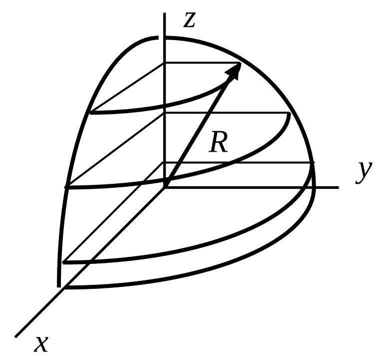
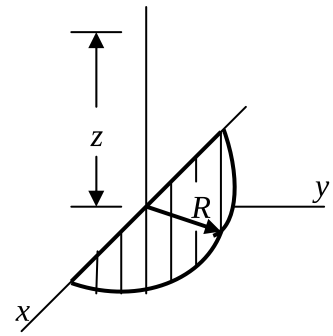
Phys. 221 – E & M I – Test 1 – Feb.12, 2007



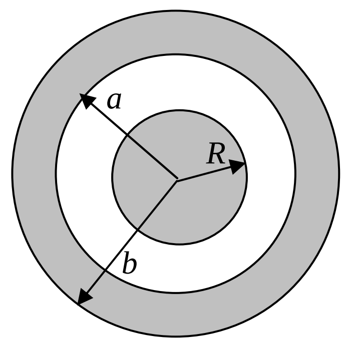
1.(25 pts) Given the vector function:

$$\vec{v} = (r\cos^2\theta)\,\hat{r} - (r\cos\theta\sin\theta)\,\hat{\theta} + (3r\cos\phi)\,\hat{\phi}$$

Calculate the integral $\oint \vec{v} \cdot d\vec{a}$ using as your enclosed volume the octant of a sphere of radius *R*.



2.(25 pts) Find the electric potential at a distance *z* above a charge distribution which consists of a half disk of radius *R* lying in the *xy*-plane. The half disk has a surface charge density given by $\sigma(s) = As^2$, where *A* is a constant and *s* is the distance from the *z*-axis.



3.(25 pts) A spherical system consists of an inner spherical ball of charge of radius *R* surrounded by a thick spherical shell of charge of inner radius *a* and outer radius *b*, so that $R < a < b$. The volume charge densities on the inner spherical ball and outer spherical shell are given by:

$$\rho(r) = A \qquad 0 < r < R$$

$$\rho(r) = -B/r^2 \qquad a < r < b$$

where *A* and *B* are both positive constants chosen in such a way as to make the total charge on the whole system equal to zero.

Find the electric field in each of the four regions; $r < R$; $R < r < a$; $a < r < b$; $r > b$.

4.(25 pts) A sphere of radius *R* carries a charge density $\rho(r) = Ar^2$, where A is a constant.

a) Determine the electric field as a function of r inside and outside the sphere.

b) Determine the electric potential as a function of r inside and outside the sphere.

c) Determine the energy stored in the charge distribution, *i.e.*, the work done to assemble the spherical charge distribution.