Solid sphere of charge.

An electric charge $Q$ is distributed uniformly throughout a non-conducting sphere of radius $r_0$. If the magnitude of the electric field on the surface of the sphere is $E_s$, then the magnitude of the electric field at a point inside the sphere at $r=r_0/2$ is:

- a) $E_s/2$
- b) $E_s/4$
- c) $E_s/8$
- d) $E_s Q/\varepsilon_0$
- e) Need more information to determine this.
Non-uniformly charged solid sphere.

Suppose the charge density of a solid sphere is given by $\rho_E = \alpha r^2$, where $\alpha$ is a constant. (a) Find $\alpha$ in terms of the total charge $Q$ on the sphere and its radius $r_0$. 
A very long straight wire possesses a uniform positive charge per unit length, \( \lambda \). Calculate the electric field at points near (but outside) the wire, far from the ends.
Charge is distributed uniformly, with a surface charge density \( \sigma \) \((\sigma = \text{charge per unit area} = \frac{dQ}{dA})\) over a very large but very thin nonconducting flat plane surface. Determine the electric field at points near the plane.
The electric field just outside a surface with uniform surface charge density $\sigma$ is:

a) $E = \frac{\sigma}{\varepsilon_0}$
Suppose a conductor carries a net charge $+Q$ and contains a cavity, inside of which resides a point charge $+q$. What can you say about the charges on the inner and outer surfaces of the conductor?

Solution: The field must be zero within the conductor, so the inner surface of the cavity must have an induced charge totaling $-q$ (so that a gaussian surface just around the cavity encloses no charge). The charge $+Q$ resides on the outer surface of the conductor.
- Electric flux: \( \Phi_E = \int \vec{E} \cdot d\vec{A} \).

- Gauss’s law: \( \oint \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\varepsilon_0} \).

- Gauss’s law can be used to calculate the field in situations with a high degree of symmetry.

- Gauss’s law applies in all situations, and therefore is more general than Coulomb’s law.
Practice Problem:
A cube with sides of length L is located with one corner at the origin. An electric field is present which is given by $\vec{E} = ax^2 \hat{i} + bxy \hat{j}$. How much charge is contained inside the cube?