Interactive Problem Set 13, SP212 Spring 2013

Topic: 25.5 - 25.7 Energy in an Electric Field, Dielectrics

For problems denoted PROOF, understanding the results and how to use them are essential. You will need to be able to follow the proof and work on your conceptual understanding and the connections of the concepts to the mathematics but these proofs will or appear on exams.

IPS 13.1 (PROOF) By thinking about the energy required to separate the $+q$ and $-q$ charges bit by bit (one dq at a time "crosses the gap") derive expressions for the energy stored in a capacitor. Your final answers can contain any combination of q, V and C.

IPS 13.2 (PROOF) For a parallel plate capacitor, show that this energy can be expressed in a form which involves the electric field strength between the plates and the volume between the plates.

From this define an volume energy density associated with the electric field (denoted u_E). It turns out this result is quite general for any electric field.

IPS 13.3 For each of the four arrangements you sketched in IPS 12, calculate the energy stored in each capacitor network as a whole and also in each individual capacitor. Organize your work in some thoughtful way.

IPS 13.4 A parallel plate capacitor is constructed of two plates each of area 2.00 m^2. They are separated by a distance of 1.40 mm. The material between the plates is characterized by a dielectric constant of 4.40.

- How much energy is stored in this capacitor if charged with a 5.00 V battery?
- What is the charge on each plate?
- What is the electric field strength between the plates?
- What is the energy density between the plates? Answer this in two ways: Method 1: By dividing the total energy by the volume between the plates. Method 2: By using the energy density formula for energy in an electric field.

Prep for next class: WPC Chapter 26.