Warm-Up for March 30th, 2022

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

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1 Memory Bank

1. Bound surface charge: $\sigma_b = \mathbf{P} \cdot \hat{\mathbf{n}}$

2. Bound charge density: $\rho_b = -\nabla \cdot \mathbf{P}$

3. Potential *inside* a sphere with radius R and $\sigma(\theta) = kP_1(\cos\theta)$ on the surface:

$$V(r,\theta) = \frac{k}{3\epsilon_0} r \cos\theta \tag{1}$$

4. Potential *outside* a sphere with radius R and $\sigma(\theta) = kP_1(\cos\theta)$ on the surface:

$$V(r,\theta) = \frac{kR^3}{3\epsilon_0 r^2} \cos\theta \tag{2}$$

2 Bound Charge and Potential

1. Find the potential and electric field produced by a uniformly polarized sphere of radius R. (a) Note that $\mathbf{P} = P\hat{\mathbf{z}}$, and $\hat{\mathbf{n}} = \hat{\mathbf{r}}$. What are ρ_b and σ_b? (b) Use your knowledge of σ_b and Eqs. 1 and 2 to determine $V(\mathbf{r})$ inside and outside the polarized sphere. (c) **Bonus:** what is $\mathbf{E}$ inside and outside?
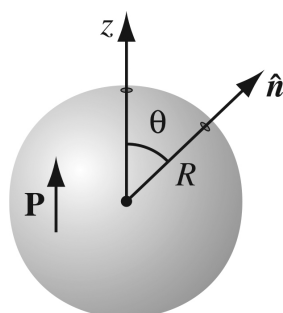

Figure 1: A uniformly polarized sphere.