Warm-Up for April 4th, 2022

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April 4, 2022

1 Memory Bank

1. Electric field and displacement in linear dielectric: $\mathbf{D} = \epsilon \mathbf{E}$.
2. Gauss' Law in dielectrics: $\oint \mathbf{D} \cdot d\mathbf{a} = Q_{\mathrm{f,enc}}$
3. Work, energy in dielectrics: $W = \frac{1}{2} \int \mathbf{D} \cdot \mathbf{E} \, d\tau$
4. Relative permittivity: $\epsilon_r = \epsilon / \epsilon_0$

2 Work, Capacitance, and Energy in Matter

1. Suppose the capacitor in Fig. 1 is filled with a linear dielectric with dielectric permittivity ϵ. Using the formulas in the memory bank, prove that the capacitance *increases* to $C = \epsilon_r C$, relative to the air-filled capacitor.

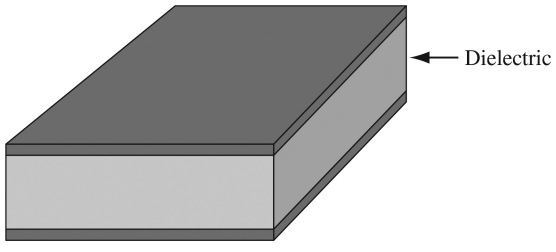

Figure 1: A capacitor area A and separation distance d filled with dielectric.