PHYS 1444 – Section 02
Lecture #8

Thursday Feb 17, 2011
Dr. **Andrew Brandt**

- Chapter 24
  - Capacitors and Capacitance
  - Capacitors in Series or Parallel
  - Electric Energy Storage

HW4 Ch 24 will be assigned tomorrow, due next Thurs 24th

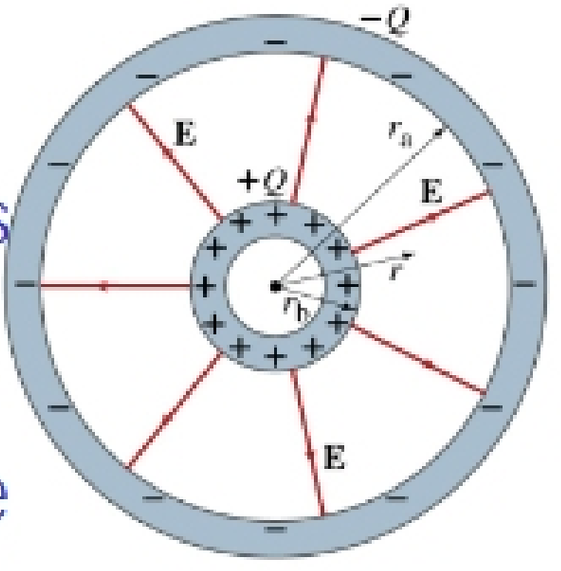
HW5 Ch 25 will be due Thurs Mar. 3

Mar 3 will be ½ period review

Test 1 will be Tues. Mar. 8 on ch 21-25

Example 24 – 3

Spherical capacitor: A spherical capacitor consists of two thin concentric spherical conducting shells, of radius r_a and r_b, as in the figure. The inner shell carries a uniformly distributed charge Q on its surface and the outer shell an equal but opposite charge –Q. Determine the capacitance of this configuration.



Using Gauss' law, the electric field outside a uniformly charged conducting sphere is

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

So the potential difference between a and b is

$$V_{ba} = -\int_a^b \vec{E}\cdot d\vec{l} =$$

$$= -\int_a^b E\,dr = -\int_a^b \frac{Q}{4\pi\varepsilon_0 r^2}\,dr = -\frac{Q}{4\pi\varepsilon_0}\int_a^b \frac{dr}{r^2} = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r}\right]_a^b = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right) = \frac{Q}{4\pi\varepsilon_0}\left(\frac{r_a - r_b}{r_b r_a}\right)$$

Thus capacitance is

$$C = \frac{Q}{V} = \frac{Q}{\frac{Q}{4\pi\varepsilon_0}\left(\frac{r_a - r_b}{r_b r_a}\right)} = \frac{4\pi\varepsilon_0 r_b r_a}{r_a - r_b}$$

Capacitor Cont'd

- A single isolated conductor can be said to have a capacitance, C.
- C can still be defined as the ratio of the charge to absolute potential V on the conductor.
  - So Q=CV.
- The potential of a single conducting sphere of radius r_b can be obtained as

$$V = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right) = \frac{Q}{4\pi\varepsilon_0 r_b} \quad \text{where} \quad r_a \to \infty$$

- So its capacitance is $C = Q/V = 4\pi\varepsilon_0 r_b$
- Although it has capacitance, a single conductor is not considered to be a capacitor, as a second nearby charge is required to form a capacitor.