

# Physics 106b: Electrodynamics

## Problem Set 3

Due: Friday 4:00 pm, March 6, 2009

Remember: Late homework will be granted 50% credit up to one week late, unless you have a note from the Dean or a health official.

**Reading:** Griffiths Chapter 4

**Problems:**

1. Prove, for odd  $l$ ,

$$P_{l+1}(0) = (-1)^{\frac{l+1}{2}} \frac{l!!}{(l+1)!!}$$

and

$$\int_0^1 P_l(x) dx = \frac{(l-2)!!}{(l+1)!!} (-1)^{\frac{l-1}{2}}$$

where  $P_l(x)$  are the Legendre polynomials, and  $!!$  means double factorial, e.g.  $5!! = 5 \times 3 \times 1 = 15$ , with  $(-1)!! \equiv 1$ . You may find the Legendre recursion relations helpful.

2. A thin spherical shell has its upper hemisphere maintained at potential  $V_0$  and its lower hemisphere at potential  $-V_0$ . Find the potential everywhere inside the sphere.
3. Consider a physical dipole, with  $+q$  located at  $z = d/2$  and  $-q$  at  $z = -d/2$ . Find the potential along the  $z$ -axis for  $|z| < d/2$ . Using a Legendre expansion find the potential off the  $z$ -axis for  $r < d/2$ .
4. Two concentric spherical surfaces have radii  $a$  and  $b$ . If the potential on the inner surface is given by  $V_a P_3(\cos\theta)$ , and the potential on the outer surface is given by  $V_b P_5(\cos\theta)$ , find the potential in the region between the two surfaces. ( $V_a$  and  $V_b$  are constants.)
5. Griffiths 4.6
6. Griffiths 4.8