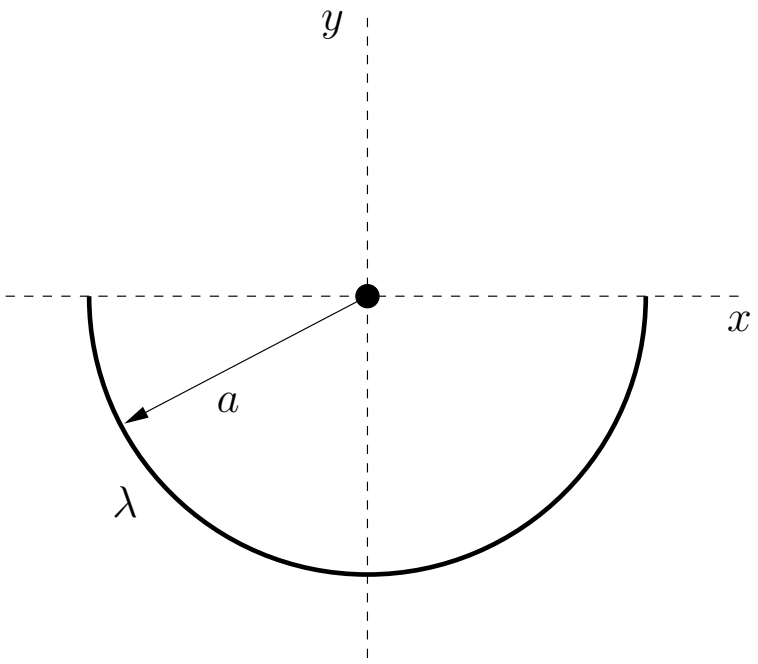
PHYS 333 — Exam #1
Friday, September 20, 2013

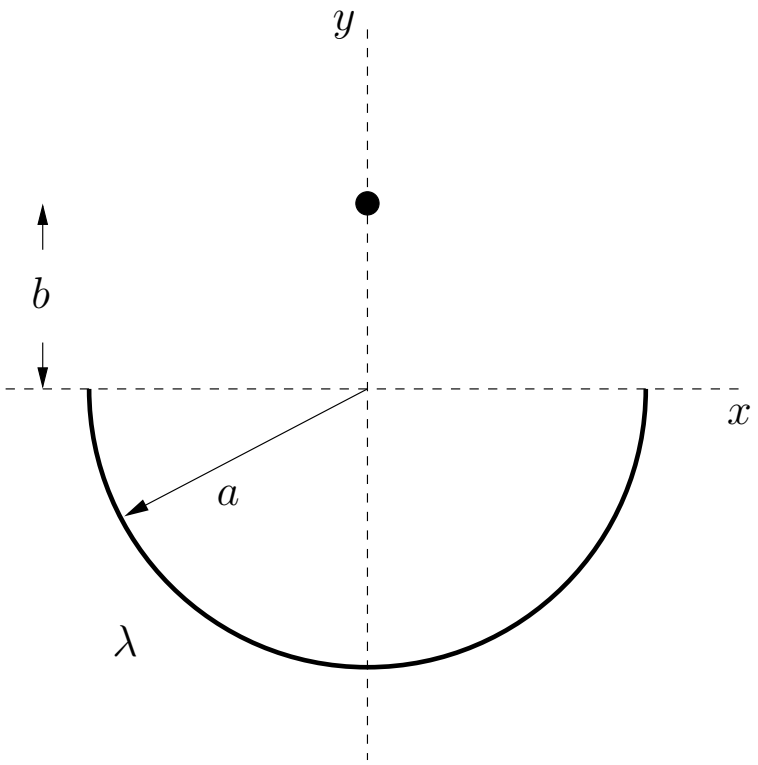
Name:_____

1. (29 pts) Charge is uniformly distributed along the illustrated semi-circle with linear charge density λ and radius a. The semi-circle lies in the x-y plane.

