Special Problem 3-4.3

A sphere with a radius of 2 m is centered at the origin.

This sphere is immersed in a conducting material, and current is flowing through this material, with a density:

$$J(\vec{r}) = \frac{1}{\rho \pi} \hat{a}_\rho \left[ \frac{A}{m^2} \right]$$

At time $t=0$, there is 1 Coulomb of charge inside the sphere.

How much charge is inside the sphere at time $t=2$ sec (i.e., 2 seconds later)?