**Chapter-25**

1. When a potential difference of 150 V is applied to the plates of a parallel-plate capacitor, the plates carry a surface charge density of 30.0 nC/cm2. What is the spacing between the plates?

 Ans: We have Thus, 

 The surface charge density on each plate has the same magnitude, given by

 

 Thus,

 

 

1. (a) Find the equivalent capacitance between points a and b for the group of capacitors connected as shown in Figure P25.12. Take C1 = 5.00 µF, C2 = 10.0 µF, and C3 = 2.00 µF. (b) What charge is stored on C3 if the potential difference between points a and b is 60.0 V?

(a) In the upper section, each *C*1-*C*2 pair, on either side of *C*3 , are in series:

**FIG. P25.12**



 and both *C*1*-C*2 pairs are in parallel to *C*3:

 

 In the lower section, the *C*2*-C*2 pair are in parallel:

 

 The upper section is in series with the lower section:

 

 (b) Capacitors in series carry the same charge as their equivalent capacitor; therefore, the upper section, equivalent to a 8.67-**F capacitor, and the lower section, equivalent to a 20.0-**F capacitor, carry the same charge as a 6.05-**F capacitor:

  The upper section is equivalent to capacitor *C*3 and two 3.33-**F capacitors in parallel, and the voltage across each is the same as that across a 8.67-**F capacitor:

 

 Therefore, the charge on *C*3 is

 

1. Two identical parallel-plate capacitors, each with capacitance C, are charged to potential difference $∆$V and then disconnected from the battery. They are then connected to each other in parallel with plates of like sign connected. Finally, the plate separation in one of the capacitors is doubled. (a) Find the total energy of the system of two capacitors before the plate separation is doubled. (b) Find the potential difference across each capacitor after the plate separation is doubled. (c) Find the total energy of the system after the plate separation is doubled. (d) Reconcile the difference in the answers to parts (a) and (c) with the law of conservation of energy.

Ans: Before the capacitors are connected, each has voltage ∆*V* and charge *Q*.

 (a) Connecting plates of like sign places the capacitors in parallel, so the voltage on each capacitor remains the same.

 

 (b) Because  the altered capacitor has new capacitance  and this change in capacitance results in a new potential difference  across the parallel capacitors. We can solve for the new potential difference because the total charge remains the same:

 

 (c) Each capacitor has potential difference ∆*V*′:

 

 (d) 

1. A 2.00-nF parallel-plate capacitor is charged to an initial potential difference $∆$Vi 5 100 V and is then isolated. The dielectric material between the plates is mica, with a dielectric constant of 5.00. (a) How much work is required to withdraw the mica sheet? (b) What is the potential difference across the capacitor after the mica is withdrawn?

Ans: We use the equation *U*E *= Q*2/2*C* to find the potential energy of the capacitor. As we will see, the potential difference changes as the dielectric is withdrawn. The initial and final energies are  and  But the initial capacitance (with the dielectric) is . Therefore, Since the work done by the external force in removing the dielectric equals the change in potential energy, we have

 

 To express this relation in terms of potential difference  we substitute  and evaluate:

 

 The positive result confirms that the final energy of the capacitor is greater than the initial energy. The extra energy comes from the work done *on* the system by the external force that pulled out the dielectric.

 (b) The final potential difference across the capacitor is .

 Substituting  and  gives

 

 Even though the capacitor is isolated and its charge remains constant, the potential difference across the plates does increase in this case.