Answer on Question#55540 - Physics - Other

Potential difference between center and surface of the sphere of radius R and uniform volume charge density d within it will be?

Solution:

According to the Gauss's law the electric flux Φ_E through the spherical surface which center coincides with the center of the charged ball is given by

$$\Phi_E = \frac{Q}{\varepsilon_0},$$

where ε_0 – is the electric constant, Q – is the charge enclosed by this surface.

Since $\Phi_E = 4\pi r^2 E$ (where r – is the radius of the sphere), the electric field at distance r from the center is given by

$$E = \frac{\Phi_E}{4\pi r^2} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

The electric charge enclosed by the sphere is given by

$$Q = \frac{4}{3}\pi r^3 d$$

Therefore the electric field is now given by

$$E = \frac{1}{4\pi\varepsilon_0}\frac{\frac{4}{3}\pi r^3 d}{r^2} = \frac{rd}{3\varepsilon_0}$$

The potential difference $\Delta\varphi$ between center and surface is given by

$$\Delta\varphi = \int_0^R E dr = \int_0^R \frac{rd}{3\varepsilon_0} dr = \frac{d}{3\varepsilon_0}\frac{R^2}{2} = \frac{R^2 d}{6\varepsilon_0}$$

Answer: $\frac{R^2 d}{6\varepsilon_0}$.