Week 3 Worksheet
Electrostatics

Jacob Erlikhman

February 6, 2026

Exercise 1. Using Dirac delta functions in the appropriate coordinates if necessary, express the following charge distributions as three-dimensional charge densities $\rho(\mathbf{r})$.

a) In spherical coordinates, a charge Q uniformly distributed over a spherical shell of radius R.

b) In cylindrical coordinates, a charge λ per unit length uniformly distributed over a cylindrical surface of radius b.

c) In cylindrical coordinates, a charge Q spread uniformly over a flat circular disc of negligible thickness and radius R.

Exercise 2. Two infinite parallel plates carry equal and opposite uniform charge densities $\pm\sigma$. Put the positively charged plate in the (x, y)-plane and the negatively charged one at $z = 1$ above it. Find the electric field in each of three regions: $z < 0$, $0 < z < 1$, and $z > 1$.

Exercise 3.

a) The potential at a point $\mathbf{r}$ is defined as

$$V(\mathbf{r}) = -\int_{\mathcal{O}}^{\mathbf{r}} \mathbf{E} \cdot \mathrm{d}\boldsymbol{\ell},$$

where $\mathcal{O}$ is some reference point. Explain why this is well-defined (i.e. unambiguous, up to the choice of $\mathcal{O}$).
Hint: Use Stokes' theorem.

b) An infinite plate carries a uniform charge density σ. Find the potential everywhere.
Hints: Recall that the electric field is $E = \sigma/2\varepsilon_0$. Where would you put your reference point $\mathcal{O}$?