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EE214000 Electromagnetics, Fall
Quiz #5, Open books, notes (22 points)

1. (3 points) What would happen if the electric field in an ideal conductor is not zero?
   Ans: Since there is an infinite amount of charges assumed for an idea conductor, an electric field in a conductor will maintain a current until the net internal field settles to zero.

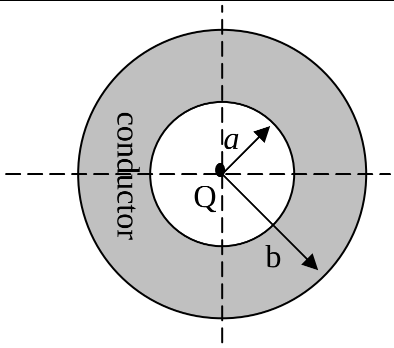
2. (3 points) For a surface charge density of ρ_s on a conductor surface in vacuum, what is the tangential component of the electric field intensity immediately outside the conductor surface?
   Ans: The tangential components of the electric field are the same at the boundary. But the electric field in a conductor at the steady state has to be zero, no matter it is the normal or tangential component. Therefore the tangential component of the electric field intensity immediately outside the conductor surface is zero.

3. (8 points) An infinitely long line charge with a line charge density of ρ_l is located on the z axis in vacuum. (a) Find the electric field intensity, including direction and magnitude, at radius $r = r_0$ from the line charge. (b) What is the work needed to be done to carry a unit positive charge from $r = r_0$ to $r = r_1$?

Ans: (a) Refer to the handout or textbook, the electric field at r_0 is $\vec{E} = \dfrac{\rho_l}{2\pi\varepsilon_o r_0}\hat{a}_r$

(b) It is the electric potential $V = -\int_{r_0}^{r_1} \vec{E}\cdot d\vec{r} = -\int_{r_0}^{r_1} \dfrac{\rho_l}{2\pi\varepsilon_o r} dr = \dfrac{\rho_l}{2\pi\varepsilon_o}\ln(r_0 / r_1\ )$

4. (8 points) In vacuum, a charge Q is at the center of a hallow conducting ball, as shown below. Calculate the surface charge density at $R = a$ and $R = b$ on the conductor. Indicate the sign of the charge.



Ans: The surface normal at R = a is $-\hat{a}_R$ and that at $R = b$ is $-\hat{a}_R$. The electric flux density at $R = a$ is $\vec{D} = \frac{Q}{4\pi a^2}\hat{a}_R$ and that at R = b is $\vec{D} = \frac{Q}{4\pi b^2}\hat{a}_R$. According to $\rho_s = \hat{a}_n \cdot \vec{D}$, the surface charge density at $R = a$ is $-\frac{Q}{4\pi a^2}$ and that at $R = b$ is $\frac{Q}{4\pi b^2}$.