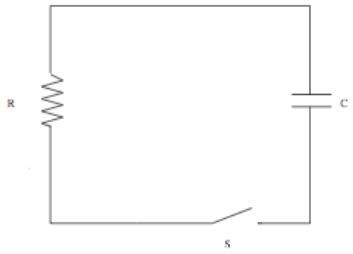
Physics 008 **Problem Set #5** **Fall 2009**

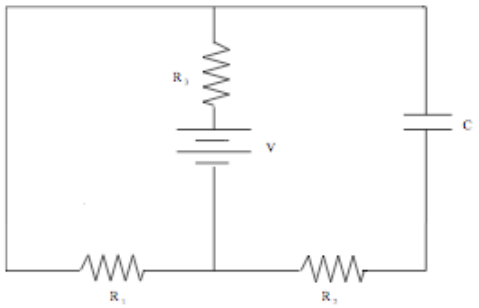
My Lectures from : Purcell Chapter 10.1-10.4;
Web Notes : Lecture Notes #4a,4b,4c
Other Notes: Capacitance; AC_circuits

Purcell Problems:
10.3 Dipole moments
10.6 Parallel plate capacitor
10.14 Three capacitors

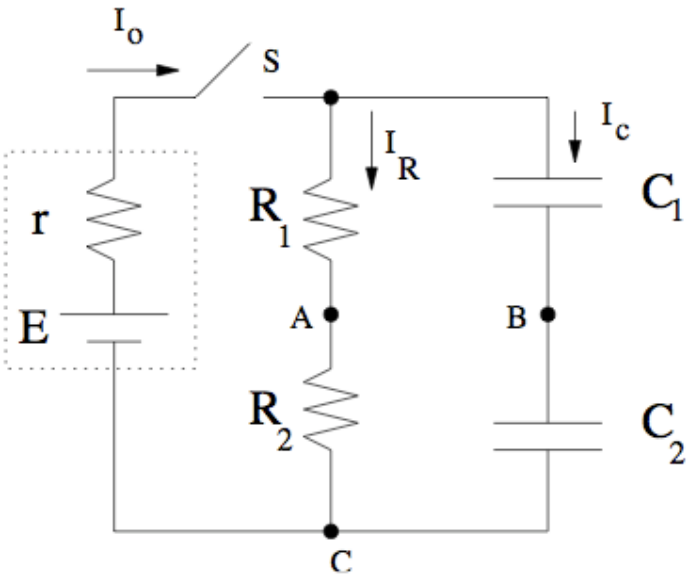
1. Consider the simplest RC circuit as shown below. Suppose that a charge Q_0 is stored on the capacitor initially. Show that the total energy dissipated in the resistor after the switch is closed equals the energy that was stored in the capacitor before the switch was closed.



2. Consider the circuit shown below. Suppose that the capacitor is initially discharged. The switch is closed at t = 0 (circuit as shown). Find the charge $I_B(t)$ through the battery, i.e., the middle branch, as a function of time, and the charge on the capacitor Q(t).



3. A battery E with internal resistance r, two resistors $R_1=10r$ and $R_2=5r$ and two capacitors C_1 and C_2 with $C_1=2C_2$ are arranged as shown below. The capacitors are initially uncharged. Express all your answers in terms of E, r, and C_2.

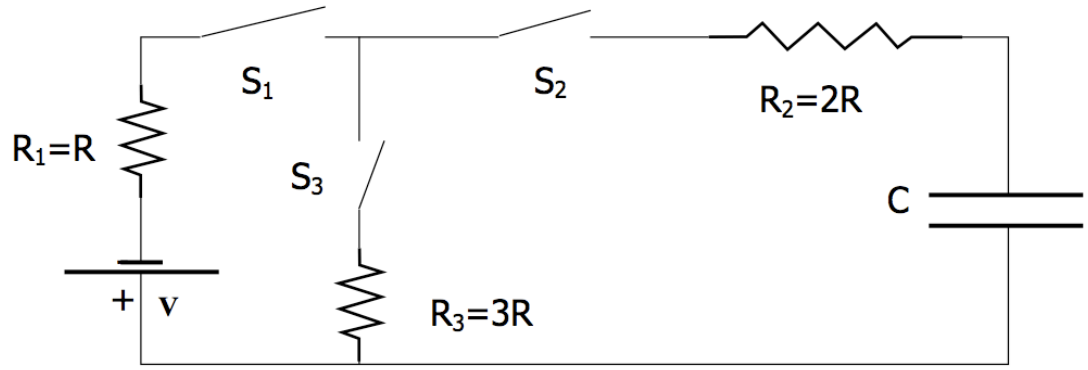


(a) At t=0, the switch S is closed. What is the potential at A with respect to C, i.e., $V_{AC}=V_A-V_C$, and what is the potential at B with respect to C, i.e., $V_{BC}=V_B-V_C$?
(b) After infinite time has elapsed(and with switch S remaining closed) what is $V_{AC}=V_A-V_C$ and $V_{BC}=V_B-V_C$?
(c) Write down a set of independent equations that will yield the solutions for the currents flowing in the three branches of the circuit, i.e., $I_0(t)$, $I_R(t)$, $I_C(T)$. Do NOT solve them.

We now short-circuit points A and B by connecting them with a resistanceless conducting wire.

(d) Will there be any current flowing through it(yes/no) and in what direction?
(e) What will be the final $V_{AC}=V_A-V_C$ and $V_{BC}=V_B-V_C$?
(f) What is the total charge the passed through the short-circuiting wire? Is this consistent with the answer to (d)?

4. Consider the circuit below.



Initially all switches are open and the capacitor C is discharged.

(a) At time t=t0, we close S_1 and S_2 simultaneously.
(b) At time $t=t_1>>t_0$, we close S_3(with S_1 and S_2 still closed)
(c) At time $t=t_2>>t_1$, we open S_1(S_2 and S_3 still closed)

Sketch how the following quantities vary with time:

(a) V_C (potential across the capacitor)
(b) I_{R2} (current through resistor R_2)
(c) V_{R3} (potential across resistor R_3)