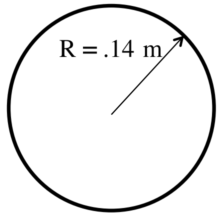
Problem 25.48

A spherical conductor of radius .14 meters has charge $26\text{x}10^{-6}$ C on it.



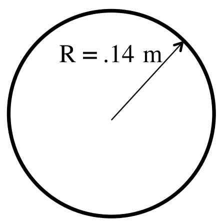
for $r = .1$ m

$E = 0$ (there is no charge inside a sphere of radius .1 meters)

The voltage part is interesting. The electric field inside the conductor must be zero. The electric field is related to how the voltage *changes*. If the electric field is zero, the *change of voltage* must be zero. . . which means the voltage will be the same everywhere. We know the voltage at the surface of the conductor. That, apparently, will be the voltage at every point inside the conductor, which means:

$$\begin{aligned} V &= k\frac{q}{R} \\ &= \left(9\text{x}10^{9}\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{\left(26\text{x}10^{-6}\text{C}\right)}{(.14\ \text{m})} \\ &= 1.6\text{x}10^{6}\ \text{V} \end{aligned}$$

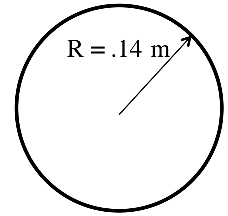
for $r = .2$ m



$$\begin{aligned} E &= k\frac{q}{r^2} \\ &= \left(9\text{x}10^{9}\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{\left(26\text{x}10^{-6}\text{C}\right)}{(.2\ \text{m})^2} \\ &= 5.84\text{x}10^{6}\ \text{N/C}\ \text{ away from the sphere's center} \end{aligned}$$

$$\begin{aligned} V &= k\frac{q}{r} \\ &= \left(9\text{x}10^{9}\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{\left(26\text{x}10^{-6}\text{C}\right)}{(.2\ \text{m})} \\ &= 1.17\text{x}10^{6}\ \text{V} \end{aligned}$$

for $r = .14$ m



$$\begin{aligned} E &= k\frac{q}{R^2} \\ &= \left(9\text{x}10^{9}\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{\left(26\text{x}10^{-6}\text{C}\right)}{(.14\ \text{m})^2} \\ &= 11.9\text{x}10^{6}\ \text{N/C}\ \text{ away from the sphere's center} \end{aligned}$$

$$\begin{aligned} V &= k\frac{q}{R} \\ &= \left(9\text{x}10^{9}\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{\left(26\text{x}10^{-6}\text{C}\right)}{(.14\ \text{m})} \\ &= 1.67\text{x}10^{6}\ \text{V} \end{aligned}$$

Interesting observation: The electric field close to a flat conducting surface is

$$\begin{aligned} E &= \frac{\sigma}{\varepsilon_o} \\ &= \frac{\left(\frac{q}{4\pi R^2}\right)}{\varepsilon_o} \\ &= \frac{\left(\frac{26\text{x}10^{-6}\text{C}}{4\pi(.14\ \text{m})^2}\right)}{\left(8.85\text{x}10^{-12}\text{C}^2/\text{N}\bullet\text{m}^2\right)} \\ &= 11.9\text{x}10^{6}\ \text{V} \end{aligned}$$

How nice. The values match!