Due date: Wednesday, Oct. 4

Griffiths reading: 2.3.4; 2.4.1-2

Note that the first hour exam will be on Wed. Oct. 11. See website for details. There will be no homework handed out next week.

1. [3 points] Based on our discussion of Dirac delta functions, describe in words or with a quick sketch the nature of the following charge distributions:
   (a) \( \rho(r) = q_0 \delta^3(r - a\hat{x} + a\hat{y}) \)
   (b) \( \rho(s, \phi, z) = \sigma_0 \delta(s - a) \)
   (c) \( \rho(s, \phi, z) = \lambda_0 \delta(s - R) \delta(|z| - h) \)
   (The last one is a little tricky; there are two disjointed pieces to the charge distribution...)

2. [4 points] Griffiths 2.23 (spherical shell revisited).
   Since this comes from Sec. 2.3.2, the idea is to use Eq. (2.21), not (2.29). Use the results of previously assigned Problem 2.15 from HW Set 3.

3. [3 points]
   Suppose the electric potential filling some region of space is spherically symmetric and is given by \( V(r) = Ar^\gamma \) for constant prefactor \( A \) and exponent \( \gamma \). (For the purposes of this problem, don’t worry about what is going on near the origin.) Use Poisson’s equation (2.24) to find the charge density \( \rho \) in this region.
   There are two values of \( \gamma \) that make the result vanish; what are they?

4. [4 points]
   (a) Use Eq. (2.29) [in the form of the second of the equations in (2.30)] to find the potential at point P a distance \( z \) above the center of the charged disk in Fig. 2.34(c).
   (An integral is required.)
   (b) Use this result and \( \mathbf{E} = -\nabla V \) to find the electric field \( E_z(z) \) on the vertical axis passing through the disk.
   (c) [Independent of Part (b).] Use the result of Part (a) to say how much work would need to be done to bring a point charge \( Q \) from infinity and place it at the center of the disk.

5. [3 points] Griffiths 2.30 (check boundary conditions).
   Do parts (a) and (b) only; skip part (c)!

6. [3 points] (This is a simplified version of Problem 2.32, and requires a bit of mechanics as well as E&Fodic.) Two point particles with different positive charges \( q_A \) and \( q_B \) but equal masses \( m \) are released from rest when they are a distance \( a \) apart, and fly off in opposite directions. Which will be going faster when they are infinitely far apart? What will be the final velocity of each particle?