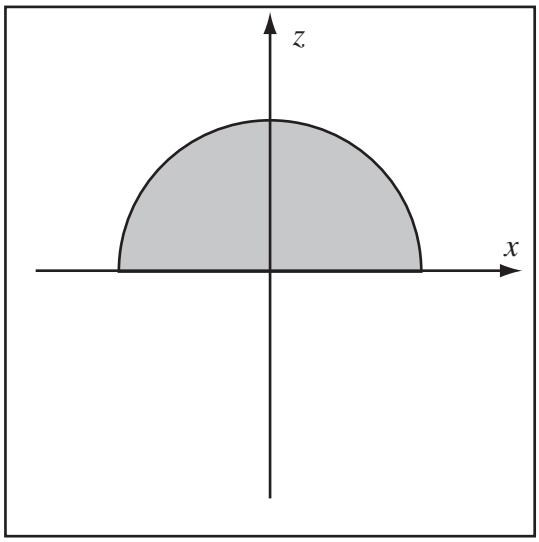
Electricity and Magnetism - Test 1 - Spring 2014

Work four of the six problems. Place the problems in the order you wish them graded. The first two problems form the first half test; the second two problems form the second half test.

Problem 1.1 Compute the electric potential at the origin of an non-uniformly charged half-sphere with charge density $\rho(r)$ where $\rho(r)$ is non-zero at points $r < a$ and $z > 0$. ρ is given by

$$\rho = \frac{\gamma \sin(\theta)}{r}$$

and γ is a constant.



Problem 1.2 Consider the electric field $\vec{E} = \gamma \cos^2(\theta)\hat{r}$ given in spherical coordinates. Is this a possible electrostatic field? If not, why? If it is, find the charge density that produced the field.

Problem 1.3 Consider the non-uniform volume change $\rho(z) = \gamma \sin(kz)$ for $-a < z < a$ where γ is a constant and $k = \pi/a$. $\rho = 0$ for $z < -a$ and $z > a$. The charge density is constant in the x and y directions. Compute the electric field everywhere.

Problem 1.4 A non-uniformly charged disk lies in the $x - y$ plane centered at the origin. The disk has charge density $\sigma = \gamma/s$ in cylindrical coordinates and is of radius a. Compute the electric field a distance R along the positive z axis.

Problem 1.5 Calculate the energy stored in the electric fields INSIDE a uniform spherical volume charge of radius a and charge density ρ.

Problem 1.6 A cylindrically symmetric system has a uniform volume charge density ρ for $s < a$ where a is the radius of the cylinder. It has $\rho = 0$ for $a < s < b$ and $s > b$. It has a cylinder concentric with the volume charge density of radius b and uniform surface charge density σ. Compute the electric field everywhere.