
General Physics: Electromagnetism, Problem Set 6

Exercise 1 :

Find the equivalent capacitance between the points a and b for the group of capacitors connected as shown below. Take $C_1 = 5.00 \mu\text{F}$, $C_2 = 10.00 \mu\text{F}$ and $C_3 = 2.00 \mu\text{F}$. What charge is stored on C_3 if the potential difference between the points a and b is 60.0 V ?

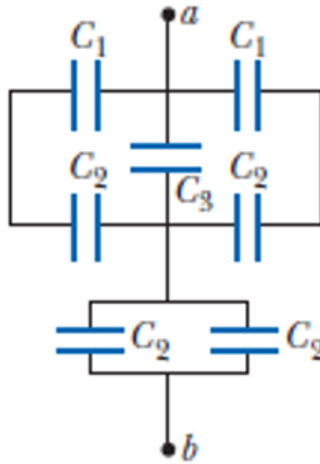


Figure 1: Group of capacitances connected in series and in parallel.

Exercise 2 :

Consider the configuration shown in the figure below. Find the equivalent capacitance, assuming that all the capacitors have the same capacitance C .

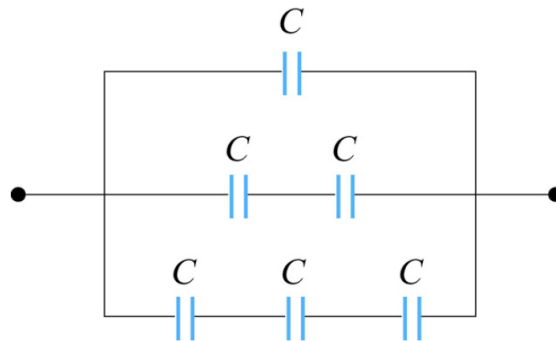


Figure 2: Combination of Capacitors

Exercise 3 :

Two dielectrics with dielectric constants κ_1 and κ_2 each fill half the space between the plates of a parallel-plate capacitor as shown in the figure below. Each plate has an area A and the plates are separated by a distance d . Compute the capacitance for the system.

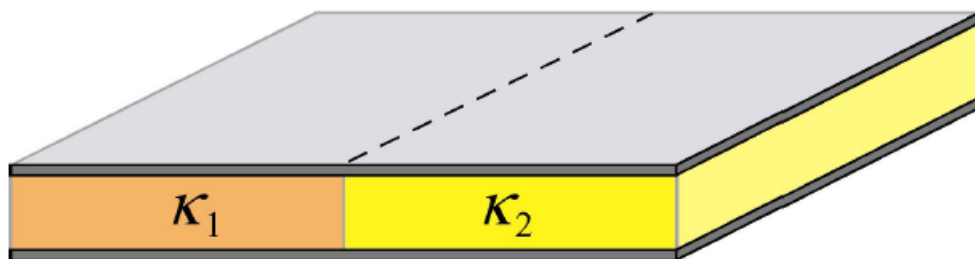


Figure 3: Capacitor filled with two different dielectrics

Exercise 4 :

Consider a conducting spherical shell with an inner radius a and outer radius c . Let the space between two surfaces be filled with two different dielectric materials so that the dielectric constant is κ_1 between a and b , and κ_2 between b and c , as shown in the figure below. Determine the capacitance of this system.

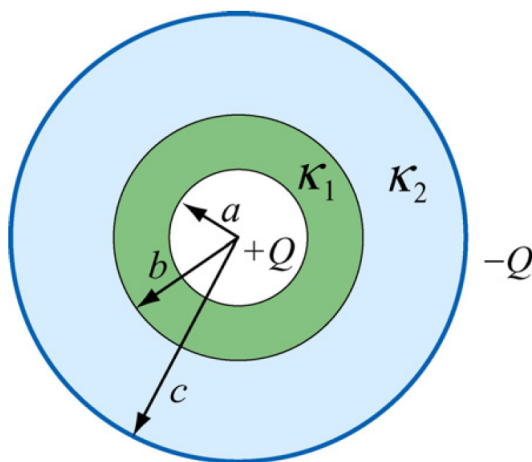


Figure 4: Spherical capacitor filled with dielectrics.

Exercise 5 :

Consider an air-filled parallel-plate capacitor with one plate connected to a spring having a force constant k , and another plate held fixed. The system rests on a table top as shown in the figure below. If the charges placed on plates a and b are $+Q$ and $-Q$, how much does the spring expand?

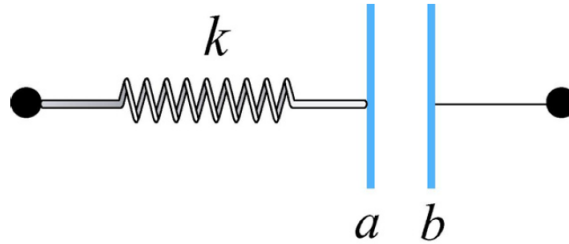


Figure 5: Capacitor connected to a spring.

Exercise 6 :

We consider a parallel-plate capacitor with plate separation d and plate area A .

1. Find the capacitance of the device when an uncharged metallic slab of thickness a is inserted midway between the plates. What is the capacitance in the limit where $a \rightarrow 0$?

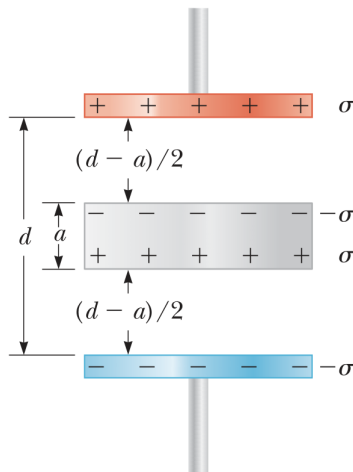


Figure 6: A parallel-plate capacitor of plate separation d partially filled with a metallic slab of thickness a .

2. Find the capacitance of the device when a slab of dielectric material of dielectric constant k and thickness fd is inserted between the plates, where f is a fraction between 0 and 1. Express the solution in terms of the capacitance C_0 in the absence of the dielectric ($C_0 = \epsilon_0 A/d$).

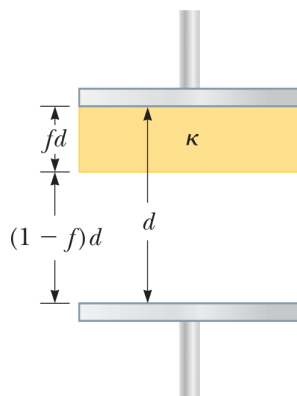


Figure 7: A parallel-plate capacitor of plate separation d filled with a dielectric of thickness fd .