Chapter 26: Capacitors $Q=C\cdot\Delta V$

1. a) How much charge is on each plate of a 4.00E-6F capacitor when it is connected to a 12 Volt battery? b) If this same capacitor is connected to a 1.50 V battery, what charge is stored?
   a)48.0μC; b) 6.00μC

Calculating capacitance

2. (3) An isolated charged conducting sphere of radius 12.0 cm creates an electric field of 4.90E4 N/C at a distance of 21.0 cm from its center. a) What is its surface charge density? b) What is its capacitance?
   a) 1.33μC/m^2 b) 13.3pF

3. (5) Two conducting spheres with diameters of 1.00m and 0.400m are separated by a distance that is large in comparison to the diameters. The spheres are connected by a conducting wire and are charged to 7.00E-6C. a) How is this total charge shared between the two spheres? b) What is the potential of the system of spheres with V=0 at infinity?
   a) 2.00 and 5.00 μC; b) 89.9kV

4. (9) A 50.0 m length of coaxial cable has an inner conductor with a diameter 0f 2.58 mm and carries a charge of 8.10E-6 C. The surrounding conductor has a diameter of 7.27mm and a charge of -8.10E-6C. a) What is the capacitance of this cable? b) What is the potential difference between the two conductors?
   a) 2.68nF b) 3.02kV

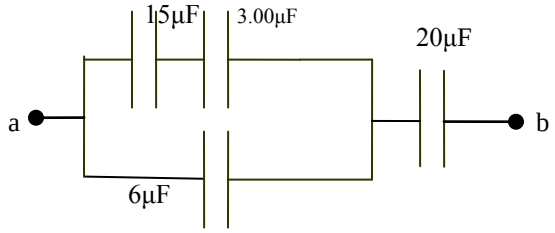
5. (11) An air-filled spherical capacitor is constructed with inner and outer shell radii of 7.00 and 14.00 cm, respectively. a) Calculate the capacitance of the device. b) What ΔV between the shells results in a charge of 4.00E-6C on the capacitor?
   a) 15.6pF; b) 256kV

Combinations of capacitors:

6. (12) Two capacitors C_1 = 5.00μF and C_2 = 12.0μF are connected in parallel, and the resultant combination is connected to a 9.00V battery. a) What is the equivalent capacitance of the combination? What are b) ΔV across each capacitor? c) the charge stored on each capacitor?
   a) 17.0μF; b) 9.00V; c) 45 and 108 μC

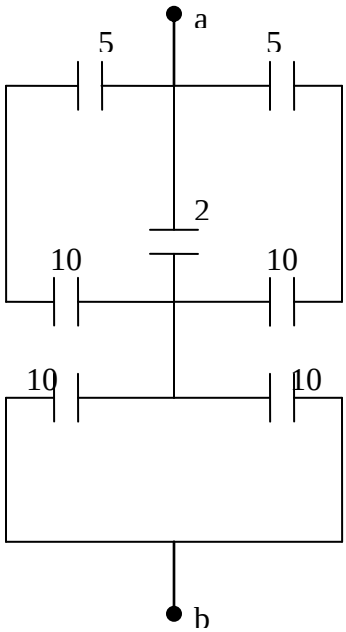
7. (13) The two capacitors of the previous problem are now connected in series and to a 9.00V battery. a)What is the equivalent capacitance of the combination? What are b) ΔV across each capacitor? c) the charge stored on each capacitor?
   a) 3.53μF b) 6.35 V and 2.65 V; c) 31.8μF

8. (17) Four capacitors are connected as shown. a) Find the equivalent capacitance between a and b, b) calculate the charge on each capacitor. The potential difference between a and b is 15V.



a) C_{eq}=5.96μF; b) on 20μF: 89.5μC, on 6μF: 63.2μC, on15 and 3 μF: 26.3μC

9. (23) Consider the following arrangement, all capacitances are in μF.



Find the equivalent capacitance between a and b. (6.04μF)

Energy stored in a capacitor:

10. (27) A 3μF capacitor is connected to a 12 V battery. a)How much energy is stored in the capacitor? b) calculate the energy for a 6 V battery.
a) 0.216mJ; b) ¼ of a)

11. (28) Two capacitors with 25.0 μF and 5.00 μF are connected in parallel and charged with a 100V power supply. a) Draw a circuit diagram and calculate the total energy stored on the two capacitors. b) What potential difference would be required across the same two capacitors connected in series in order that the assembly stores the same amount of energy as in a). a) 150mJ b) 268V

12. (33) Show that the energy associated with a conducting sphere of radius R and charge Q surrounded by a vacuum is $U = k_e \frac{Q^2}{2R}$

Capacitors with dielectrics:

13. (37) Determine a) the capacitance and b) the maximum potential difference that can be applied to a Teflon-filled parallel-plate capacitor having a plate area of 1.75cm^2 and a plate separation of 0.0400 mm. The dielectric strength of Teflon is E_{max}=60MV/m ($\kappa = 2.10$) a) 81.3pF b) 2.40 kV.

Electric dipole in an electric field:

14. (42) A small rigid object carries positive and negative 3.50 nC charges. It is oriented so that the positive charge has coordinates (-1.20mm, 1.10mm) and the negative charge has coordinates (1.40mm, -1.30mm). a) Find the electric dipole moment of the object.

The object is placed in an electric field $\vec{E} = \langle 7800, -4900 \rangle \frac{V}{m}$. b) Find the torque acting on the object. c) Find the potential energy of the object-field system when the object is in this orientation. d) If the orientation of the object can change, find the difference between the maximum and minimum potential energies of the system.

a) $\vec{p} = \langle -9.10, 8.40 \rangle 10^{-12} Cm$; b) $\vec{\tau} = \langle 0, 0, -2.09 \rangle 10^{-8} Nm$ c) U=112nJ;

d) ΔU=228nJ