

Transformed E&M I materials

Potential (Griffiths Chapter 2)

TIMELINE

Prof A covers this in lectures 7.

Prof B. covers this in lecture 6.

Transformed course covered in lectures 6-8.

LEARNING GOALS

1. Students should be able to state two ways of calculating the potential (via the charge distribution and via the E-field); indicate which is the appropriate formulation in different situations; and correctly evaluate it via the chosen formulation.
 2. Students should be able to calculate the electric field of a charge configuration or region of space when given its potential.
 3. Students should be able to state that potential is force per unit charge, and give a conceptual description of V and its relationship to energy.
 4. Students should be able to explain why we can define a vector potential V (because the curl of E is zero and E is a conservative field).
 5. Students should be able to defend the choice of a suitable reference point for evaluating V (generally infinity or zero), and explain why we have the freedom to choose this reference point (because V is arbitrary with respect to a scalar – its slope is important, not its absolute value).
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CLASS ACTIVITIES

Discussion

Questions for Lecture (from UIUC)

- 1.) What two mathematical conditions *uniquely* specifies the nature of an

arbitrary, but differentiable vector field $\mathbf{F}(\mathbf{r})$ that goes to zero faster than $1/r$ as $r \rightarrow \infty$? Answer: $\nabla \cdot \mathbf{F}(\mathbf{r})$ and $\nabla \times \mathbf{F}(\mathbf{r})$. Why? (See Griffiths Appendix B re: the Helmholtz theorem).

2.) Is the absolute potential $V(\mathbf{r})$ at an arbitrary point in space (\mathbf{r}) a physically meaningful quantity? Or are only potential differences $V(\mathbf{r}_b) - V(\mathbf{r}_a)$ physically meaningful?

Whiteboard

Griffith's Triangle

Let them whiteboard the "Griffiths' triangle", with E, rho, and V on vertices. Asked them to fill in how to go from one to the other.

Discussion

Square of Electricity

The relationships between U, V, E and F are elucidated by putting them in a square. Started class with a square on the board, E upper left, F lower left, V upper right (and a blank which became PE lower right later on), and talked about how "E is to F as V is to PE" and "E is to V as F is to PE", and so on. (Basically, connecting back to 2210 and 1110 ideas). See "Electric Field Map" and "Square of Electricity" in "Activity Resources" folder.

Demo

Voltage & lightning

(CU Demo # 5B30.30)

Using the van de Graaf generator, the formation of lightning is demonstrated.

Tutorial

Potential Differences

Paul van Kampen – Dublin University (Tutorials 9-16, page 7)

In document "Tutorials 9-16"

Nice tutorial on potential differences using a charged rod, and then finding E field.

Tutorial

Electrostatic Potential Due to Two Charges

In this activity, students working in small groups to write the electrostatic potential in all space due to two charges separated by a distance d . The groups are then asked to expand this potential in a series, either on the axis or the plane of symmetry, and either close to the center of the charge distribution or far away.

Tutorial

Electrostatic Potential due to a Ring of Charge

Oregon State University

In this activity, students working in small groups to write the electrostatic potential in all space due to a charged ring. The groups are then asked to expand this potential in a series, either on the axis or the plane of symmetry, and either close

to the center of the charge distribution or far away.