Electric Potential (H.1)

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Based on
Engineering Electromagnetics
Hayt & Buck

$$E_\rho = \frac{\rho_L}{2\pi\varepsilon_0\rho}$$

$$\mathbf{E} = \frac{\rho_L}{2\pi\varepsilon_0\rho}\,\mathbf{a}_\rho$$

$$\mathbf{E} = \frac{\rho_s}{2\,\varepsilon_0}\,\mathbf{a}_N$$

$$F_E = QE$$

$$dW = -Q\,\mathbf{E}\cdot d\mathbf{L}$$

$$W = -Q\int_{initial}^{final} \mathbf{E}\cdot d\mathbf{L}$$

$$d\mathbf{L} = dx\,\mathbf{a}_x + dy\,\mathbf{a}_y + dz\,\mathbf{a}_z$$

$$d\mathbf{L} = d\rho\,\mathbf{a}_\rho + \rho\, d\phi\,\mathbf{a}_\phi + dz\,\mathbf{a}_z$$

$$d\mathbf{L} = dr\,\mathbf{a}_r + r\,d\theta\,\mathbf{a}_\theta + r\sin\theta\, d\phi\,\mathbf{a}_z$$

$$W = -Q\int_{initial}^{final} \mathbf{E}\cdot d\mathbf{L}$$

$$V = -\int_{initial}^{final} \mathbf{E}\cdot d\mathbf{L} \quad = \text{potential difference}$$

$$V_{AB} = -\int_{B}^{A} \mathbf{E}\cdot d\mathbf{L} \; V \quad = V_A - V_B$$

$$V = \frac{Q}{4\pi\varepsilon_0 r}$$

$$\oint \mathbf{E} \cdot d\mathbf{L} = 0$$

$$V = -\int \mathbf{E} \cdot d\mathbf{L}$$

$$\text{grad } T = \frac{dT}{dN} \mathbf{a}_N$$

$$\nabla T = \text{grad } T$$

$$\mathbf{E} = -\text{grad } V$$

$$\mathbf{E} = -\left(\frac{\partial V}{\partial x} \mathbf{a}_x + \frac{\partial V}{\partial y} \mathbf{a}_y + \frac{\partial V}{\partial z} \mathbf{a}_z \right)$$

$$\text{grad } V = \left(\frac{\partial V}{\partial x} \mathbf{a}_x + \frac{\partial V}{\partial y} \mathbf{a}_y + \frac{\partial V}{\partial z} \mathbf{a}_z \right)$$

$$\mathbf{E} = -\nabla V$$

$$\nabla V = \frac{\partial V}{\partial x} \mathbf{a}_x + \frac{\partial V}{\partial y} \mathbf{a}_y + \frac{\partial V}{\partial z} \mathbf{a}_z$$

$$\nabla V = \frac{\partial V}{\partial \rho} \mathbf{a}_\rho + \frac{1}{\rho} \frac{\partial V}{\partial \phi} \mathbf{a}_\phi + \frac{\partial V}{\partial z} \mathbf{a}_z$$

$$\nabla V = \frac{\partial V}{\partial r} \mathbf{a}_r + \frac{1}{r} \frac{\partial V}{\partial \theta} \mathbf{a}_\theta + \frac{1}{r \sin\theta} \frac{\partial V}{\partial \phi} \mathbf{a}_\phi$$

$$V = \frac{Qd\cos\theta}{4\pi\varepsilon_0 r^2}$$

$$\mathbf{E} = \frac{Qd}{4\pi\varepsilon_0 r^2}(2\cos\theta\, \mathbf{a}_r + \sin\theta\, \mathbf{a}_\theta)$$

$$\mathbf{p} = Q\mathbf{d}$$

$$W_E = \frac{1}{2}\int_{vol} \mathbf{D}\cdot\mathbf{E}\, dV = \frac{1}{2}\int_{vol} \varepsilon_0 E^2\, dV$$