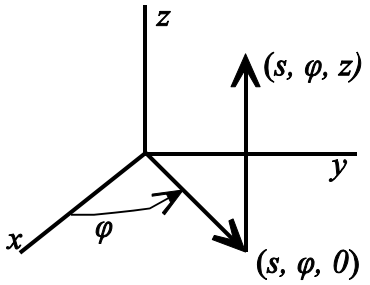
Phys. 221 – E & M- I – Test 1 – Feb. 18, 2005

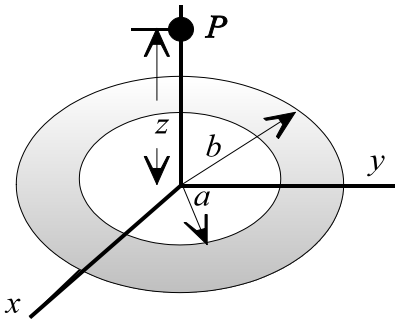
1. (25 pts) An electrostatic field is given by $\vec{E} = C\left[s^2(2+\sin^3\phi)\hat{s} + s^2(\sin^2\phi\cos\phi)\hat{\phi} + 3z\hat{z}\right]$, where C is a constant with the appropriate units.



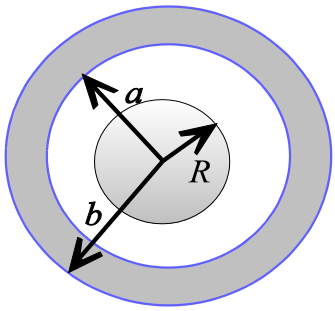
a) Verify that this is a possible electrostatic field.

b) Find the potential, using the *origin* as your reference point. Use the indicated path from the origin to the point; that is, go from *0* to *s* along the path with φ fixed and then from *0* to *z* up to the point.

2. (25 pts) Find the electric field at a distance *z* above the center of a flat circular disk of inner radius *a* and outer radius *b* which carries a uniform surface charge σ. The disk is in the *xy*-plane.



3. (25 pts) A metal sphere of radius *R*, carrying a charge *q*, is surrounded by a thick concentric metal shell of inner radius *a* and outer radius *b*. The shell carries no net charge.



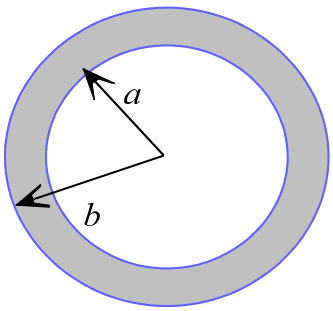
a) Find the surface charge density σ at *R,* at *a*, and at *b*.

b) Find the potential at the center, using infinity as the reference point.

c) Now the outer surface is touched to a grounding wire, which lowers its potential to zero. How do the answers to (a) and (b) change?

4. (25 pts) A hollow spherical shell carries a charge density

$$\rho(r) = \frac{A}{r} \quad \text{for } a \le r \le b \text{, where } A \text{ is a constant.}$$



a) Find the electric field in each of the three regions:
(*i*) $r < a$, (*ii*) $a < r < b$, (*iii*) $r > b$.

b) Find the energy stored in the distribution, *i.e.,* the work done to assemble the charge distribution.