Homework 19 for September 30 2008
Due 8AM on September 30 2008
Physics 221 with Professor Jeff Terry

1. When a potential difference of 150V is applied to the plates of a parallel-plate capacitor, the plates carry a surface charge density of 30 nC/m^2. What is the spacing between the plates?

$$Q = \frac{\varepsilon_0 A}{d}(\Delta V) \qquad \frac{Q}{A} = \sigma = \frac{\varepsilon_0 (\Delta V)}{d}$$

$$d = \frac{\varepsilon_0 (\Delta V)}{\sigma} = \frac{(8.85\times10^{-12}\ \mathrm{C^2/N\cdot m^2})(150\ \mathrm{V})}{(30.0\times10^{-9}\ \mathrm{C/cm^2})(1.00\times10^{4}\ \mathrm{cm^2/m^2})} = \boxed{4.42\ \mu\mathrm{m}}$$

2. Two capacitors of 5.0 microfarads and 8.0 microfarads are connected in series to a 24-V battery. What is the potential difference across each capacitor? What if they were connected in parallel?

Any two elements connected in parallel will have the same potential difference – in this case 24V. For series capacitors, it is a little more complex…

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \therefore C = \frac{C_1 C_2}{C_2 + C_1}$$

$$Q_1 = Q_2 = CV = \frac{C_1 C_2 V}{C_2 + C_1}$$

$$V_n = \frac{Q_n}{C_n} = \frac{C_1 C_2 V}{C_n (C_2 + C_1)}$$

$$V_1 = \frac{C_2 V}{(C_2 + C_1)} = \frac{(8.0\mu F)24V}{13.0\mu F} = 15V$$

$$V_2 = \frac{C_1 V}{(C_2 + C_1)} = \frac{(5.0\mu F)24V}{13.0\mu F} = 9.2V$$