PHYS 2020: Homework 3 (due Monday Oct. 5)

Reading: Purcell & Morin, Chapters 1.9–1.14.

Problem 1 (15 points): Suppose you have two infinite planes with uniform surface charge σ that intersect at a 90° angle, one in the x-y plane and one in the y-z plane, shown in Fig. 1 (left).

(a) What is the electric field $\vec{E}$ in each of the four regions? Sketch the electric field lines. **(10 points)**

(b) Draw a Gaussian surface that is normal† to $\vec{E}$ and verify that Gauss's law is satisfied. **(5 points)**

† Note your Gaussian surface may include areas that are parallel to $\vec{E}$ that do not contribute to the flux.

Problem 2 (15 points): Consider a cube, of side length a, with a point charge q located at the center of the cube. What is the electric flux Φ_E through one face of the cube?

Problem 3 (20 points): A solid charged sphere has radius R and total charge Q. However, the charge density is **not uniform** over the volume of the sphere. Assuming that the charge density $\rho(r)$ depends only on r, the radial distance from the center of the sphere, determine $\rho(r)$ such that E is constant throughout the sphere.

Problem 4 (20 points): Consider a semi-infinite cylindrical tube centered along the positive z axis, as shown in Fig. 1 (right). The tube is hollow and open at the ends, and has radius R and uniform surface charge σ. Compute $\vec{E}$ at the point $\vec{r} = (0, 0, 0)$.

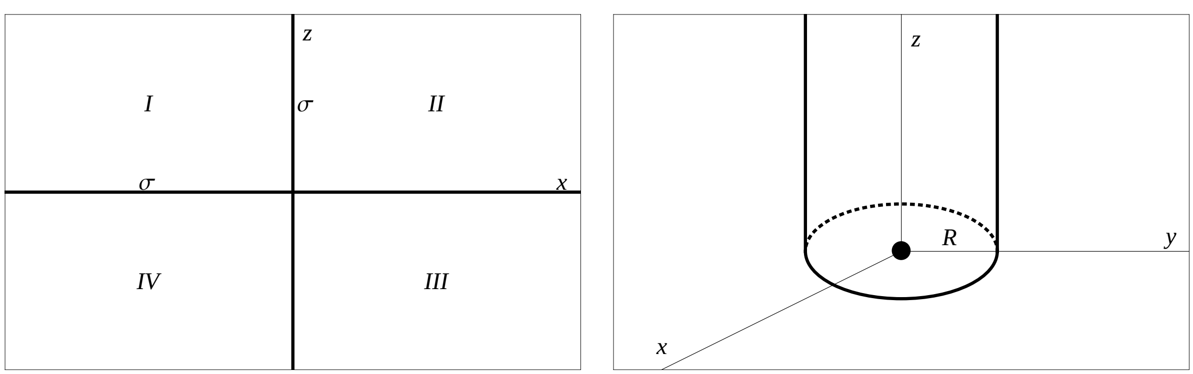

Figure 1: **Left:** Cross section of intersecting infinite charged planes for problem 1. **Right:** Hollow tube of radius R and surface charge σ for problem 4. Compute $\vec{E}$ at the origin, shown by the black dot.