CAPACITANCE

A question was raised by a good student regarding one of the short questions on Quiz 2 from Spring 2005.

iii) The capacitance of two fixed conductors with free space between them:

      a. Increases if the voltage difference between the conductors decreases.
      b. Increases if the magnitude of the charge on a conductor increases.
      c. Increases if a dielectric material is placed between the conductors.
      d. Increases if the stored electric field energy, W_E, increases.

As you can see, the correct answer is *c* and none of the other answers is correct. To answer a question like this, it is usually easiest to consider a simple case, such as the parallel plate capacitor, whose capacitance is given by $C = \dfrac{\varepsilon A}{d} \, Farads$ where *A* is the area of the plates and *d* is the separation between the plates. ε is the permittivity or dielectric constant of the insulator between the plates. In the question above, the initial configuration is air insulated so that $\varepsilon = \varepsilon_o$. If a dielectric material is placed between the plates, then the capacitance will increase since $\varepsilon \geq \varepsilon_o$ for insulators. Thus, it is clear that *c* is correct. What about the other answers? I suggest that you read over Unit III of the class notes posted on the WebCT page or on the CD that you obtained from my secretary. In that unit, you will see that capacitance only depends on the geometry and materials of the capacitor. Typically capacitance increases with surface area and decreases with separation between the capacitor electrodes, just as is the case for the parallel plate capacitor.

Confusion can result if one looks at other forms of the capacitor equation without recognizing how each term varies. For example, we can find the capacitance from the following expressions $C = \dfrac{Q}{V} = \dfrac{2W_e}{V^2}$. It looks like increasing charge or decreasing voltage would also increase capacitance. However, recall that *Q* is linearly proportional to *V* and W_e is linearly proportional to V^2 and, thus, *C* does not change with any of these other parameters.

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