Question #81254, Physics / Other

A charge of total amount Q is distributed over two concentric hollow spheres of radii r and R{R>r} such that the surface charge densities on the two spheres are equal. The electric potential at the common center is

Solution

By superposition principle, potential at the common center is equal to algebraic sum of potentials at center due to each sphere.

If we want the potential of a sphere, we need the radius (given) and the charge on it (which is what we should find now).

If the total charge is Q, then let's assume charge of small sphere is q_1, and large sphere is q_2.

Thus $Q = q_1 + q_2$

It is given that the surface charge density is the same, thus:

$$\frac{q_1}{4\pi r^2} = \frac{q_2}{4\pi R^2}.$$

Therefore,

$$q_1 = \frac{(r^2)(q_2)}{R^2}$$

But $Q = q_1 + q_2$, therefore,

$$q_2 = \frac{Q(R^2)}{r^2 + R^2},$$

and similarly (from the same equation),

$$q_1 = \frac{Q(r^2)}{r^2 + R^2}.$$

Potential at common centre is now given as:

$$V = \frac{k(q_1)}{r} + \frac{k(q_2)}{R}.$$

Substituting previously found values, this becomes:

$$V = \frac{kQ(r+R)}{r^2 + R^2}.$$