A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere, the equipotential surfaces with potentials $3V_0/2$, $5V_0/4$, $3V_0/4$ and $V_0/4$ have radius R_1, R_2, R_3, and R_4 respectively. Then,

(a) $R_1 = 0$ and $R_2 > (R_4 - R_3)$

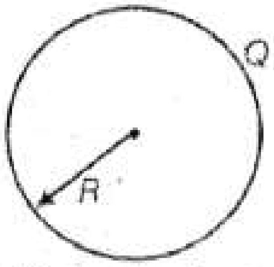
(b) $R_1 = 0$ and $(R_2 - R_1) > (R_4 - R_3)$

(c) $R_1 = 0$ and $R_2 < (R_4 - R_3)$

(d) $2R < R_4$

Correct Option (c) $R_1 = 0$ and $R_2 < (R_4 - R_3)$ and (d) $2R < R_4$

Explanation:



Charged sphere

Potential at the surface of the charged sphere

$$V_0 = \frac{KQ}{R}$$

$$V = \frac{KQ}{r}, r \geq R$$

$$= \frac{KQ}{2R^3}(3R^2 - r^2),$$

$$r \leq R$$

$$V_{\text{centre}} = V_c = \frac{KQ}{2R^3} \times 3R^2$$

$$= \frac{3KQ}{2R} = \frac{3V_0}{2}$$

$$R_1 = 0$$

As potential decreases for outside point. Thus. according to the question, we can write

$$V_{R_2} = \frac{5V_0}{4} = \frac{KQ}{2R^3}(3R^2 - R_2^2)$$

$$\frac{5V_0}{4} = \frac{V_0}{2R^2}(3R^2 - R_2^2)$$

or $$\frac{5}{2} = 3 - \left(\frac{R_2}{R}\right)^2$$

or $$\left(\frac{R_2}{R}\right)^2 = 3 - \frac{5}{2} = \frac{1}{2}$$

or $$R_2 = \frac{R}{\sqrt{2}}$$

Similarly,

$$V_{R_3} = \frac{3V_0}{4} \Rightarrow \frac{KQ}{R_3} = \frac{3}{4} \times \frac{KQ}{R}$$

or $R_3 = \frac{4}{3}R$

$$V_{R4} = \frac{KQ}{R_4} = \frac{V_0}{4} \Rightarrow \frac{KQ}{R_4} = \frac{1}{4} \times \frac{KQ}{R}$$

or $R_4 = 4R$