Physics 3201
Problem Set 6

Due: Thursday, October 10. Solutions will be posted on Monday, October 14, although I encourage you to complete the problems before then if at all possible. This problem set is quite short, to allow study time to prepare for the first exam.

Notes: This problem set covers Sections 3.1–3.2 of Griffiths. You should be reading Sections 3.2–3.3, which will be discussed next in lecture.

Exam 1: The first hour exam is scheduled for Thursday, October 10, from 9:30-10:45. It will cover the subjects corresponding to Problem Sets 1–5, most of which are discussed in Chapters 1 and 2 of Griffiths. No notes are permitted, although you will be provided with copies of all of the formulas on the inside covers of Griffiths.

Study Session: There will be an optional meeting at 6 PM on Wednesday Oct. 9, for those who have questions that came up while preparing for the exam. A quick review will also be optionally presented. We will meet in either in room P407, or in one of the nearby rooms if it is occupied.

1.

(a) Griffiths, problem 2.60 (new in 4th Ed.). I recommend solving this by initially considering where in space the electric field is different from that of an isolated point charge. If you integrate E^2 over this region to find the difference in the electrostatic energy stored in the field, with vs. without the conducting shell, you can determine the work required to remove the charge to infinity.

(b) In his latest Instructor's Solution Manual, Griffiths gives an incorrect solution to this problem that depends only on a, not b. He proceeds by adding up the energy needed to build up the system in sequential pieces, starting with no energy to bring in the point charge, followed by energy $-qV$ to bring in the induced charge $-q$ that's distributed on the inner surface of the shell. Finally, he states that no additional work is needed to bring in the induced charge $+q$ distributed on the outer surface at $r = b$, because the net field from the other two charges is zero for $r > b$. What is wrong with this last argument? Is there a related problem with the rest of the argument, too? Show that this approach can also give the right answer, if done correctly.

2. Griffiths, problem 3.3.

3. Griffiths problem 3.9 (problem 3.8 in 3rd Ed.).

4. Griffiths problem 3.11 (3.10 in 3rd Ed.). *Hint*: This can be a little tricky, particularly the last question about angles other than 90°. For the first part of the problem, try using three image charges, keeping things symmetric, and don't forget that image charges *cannot* be placed within the physical region in which you are trying to solve for V. If you do that, you've solved for a different problem altogether.

Honors: Add problem 3.50. We already used the result of this "reciprocity" theorem in Problem Set 5, but this is the proof of the theorem itself. We will meet next on Friday, October 11.