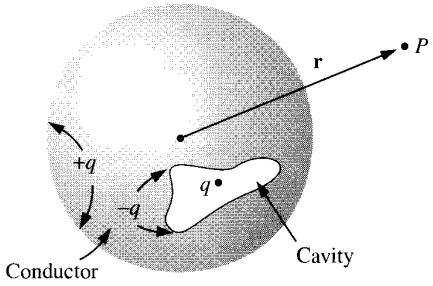
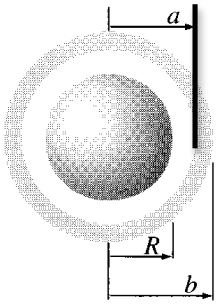
PHYS 507
HANDOUT 4 - *Questions on Conductors and Capacitors*

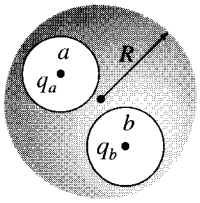
4.1 An uncharged conductor with a weird shape has a cavity inside, In the cavity there is a charge *q*. What is the field outside the sphere?



4.2 A metal sphere of radius *R,* carrying charge *q,* is surrounded by a thick concentric metal shell (with 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 it potential to zero (same as infinity). How do your answers to (a) and (b) change?



4.3 Two spherical cavities, of radii *a* and *b,* are hollowed out from the interior of a (neutral) conducting sphere of radius *R.* At the center of each cavity a point charge is placed – call these charges q_a and q_b. (a) Find the surface charge densities σ_a, σ_b and σ_R. (b) What is the field outside the conductor? (c) What is the field within each cavity? (d) What is the net force on q_a and q_b? (e) Which of these answers would chance if a third charge q_c were brought near the conductor?

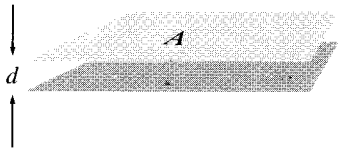


4.4 Two large metal plates (each of area *A*) are held a distance *d* apart. Suppose we

put a charge Q on each plate; what is the electrostatic pressure on the plates?

4.5 A metal sphere of radius R carries a total charge Q. What is the force of repulsion between the "northern" hemisphere and the "southern" hemisphere?

4.6 Find the capacitance of a «parallel» plate capacitor consisting of two metal surfaces of area A held a distance d apart.



4.7 Find capacitance of two concentric spherical metal shells, with radii a and b.

4.8 Find the capacitance per unit length of two coaxial metal cylinder tubes of radii a and b.

4.9 Prove that the electric field inside a cavity surrounded by a conductor is zero.

4.10 Prove that the force per unit surface on a large charged surface is given by $\mathbf{f} = \frac{1}{2\varepsilon_0}\sigma^2\hat{\mathbf{n}}$.

4.11 Prove that the energy of a charged capacitor is given by $C = Q^2 / 2C$.