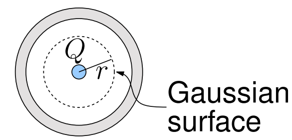
Tutorial 6 Question

- Text: Ch. 22: Pr. 16.
- A point charge Q rests at the center of an uncharged thin spherical conducting shell. What is the electric field E as a function of r (*a*) for r less that the radius of the shell, (*b*) inside the shell, and (*c*) beyond the shell? (*d*) Does the shell affect the field due to Q alone? Does the charge Q affect the shell?

Solution

(*a*) What is the electric field E as a function of r for r less that the radius of the shell?

- From spherical symmetry, electric field must point radially away/to charge.
- So good choice of Gaussian surface is sphere.
- Then electric field is $\perp$ to surface everywhere.



- Enclosed charge: $Q_{\mathrm{encl}} = Q$.
- Area: $A = 4\pi r^2$ (surface area of sphere).

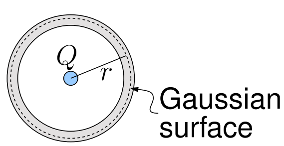
Solution, contd

- Flux: $\Phi_E = E_\perp A = E(4\pi r^2)$.
- Gauss's law: $E_\perp A = Q_{\mathrm{encl}}/\epsilon_0$, so

$$E = \frac{Q}{4\pi\epsilon_0 r^2}.$$

(*b*) What is the electric field E as a function of r inside the shell?

- Now we expand our Gaussian surface so it lies within the conductor (same symmetry).



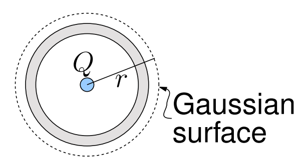
Solution, contd

- Recall, E inside a conductor is always zero,

$$E = 0.$$

(*c*) What is the electric field E as a function of r beyond the shell?

- Again we expand the Gaussian surface so now it is outside the shell.



- The shell carries no net charge so $Q_{\mathrm{encl}} = Q$, as before.