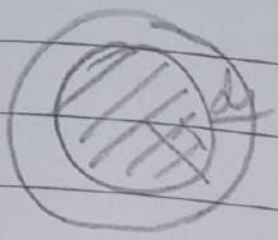
Q. A sphere of radius R carries a charge density $l(r) = Kr^3$. Find energy of the configuration



Charge of sphere of radius R $= Q$

$$= \int_0 K r^3 \, 4\pi r^2 \, dr$$

$$= \frac{K 4\pi r^6}{6}$$

Potential at surface of sphere of radius r

$$V(r) = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r} = \frac{1}{4\pi\varepsilon_0 \times r} \frac{K \times 4\pi r^5}{6}$$

$$= \frac{K r^5}{6\varepsilon_0}$$

Energy to add one shell of thickness dr to the sphere be dE.

$$dE = V dq. \qquad dq = Kr^3 \cdot 4\pi r^2 \cdot dr$$

$$= 4\pi K r^5 dr$$

$$= \frac{K r^5 \times 4\pi K r^5 dr}{6\varepsilon_0}$$

$$= \frac{K^2 5 \, 4\pi K^2 r^{10} \cdot dr}{6\varepsilon_0}$$

$$E = \int dE = \int_0^R V dq = \int_0^R \frac{4\pi K^2 r^{10} dr}{6\varepsilon_0} = \frac{2\pi K^2 R^{11}}{33\varepsilon_0}$$