Due 3/11/2005, 4 PM in mailboxes outside Science Center 109

Read: Chapters 27, 28

Instructions: Please box your solutions. The homework problems are graded out of 3 points, and then the total re-scaled to 30. For each problem, in order to get full credit, you must also include a sentence explaining the most important idea you used in order to solve it. Do not summarize the whole solution, simply the one most important idea.

HW Problems

1. Serway & Jewett 26.5
Two conducting spheres with diameters of 0.400 m and 1.00 m are separated by a distance that is large compared with the diameters. The spheres are connected by a thin wire and are charged to 7.00 $\mu$C. (a) How is this total charge shared between the spheres? (Ignore any charge on the wire.) (b) What is the potential of the system of spheres when the reference potential is taken to be $V = 0$ at $r = \infty$?

2. Serway & Jewett 26.8
A 1-megabit computer memory chip contains many 60.0-f F capacitors. Each capacitor has a plate area of $21.0 \times 10^{-12}$ m$^2$. Determine the plate separation of such a capacitor (assume a parallel-plate configuration). The order of magnitude of the diameter of an atom is $10^{-10}$ m = 0.1 nm. Express the plate separation in nanometers.

Two identical parallel-plate capacitors, each with capacitance $C$, are charged to potential difference $\Delta V$ and connected in parallel. Then 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.

4. Serway & Jewett 26.44
(a) How much charge can be placed on a capacitor with air between the plates before it breaks down, if the area of each of the plates is 5.00 cm$^2$? (b) What If? Find the maximum charge if polystyrene is used between the plates instead of air. The dielectric constant $\kappa$ is 1.00059 for air, 2.56 for polystyrene. The dielectric strength (the maximum electric field that can exist in a dielectric without electrical breakdown) is $3 \times 10^6$ V/m for air, $24 \times 10^6$ V/m for polystyrene.
5. **Serway & Jewett 27.14**

A resistor is constructed of a carbon rod that has a uniform cross-sectional area of 5.00 mm$^2$. When a potential difference of 15.0 V is applied across the ends of the rod, the rod carries a current of 4.00 × 10$^{-3}$ A. Find (a) the resistance of the rod and (b) the rod’s length. The resistivity of carbon is 3.5 × 10$^{-5}$ Ω·m.

6. **Serway & Jewett 27.29**

A certain lightbulb has a tungsten filament with a resistance of 19.0 Ω when cold and 140 Ω when hot. Assume that the resistivity of tungsten varies linearly with temperature even over the large temperature range involved here, and find the temperature of the hot filament. Assume the initial temperature is 20.0°C.

7. **Serway & Jewett 27.43**

A coil of Nichrome wire is 25.0 m long. The wire has a diameter of 0.400 mm and is at 20.0°C. If it carries a current of 0.500 A, what are (a) the magnitude of the electric field in the wire, and (b) the power delivered to it? (c) **What If?** If the temperature is increased to 340°C and the voltage across the wire remains constant, what is the power delivered? Nichrome has a resistivity of 1.50 × 10$^{-6}$ Ω·m at 20.0°C, with a temperature coefficient of 0.4 × 10$^{-3}$/°C.

8. **Serway & Jewett 27.53**

Make an order-of-magnitude estimate of the cost of one person’s routine use of a hair dryer for 1 yr. If you do not use a blow dryer yourself, observe or interview someone who does. State the quantities you estimate and their values.