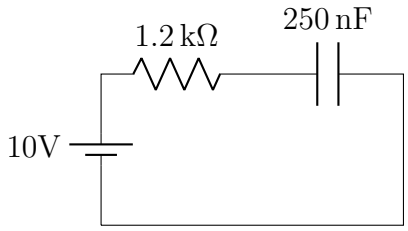
   (c) If we wait for a very long time (until $t = \infty$), current will cease flowing in the circuit. After the current has stopped flowing, how much charge is on the positive plate of the capacitor? Which plate is positive at this point?

   (d) Between times $t = 0$ and $t = \infty$, how much charge passes through the resistor?

   (e) How much energy is stored by the capacitor at time $t = 0$? How much is stored by the capacitor at $t = \infty$?

**Solution:**

(a) Get ur schematic here!



(b) First, we have to figure out the voltage across the capacitor.

$$Q = CV$$

$$V = \frac{Q}{C}$$

$$V = \frac{0.000004\,C}{0.000000250\,F} = 16V$$

So the voltage across the capacitor is 16 V.
Now, we find the voltage across the resistor.

$$V_{total} = V_r + V_c$$

$$V_r = V_{total} - V_c$$

$$V_r = -6V$$

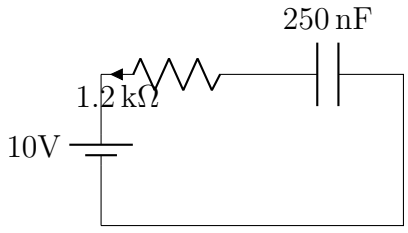
Calculating the current is trivial.

$$I = \frac{V_r}{R}$$

$$I = \frac{-6V}{1200\,\Omega}$$

$$I = -0.005A$$

The current is flowing towards the positive plate.



(c) At $t = \infty$ the voltage across the capacitor will equal the supply voltage.

$$V_c = 10V$$

$$Q = CV_c$$

$$Q = (0.00000025F)(10V) = 0.000025C$$

So the positive plate of the capacitor would be at 2.5 $\mu$C.
The side facing the positive terminal would be positive.

(d)

$$4\,\mu C - 2.5\,\mu C = 1.5\,\mu C$$

(e)

$$E = \frac{1}{2}CV^2$$

$$E_0 = \frac{1}{2}(0.00000025F)(16V)^2$$

$$E_0 = 0.000032J = 32\,\mu J$$

So the energy stored in the capacitor at $t = 0$ is 32 $\mu J$.

$$E_\infty = \frac{1}{2}(0.00000025F)(10V)^2$$

$$E_\infty = 0.0000125J = 12.5\,\mu J$$

And the energy stored in the capacitor at $t = \infty$ is 12.5 $\mu J$.