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Spring 2015

ELEC 318 – *Electromagnetic Fields*

Lecture 8(a)

Review for Final Exam
Part 1

THE CITADEL, THE MILITARY COLLEGE OF SOUTH CAROLINA
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Example: Potential, Point Charge

A point charge of 5 nC is located at the origin.

If the potential at (0, 6 m, –8 m) is 2 V , determine the potential at $P(-3\text{ m}, 2\text{ m}, 6\text{ m})$.

Assume $\varepsilon = \varepsilon_0$.

$$V_{\text{charge}}^{\text{point}} = \frac{q}{4\pi\varepsilon_0 \left|\mathbf{R} - \mathbf{R}'\right|}$$

Triboelectric Series

TABLE 4.1 The Triboelectric Series

Material	Polarity of Charge
Air	+
Human hands	
Rabbit fur	
Glass	
Mica	
Human hair	
Fur	
Lead	
Silk	
Aluminum	
Paper	
Cotton	
Steel	
Wood	
Amber	
Wax	
Hard rubber	
Nickel, copper	
Gold	
Polyester	
Polyethylene	
PVC (vinyl)	
Silicon	
Teflon	−

Example: E Field, Potential, Work

Given the electric field intensity (at right),
(a) determine if this field is irrotational, and
(b) determine the work done in moving a –2 μC charge from (0, 5 m, 0) to (2 m, –1 m, 0) along the straight-line path between these points.

$$\mathbf{E} = \left(3x^2 + y\right)\hat{\mathbf{x}} + x\,\hat{\mathbf{y}} \quad \frac{\text{kV}}{\text{m}}$$

$$\nabla \times \mathbf{E} = \begin{vmatrix} \hat{\mathbf{x}} & \hat{\mathbf{y}} & \hat{\mathbf{z}} \\ \dfrac{\partial}{\partial x} & \dfrac{\partial}{\partial y} & \dfrac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix}$$

$$V_{AB} = \frac{W}{q} = -\int_A^B \mathbf{E} \cdot d\mathbf{l}$$

Lightning

FIGURE 7.22 A cloud-to-ground lightning.

Example: Point Charges, Energy Stored

Three point charges and their locations are given:
–1 nC at (0, 0, 0)
+4 nC at (0, 0, 1 m)
+3 nC at (1 m, 0, 0)

Determine the electrostatic energy stored in this system.

$$V_{AB} = \frac{W}{q} \qquad V_{\text{charge}}^{\text{point}} = \frac{q}{4\pi\varepsilon_0 \left|\mathbf{R} - \mathbf{R}'\right|}$$

Magneto-Resonance Imaging

Example: Current & Current Density

Determine the total current passing through the hemispherical shell given below, for the current density also defined below.

$$R = 20 \text{ cm}, \quad 0 < \theta < \pi/2, \quad 0 < \phi < 2\pi$$

$$\mathbf{J} = \frac{1}{R^3}\left(2\cos\theta\ \hat{\mathbf{R}} + \sin\theta\ \hat{\boldsymbol{\theta}}\right) \quad \left(\frac{\text{mA}}{\text{m}^2}\right)$$