Concept Problem

1. A dielectric is inserted between the plates of a capacitor. The system is then charged and the dielectric is removed. The electrostatic energy stored in the capacitor is
   1. greater than
   2. the same as
   3. smaller than

   It would have been if the dielectric was left in place. Why?
   The energy stored decreases if the voltage remains constant. It also takes work to remove the dielectric from the system. Conclusion, as capacitance decreases from the dielectric being removed, the energy stored also decreases.

2. Does the capacitance C of a capacitor increase, decrease, or remain the same (a) when the charge q is doubled and (b) when the potential difference V across it is tripled?
   C decreases by 1/3 when the potential difference is tripled. The voltage is going to change by a ratio where C always determines the ratio of that change.

   \[ Q = CV \] can be switched to find C as \[ C = \frac{Q}{V} \]
   2Q = an increase in C
   As V increases, V decreases by a proportional ratio.
   The ratio of change: \[ C = \varepsilon_0 \frac{A}{d} \]

3. Doubling the voltage across a parallel plate capacitor does not double which of the following?
   a. the charge
   b. the electrical field between the plates
   c. the energy stored
   d. the electric force on the plates
   e. both a and b

   a) \[ Q = CV \], yes  b) \[ E = KE \frac{Q}{r^2} \], yes  c) \[ (2Q)^2 / 2(1/2 C) \], No

   d) \[ F = q_0 E \], where F is proportional to \[ V^2 \], yes  Capacitance is independent of voltage.
4. Electric field lines can never cross. All electric field lines must have both magnitude and direction. Equal potential lines have the same potential and if they cross, then they are no longer equal in potential.

Quantitative Problems

1. A certain conductor has 7.50E28 free electrons / m^3, a cross-sectional area of 4.00E-6 m^2, and carries a current of 2.50 A. Find the drift speed of the electrons in the conductor.

\[ V_d = \frac{X}{\text{change in } t} = \frac{I}{nqA} \]

\[ 2.5 \text{ A} / (-1.6E-19)(4.00 \text{ E-6})(7.5E28) = V_d = 5.2E-5 \]

2. Two capacitors with capacitances of 1.5 microfarads and 0.25 microfarads, respectively, are connected in parallel. The system is connected to a 50.0 –V battery. What electrical potential energy is stored in the 1.5-microfarad capacitor?

Energy stored = \( \frac{1}{2} C (\Delta V)^2 \)

\( \frac{1}{2} (1.5E-6)(50)^2 = 1.88 \text{ E3 J} \)

or

\[ E = \frac{Q^2}{2C} = \frac{(7.5 \text{ E-5})^2}{2(1.5 \text{ E-6})} = 1.88 \text{ E-3} \]