Electrodynamics (PHYS 480) Second Guide

Fall 2007 v1.0

In the second week we'll leave Chapter 1, but it is a great resource for later chapters. You may find some of the developments more immediate once we encounter their use in the physics.

Chapter 2 is the first of what will be five chapters on the kinematics of electromagnetism. This study of electro- and magneto- statics will comprise about half the material of the seminar. And we start with the most familiar electric field. "The Problem" that we are faced with (or, rather, electrodynamics is faced with) is stated in the first paragraph: Given a set of charges, find the electromagnetic fields. Many of the techniques introduced in this and later chapters help us with this problem.

Much of this material is review. As the week progresses, we'll discuss where we are and whether we should speed up, slow down, or keep the pace as is. If we slow down, some of the problems will be moved to next week. In any case I recommend pushing along as far as you can over the weekend.

Problems of note: Starred (*) problems are required.

(1) * 2.1 Use superposition and symmetry to "just write down the answer" (although justify your result of course!)
(2) * 2.2 What is the object in part (b) called? (The problem is nice because of the use of limits - a very, very useful technique.)
(3) * 2.6 integration and limits
(4) 2.10 look for an easy way (there's a trick)
(5) * 2.11 Gauss's law and spherical symmetry: This begins a series of important and basic (in the sense of fundamental) problems. You can also try the "alternate charge density track" of 2.8, 2.12, 2.18, 2.21.
(6) * 2.13 Gauss's law and cylindrical symmetry
(7) * 2.15 Spherical symmetry, with a varying density
(8) * 2.20 Use curl to weed out impossible electric fields. Choose your path so the integration is as easy as possible.
(9) * 2.21 Finding potential via integration in spherical symmetry
(10) * 2.25 Find the potential from the electric field. Only work through the configuration of Fig 2.34 (c)
(11) * 2.31 the work required to assemble charges
(12) * 2.32 (a) and (b) only. The variety of ways to finding energy! Check to be sure you have 2.21 correct before starting this one.
(13) * 2.35 Finding the induced charges
(14) * 2.37 Calculating the electrostatic pressure of a capacitor
(15) 2.49 The electrostatics of a "new force". BTW this is the default form of any new force (such as the "Fifth Force" that you might have read about in the press some years ago.
(16) * 2.50 Which three inputs determine the field? Hint: If you have a PDE can you find a unique solution with only the equation?

Notes on text:

- page 58 Griffiths very nicely states the goal: Given the sources, electrodynamics determines the fields and forces.
- page 66 If (1) "Field lines begin on positive charges and end on negative ones" and (2) Positive and negative charges "occur in exactly equal amounts, to fantastic precision, . . . " then how is it possible to have field lines extending to infinity?
- pages 68-9 You, of course, did this derivation the "other way." Note that the physics you have to invoke is different depending on the direction of your derivation, e.g. the total charge was

already defined in Griffiths derivation while the density was already defined in the derivation we did in class.

- pages 70-76 absolutely core material
- pages 79-81 a very nice set of comments on the potential
- pages 88-90 boundary conditions! Are these new or already familiar?
- page 90 This section on energy is worth reading once and then reading again as he leaves some important comments to the end. Why does that surface term drop out?

Material of note:

- The characters and their relations: Griffiths has introduced a number of "new" objects $\mathbf{E}, V, \rho \ldots$ Describe in physical terms what these things are (be conservative in these definitions) then describe the mathematical relations.
- Gaussian surfaces: Use the arguement in the three situations including problems 2.11 and 2.13.
- Define electrostatic energy. Include careful discussions of the "inconsistency" between equations 2.45 and 2.42 and on where the energy is stored. Why does that surface term drop out? Consider 2.34.
- Discuss conductors - properties and induced charges. Read the articles in the "By the way" footnote on page 98.
- Discuss boundary conditions of the $\mathbf{E}$ and V and the section 2.5.3