



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

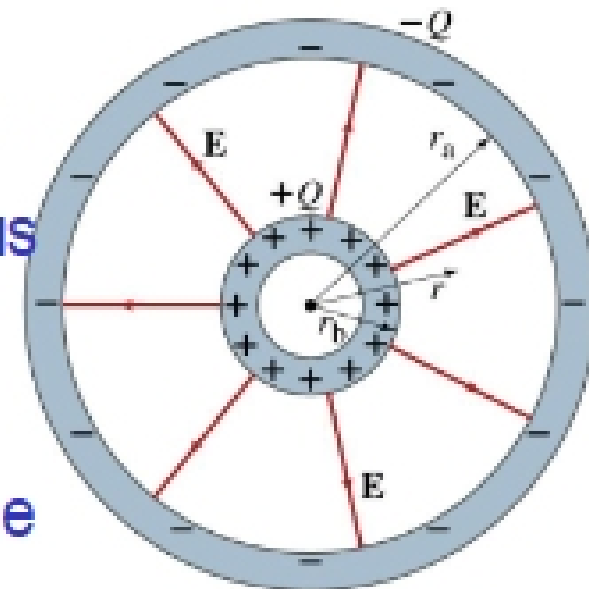
Mar 3 will be 1/2 period review

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

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

So the potential difference between a and b is

$$\begin{aligned} V_{ba} &= -\int_a^b \vec{E} \cdot d\vec{l} = \\ &= -\int_a^b E \cdot dr = -\int_a^b \frac{Q}{4\pi\epsilon_0 r^2} dr = -\frac{Q}{4\pi\epsilon_0} \int_a^b \frac{dr}{r^2} = \frac{Q}{4\pi\epsilon_0} \left(\frac{1}{r} \right)_{r_b}^{r_a} = \frac{Q}{4\pi\epsilon_0} \left(\frac{1}{r_b} - \frac{1}{r_a} \right) = \frac{Q}{4\pi\epsilon_0} \left(\frac{r_a - r_b}{r_b r_a} \right) \end{aligned}$$

Thus capacitance is

$$C = \frac{Q}{V} = \frac{Q}{\frac{Q}{4\pi\epsilon_0} \left(\frac{r_a - r_b}{r_b r_a} \right)} = \frac{4\pi\epsilon_0 r_b r_a}{r_a - r_b}$$



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

$$V = \frac{Q}{4\pi\epsilon_0} \left(\frac{1}{r_b} - \frac{1}{r_a} \right) = \frac{Q}{4\pi\epsilon_0 r_b} \quad \text{where } r_a \rightarrow \infty$$

- So its capacitance is $C = Q / V = 4\pi\epsilon_0 r_b$
- 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.