Warm-Up for April 1st, 2022

Dr. Jordan Hanson - Whittier College Dept. of Physics and Astronomy

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1 Memory Bank

1. The electric displacement ... $\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P}$
2. Gauss' Law for displacement ... $\nabla \cdot \mathbf{D} = \rho_f$, $\oint \mathbf{D} \cdot d\mathbf{a} = Q_{\text{f,enc}}$
3. For a linear dielectric ... $\mathbf{P} = \epsilon_0 \chi_e \mathbf{E}$, $\mathbf{D} = \epsilon_0(1 + \chi_e)\mathbf{E} = \epsilon \mathbf{E}$
4. Relative permittivity/dielectric constant ... $\epsilon_r = 1 + \chi_e = \epsilon/\epsilon_0$
5. Speed of an electromagnetic plane wave in a linear dielectric ... $v = c/n$, where c is the speed of light and $n = \sqrt{\epsilon_r}$.

2 Linear Dielectrics

1. The space between the plates of a parallel-plate capacitor (Fig. 1) is filled with two slabs of linear dielectric material. Each slab has thickness a, so the total distance between plates is $2a$. Slab 1 has a dielectric constant of 2, and slab 2 has a dielectric constant of 1.5. The free charge density on the top plate is σ and on the bottom plate $-\sigma$.
   - (a) Find $\mathbf{D}$ in each slab.
   - (b) Find $\mathbf{E}$ in each slab.
   - (c) Find $\mathbf{P}$ in each slab.
   - (d) Find ΔV between the plates.

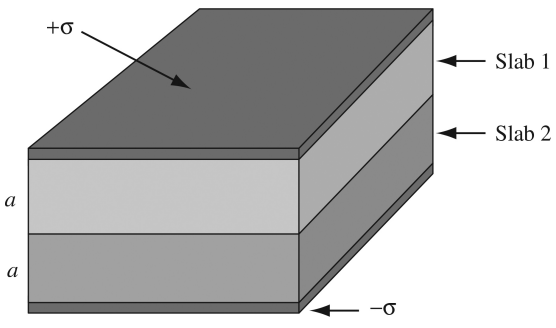

Figure 1: A capacitor with some linear dielectric in between the plates.