proprep

Workbook

Table of Contents

Capacitors

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Questions

1) A cylindrical capacitor is given. Its length is L, its inner radius is a and its outer radius is b.

a. Calculate the capacitance.

b. Now two dielectric materials are put in between the plates. k_1 is between a and d, k_2 is from d until b. Calculate the capacitance.

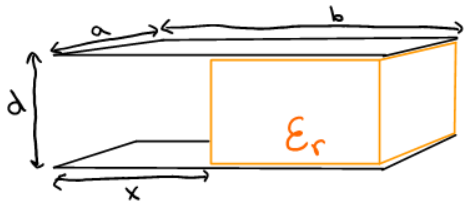
c. A dielectric material is inserted between the plates. Its constant is dependent on the radius, $k(r) = k_0 \frac{r}{b}$. Calculate the capacitance in this case.

d. We return to the case with the two dielectric materials (from Q2). Calculate the surface area charge distribution.

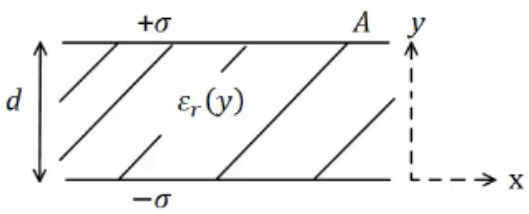
2) We are given the following capacitor. The plate length is *b*, the plate width is *a*, and the distance between the plates is *d*. A distance *x* away from the left edge of the capacitor a dielectric material of constant ε_r is inserted.

a. Calculate the capacitance of the capacitor.

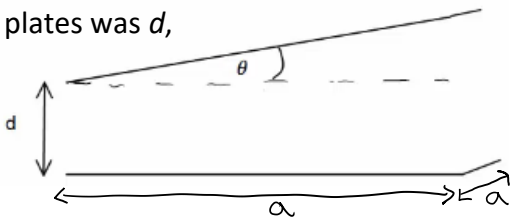
b. A voltage source V_0 is connected. Calculate the charge distribution on capacitor's plates.



3) A parallel plate capacitor is charged with $\pm\sigma$. The area of the plates is *A*, and the distance between the two plates is *d*. A dielectric material is placed between the plates. Its ielectric constant is dependent on *y* and is given by $\varepsilon_r(y) = 1 + \left(\frac{y}{d}\right)^2$.
The lower plate is located at $y = 0$. Calculate the capacitance.

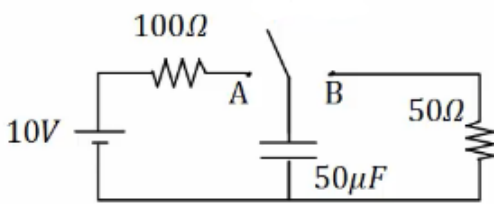


4) A parallel plate capacitor was partially deformed at production.
Each plate is of length and width a. The distance between the plates was d, but now the upper plate has a deviation of θ, where $\theta \ll \pi$.
What is the capacitance of this capacitor as a function of θ?
What is the charge distribution,σ, on the capacitor's plates?



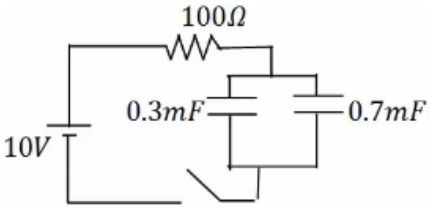
5) At *t=0* the switch is switched to point *A*. At *t=0.01* the switch is switched to point *B*.

a. What is the voltage across the capacitor as a function of time?
b. What is the charge on the capacitor at *t=0.02*?
c. What is the current as a function of time?
d. Draw graphs representing the current, and voltage as a function of time.

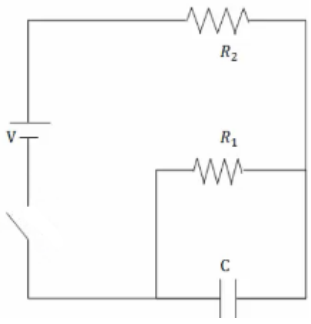


6) In the following circuit, at *t=0*, the switch is closed.

a. What is the RC time constant for this circuit?
b. Calculate the voltage and charge on each capacitor at times *t=0.2s* and *t=0.8s*.

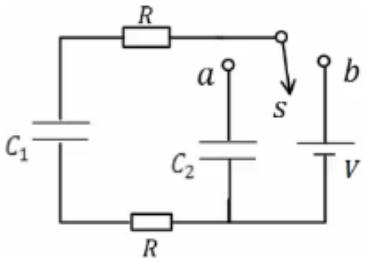


7) In the following circuit, at *t=0*, the capacitor has no charge and the switch is closed.
Calculate the charge on the capacitor and the current in each resistor as a function of time.
We are givenV, R_1, R_2, C.



8) In the following circuit, capacitor C_1 is charged with charge Q_0, before the switch is switched to a.

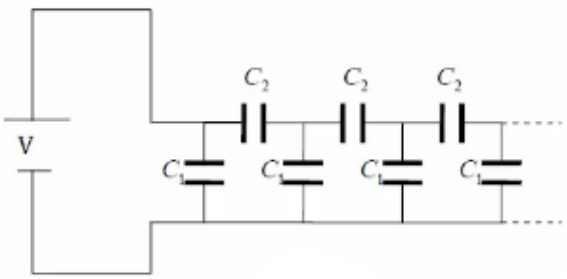
a. Write an equation which can be solved to give us the charge on C_1 as a function of time.
b. Solve the equation and calculate the charge on each capacitor as a function of time.
c. What are the currents through each resistor, as a function of time?



9) Two spheres of radii *a* and *b* are placed far apart, and have charges $+Q$ and $-Q$, respectively.

a. Calculate the total electrostatic energy of the system.
b. Using the answer to question 1, calculate the capacitance of the system.
c. If the spheres were to be joined via a very long wire of resistance *R*, what would be the RC time constant for the discharge of the system?

10) Calculate the total capacitance of the following infinite ladder circuit. Assume that the capacitance of each capacitor is given.



*For the solutions go see the videos