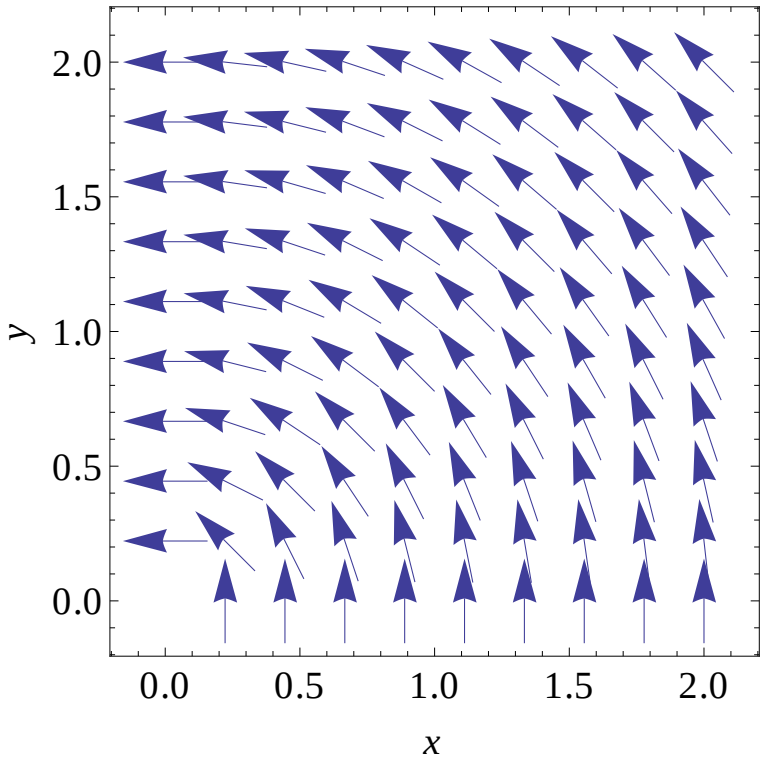
   (a) Determine an expression for the electric field at the origin.



(b) Determine an expression for the electric field at the illustrated point located a distance b above the origin on the y-axis. You do not need to evaluate any integrals that arise in part (b), but the integrand, the variable(s) of integration, and the limits should be given in terms of the variables defined in the problem statement, along with any necessary physical constants.



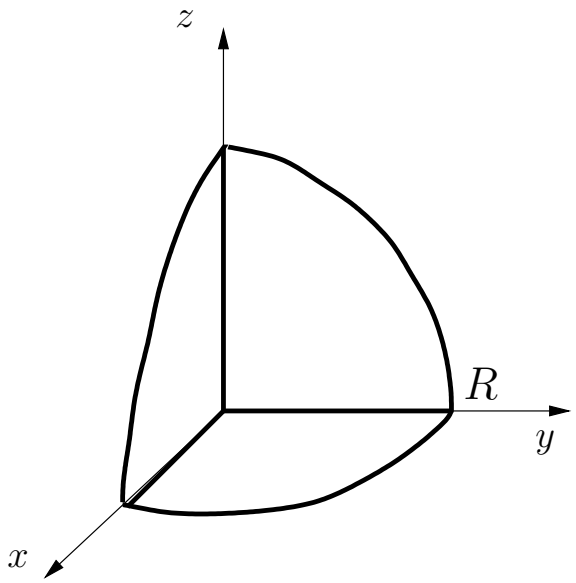
2. (13 pts) Consider the illustrated vector field in the x-y plane. At the point with coordinates $x = 1$, $y = 1$, is the z-component of the curl positive (out of the plane), negative (into the plane), or zero? Explain your reasoning.



3. (29 pts) Consider the following vector field:

$$\mathbf{v}(\mathbf{r}) = r^2 \cos\phi\, \hat{\boldsymbol{\theta}} - r^2 \cos\theta \sin\phi\, \hat{\boldsymbol{\phi}}$$

Test the Divergence Theorem, a.k.a. the Fundamental Theorem for Divergences, for the illustrated octant of a sphere of radius R surrounding the origin, with its base lying in x-y plane.



4. (29 pts) An infinitely long solid cylinder with radius a has a *nonuniform* charge density $\rho = ks$, where s is the perpendicular distance from the axis of the cylinder, and k is a constant. Find the electric field at all points inside the cylinder.