

# Electric Potential (H.1)

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Based on  
Engineering Electromagnetics  
Hayt & Buck

$$E_{\rho} = \frac{\rho_L}{2\pi\epsilon_0\rho}$$

$$\mathbf{E} = \frac{\rho_L}{2\pi\epsilon_0\rho} \mathbf{a}_{\rho}$$

$$\mathbf{E} = \frac{\rho_s}{2\epsilon_0} \mathbf{a}_N$$

$$F_E = QE$$

$$dW = -Q E \cdot dL$$

$$W = -Q \int_{\text{initial}}^{\text{final}} E \cdot dL$$

$$dL = dx a_x + dy a_y + dz a_z$$

$$dL = dp a_p + p d\phi a_\phi + dz a_z$$

$$dL = dr a_r + r d\theta a_\theta + r \sin\theta d\phi a_\phi$$

$$W = -Q \int_{\text{initial}}^{\text{final}} E \cdot dL$$

$$V = - \int_{\text{initial}}^{\text{final}} E \cdot dL = \text{potential difference}$$

$$V_{AB} = - \int_B^A E \cdot dL \quad V = V_A - V_B$$

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

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

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

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

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

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

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

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

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

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

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

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

$$V = \frac{Qd \cos \theta}{4\pi\epsilon_0 r^2}$$

$$E = \frac{Qd}{4\pi\epsilon_0 r^2} (2 \cos \theta \mathbf{a}_r + \sin \theta \mathbf{a}_\theta)$$

$$P = Qd$$

$$W_E = \frac{1}{2} \int_{vol} \mathbf{D} \cdot \mathbf{E} dV = \frac{1}{2} \int_{vol} \epsilon_0 E^2 dV$$

