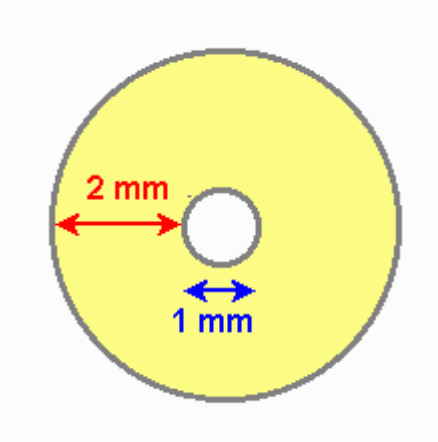
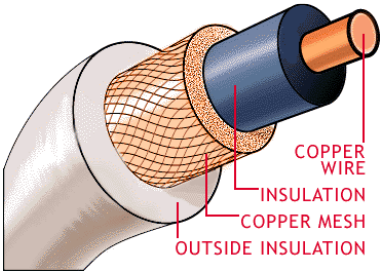
DAY 9 -- Homework



1) A coaxial cable (the "cable" in cable TV) that is 100 m long consists of two cylindrical conductors separated by 2 mm of insulation. The inner conductor has diameter of 1 mm. The inner conductor carries a positive charge (+Q), and the out one an equal but opposite negative charge (-Q).

   Show that only in the yellow region is there any electric field. Use Gauss's Law.



2) In the problem above, if the insulation between the two conductors will break down at 50,000 V/cm, what is the maximum Q can be?

3) A uniform ball of charge has total charge Q and radius R. Find an expression in terms of distance from the center of the ball (r) for the E-field inside the ball (r < R) and outside the ball (r > R).

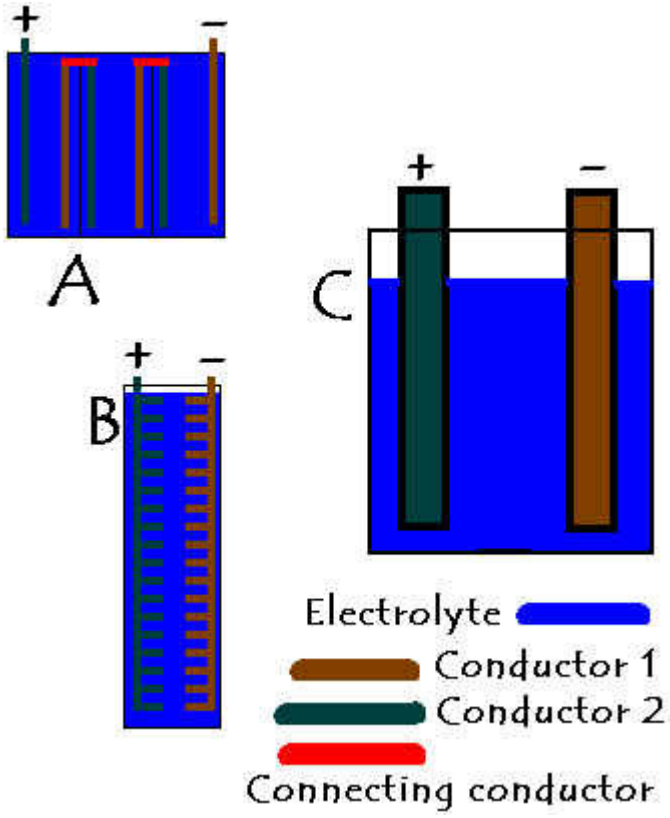
4) Prove that the E-field just outside a flat conducting surface that has charge per unit area of σ is

   $E = 4 \pi k \sigma$

5) What determines the maximum voltage a battery can produce? What determines how long a battery can last under a modest load?

6) Refer to the figure. Which battery (A, B, or C) will last the longest under a given load? Which can produce charge at the greatest rate? Which produces the most voltage?

7) A 12V lead-acid battery is connected to a load. Charge flows from the battery at a rate of 10 C/s. At what rate (in reactions/second) must the chemical reactions that occur within the battery take place in order to supply this current?



8) Lead--207.2 u; Sulfur--32.06 u; Oxygen--15.999 u; Hydrogen--1.0080 u; 1 u = 1.66×10^{-27} kg. In the above problem, calculate the rate at which lead sulfate is formed (in grams/minute). If the battery weighs several pounds, how long will it take before an appreciable amount of the battery's plates are converted to lead sulfate?