EMSpring01B

A metal sphere of radius a is placed inside a grounded hollow metal sphere of radius b. The total charge on the inner sphere is q.

(1) Consider first the simple case in which the two spheres are concentric.

(a) Find the potential in the space between the spheres.

(b) Find the surface charge density σ on the inner sphere.

(c) Find the net electrostatic force F acting on the inner sphere, indicating magnitude and direction.

(2) Now treat the case in which the two spheres are not concentric, but assume that the departure from spherical symmetry is small as follows (see figure below): The distance between the centers of the two spheres is c, where $c \ll a$, $c \ll b$ and $c \ll |b - a|$. In the following, work to linear order in c, neglecting terms involving second and higher powers.

(a) Find the potential in the space between the spheres.

Hint: Work in spherical polar coordinates centered on the inner sphere, with the z axis connecting the centers, as shown in the figure below; θ is the polar angle. Use the fact that $R \approx b + c\cos(\theta)$ and that to linear order in c, departures from spherical symmetry need only be kept to linear order in $\cos(\theta)$.

(b) Find the surface charge density σ on the inner sphere.

(c) Find the net electrostatic force F acting on the inner sphere, indicating magnitude and direction.