***Answer to Essential Question 16.8*:** The surface of the spherical volume is well within the metal sphere, where the electric field is zero. Thus, when we apply Equation 16.5, $AE = \frac{q_{enc}}{\varepsilon_0}$, the left-hand side is zero because the field is zero. Thus, the right-hand side must also be zero, which means that there is no charge enclosed in the spherical volume. This is true as long as the radius, r, of the spherical volume is less than the radius, R, of the metal sphere. In other words, for $r < R$, the enclosed charge is zero. Thus, Gauss' law leads us to the conclusion that the excess charge on the metal sphere is all at the surface of the sphere. For $r \geq R$, the enclosed charge is the net charge on the sphere, $+8q$. Using Gauss' law, in fact, we can show that the electric field at points outside the sphere, at a distance r away from the center, is the same as that a distance r away from a point charge having a charge equal to the net charge on the sphere.

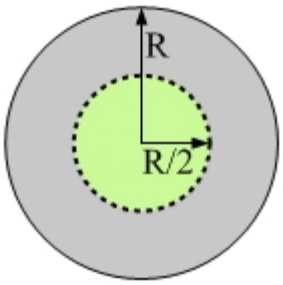

Figure 16.8C: A metal sphere with a net charge of $+8q$, and a spherical volume that has half the radius of the metal sphere.