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(2) There is an uncharged spherical conducting shell inside the Gaussian surface. Neither charge will affect the surface integral or q_{enc} , so the electric field outside the shell is still

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

(3) This is a subtle question. With all the symmetry here it appears as if the shell has no effect; the field just looks like a point charge field. It, however, the charge were moved off center the field inside the shell would become distorted, and we wouldn't be able to use Gauss' law to find it. So the shell does make a difference.

Outside the shell, however, we can't tell what is going on inside the shell. So the electric field outside the shell looks like a point charge field originating from the center of the shell regardless of where inside the shell the point charge is placed.

(4) Yes, q induces surface charges on the shell. There will be a charge $-q$ on the inside surface and a charge $+q$ on the outside surface.

(5) Yes, so there is an electric field from the shell, isn't there?

(6) No, so the electric field from the outside charge won't make it through a conducting shell. The conductor acts as a shield.

(7) No, this is not a contradiction, because the outside charge never experienced any electrostatic attraction or repulsion from the inside charge. The force is between the shell and the outside charge.

P27-12 The repulsive electrostatic force must exactly balance the attractive gravitational force. Then

$$\frac{1}{4\pi\epsilon_0} \frac{q^2}{r^2} = \frac{GMm}{r^2}$$

$$q = \sqrt{4\pi\epsilon_0 GMm} \quad \text{Numerically,} \quad q = \sqrt{4\pi(8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2)(6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2)(1.60 \times 10^{-19} \text{ C})} = 1.86 \times 10^{-19} \text{ C}$$

P27-13 The problem has spherical symmetry, so we use a Gaussian surface which is a spherical shell. The \mathbf{E} field will be perpendicular to the surface, so Gauss' law will simplify to

$$E_{out}(4\pi r^2) = \int \mathbf{E} \cdot d\mathbf{A} = \int E dA = E \int dA = E(4\pi r^2)$$

Consequently, $E = q_{enc}/4\pi\epsilon_0 r^2$.

$q_{enc} = q + 4\pi \int r^2 \rho(r) dr = q + 2\pi A(r^3 - r_0^3)$.

The electric field will be constant if q_{enc} behaves as r^2 , which implies $q = 2\pi A r_0^3$, or $A = q/2\pi r_0^3$.

P27-14 (a) The problem has spherical symmetry, so we use a Gaussian surface which is a spherical shell. The \mathbf{E} field will be perpendicular to the surface, so Gauss' law will simplify to

$$E_{out}(4\pi r^2) = \int \mathbf{E} \cdot d\mathbf{A} = \int E dA = E \int dA = E(4\pi r^2)$$

Consequently, $E = q_{enc}/4\pi\epsilon_0 r^2$.

$q_{enc} = 4\pi \int r^2 \rho(r) dr = 4\pi \rho r^3/3$, so $E = \rho r/3\epsilon_0$.