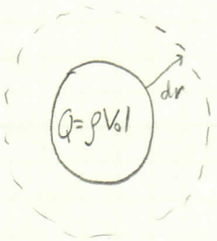
2.35



$$\rho = \frac{q}{V_{0l}} = \frac{3q}{4\pi R^3}$$

$$dq = \rho\, dV_{0l} \qquad dV = \frac{4}{3}\pi\left[(r+dr)^3 - r^3\right] = \frac{4}{3}\pi\left(r^3 + 3r^2dr + 3r\,dr^2 + dr^3 - r^3\right)$$

$$dV = \frac{4}{3}\pi(3r^2dr) = 4\pi r^2 dr$$

$$dq_i = \frac{3q}{4\pi R^3}\cdot 4\pi r^2 dr = \frac{3q}{R^3} r^2 dr$$

$$dw = dq_i V(r_i)$$

$$V = \frac{q}{4\pi\varepsilon_0 r} = \frac{\rho V_{0l}}{4\pi\varepsilon_0 r} = \frac{\left(\frac{3q}{4\pi R^3}\right)\frac{4}{3}\pi r^3}{4\pi\varepsilon_0 r} = \frac{q(r^3/R^3)}{4\pi\varepsilon_0 r} = \frac{qr^2}{4\pi\varepsilon_0 R^3}$$

$$dw = \frac{q}{4\pi\varepsilon_0 R^3} r^2 \cdot \frac{3q}{R^3} r^2 dr = \frac{3q^2}{4\pi\varepsilon_0 R^6} r^4 dr$$

$$W \cong \sum_{i=1}^{n} dq_i V \Rightarrow W = \lim_{n\to\infty} \sum_{i=1}^{n} dq_i V(r_i) = \int V dq = \int_0^R \frac{3q^2}{4\pi\varepsilon_0 R^6} r^4 dr$$

$$W = \frac{3q^2}{20\pi\varepsilon_0}\left(\frac{r^5}{R^6}\right)_0^R = \frac{3q^2}{20\pi\varepsilon_0 R}$$