Princeton University
Ph304 Problem Set 11
Electrodynamics

(Due in class Wednesday Apr. 30, 2003)

Instructor: Kirk T. McDonald, Jadwin 309/361, x6608/4398
kirkmcd@princeton.edu
http://puhep1.princeton.edu/˜mcdonald/examples/

AI: Matthew Sullivan, 303 Bowen Hall, x8-2123
mtsulliv@princeton.edu

Problem sessions: Sundays, 7 pm, Jadwin 303

Text: *Introduction to Electrodynamics, 3rd ed.*
by D.J. Griffiths (Prentice Hall, ISBN 0-13-805326-X, now in 6th printing)
Errata at http://academic.reed.edu/physics/faculty/griffiths.html

Reading: Griffiths chap. 10.

1. Griffiths' prob. 10.9, part a) only. Verify that the electric and magnetic fields first seen by an observer at distance $\mathbf{r}$ from the wire obey the radiation condition $\mathbf{E} = c\mathbf{B} \times \hat{\mathbf{r}}$. That is, consider the fields at time $r/c + \epsilon$. Show also that for $t \gg r/c$ the magnetic field is that given by the instantaneous magnetostatic value: $B \approx \mu_0 kt/2\pi r$. However, the electric field never drops to its instantaneous static value (zero), because the ever increasing magnetic field continually induces more electric field.

2. Griffiths' prob. 10.14. It may be simpler to proceed from eq. (10.39) than from (10.42).

3. Griffiths' prob. 10.24. Hint: At what time does the observer at the origin first become aware of the fields of the moving charge?

4. Griffiths' prob. 10.26. For another example of how electromagnetic field momentum is needed for Newton's 3rd law to be satisfied in electrodynamics, see http://puhep1.princeton.edu/˜mcdonald/examples/transmom2.pdf

5. Griffiths' prob. 11.3. The "dipole" is that of sec. 11.1.2. Verify that $\sqrt{\mu_0/\epsilon_0} = 377\ \Omega$.

6. Griffiths' prob. 11.4. Besides following Griffiths' hint, another way to work the problem is to write the dipole moment as $\mathbf{p} = p_0(\hat{\mathbf{x}} + i\hat{\mathbf{y}})e^{-i\omega t}$, and use Griffiths' eqs. (11.56) and (11.57).