

Equations

$$\mathbf{F}(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \frac{Qq}{r^2} \hat{\mathbf{n}} \quad \mathbf{F} = QE \quad \hat{\mathbf{n}} = \mathbf{r} - \mathbf{r}'$$

$$\mathbf{E}(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \sum_i \frac{q_i}{r_i^2} \hat{\mathbf{n}}_i \quad \mathbf{E}(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \int \frac{dq}{r^2} \hat{\mathbf{n}} \quad \oint_S \mathbf{E} \cdot d\mathbf{a} = \frac{1}{\epsilon_0} Q_{\text{enc}} \quad \nabla \cdot \mathbf{E} = \frac{1}{\epsilon_0} \rho$$

$$\mathbf{E} = \frac{\sigma}{2\epsilon_0} \hat{\mathbf{n}} \quad \nabla \times \mathbf{E} = 0 \quad V(\mathbf{r}) = - \int_{\mathcal{O}}^{\mathbf{r}} \mathbf{E} \cdot d\mathbf{l} \quad \mathbf{E} = -\nabla V$$

$$\nabla^2 V = -\frac{\rho}{\epsilon_0} \quad V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \sum_i \frac{q_i}{r_i} \quad V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\mathbf{r}')}{r} d\tau' \quad \mathbf{E}_{\text{above}} - \mathbf{E}_{\text{below}} = \frac{\sigma}{\epsilon_0} \hat{\mathbf{n}}$$

$$W = \frac{1}{2} \int_{\mathcal{V}} \rho V d\tau = \frac{\epsilon_0}{2} \int_{\text{all space}} E^2 d\tau$$

$$d\tau = dx dy dz = s ds d\phi dz = r^2 \sin \theta dr d\theta d\phi$$

$$C \equiv Q/\Delta V = Q/(V_+ - V_-) \quad \sigma = -\epsilon_0 \left(\frac{\partial V^{\text{above}}}{\partial n} - \frac{\partial V^{\text{below}}}{\partial n} \right) \Big|_{\text{at the surface}}$$

$$V(r, \theta) = \sum_{l=0}^{\infty} \left(A_l r^l + \frac{B_l}{r^{l+1}} \right) P_l(\cos \theta)$$

$$P_0(x) = 1 \quad P_1(x) = x \quad P_2(x) = \frac{1}{2}(3x^2 - 1) \quad P_3(x) = \frac{1}{2}(5x^3 - 3x)$$

$$\int_0^a \sin\left(\frac{n\pi y}{a}\right) \sin\left(\frac{n'\pi y}{a}\right) dy = \begin{cases} 0 & \text{for } n \neq n' \\ a/2 & \text{for } n = n' \end{cases}$$

$$\int_{-1}^1 P_l(x) P_{l'}(x) dx = \int_0^\pi P_l(\cos \theta) P_{l'}(\cos \theta) \sin \theta d\theta = \begin{cases} 0 & \text{for } l \neq l' \\ \frac{2}{(2l+1)} & \text{for } l = l' \end{cases}$$