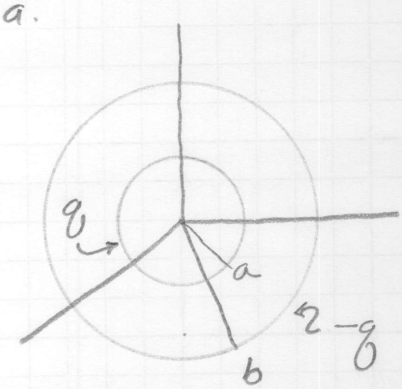
2-34) a.



Get $\vec{E}$ first

for $r < a$

$$\nabla \cdot \vec{E}_1 = \frac{\rho}{\varepsilon_0} = 0$$

$$\int \nabla \cdot \vec{E}_1 \, d\tau = 0$$

$$\oint \vec{E}_1 \cdot d\vec{A} = 0$$

$$\vec{E} = E\hat{r}, \; d\vec{A} = r^2 d\cos\theta \, d\phi \, \hat{r}$$

$$\oint E_1 r^2 d\cos\theta \, d\phi = 0$$

$$E_1 r^2 \int_0^{2\pi}\int_{-1}^{1} d\cos\theta \, d\phi = 0$$

$$E_1 4\pi r^2 = 0$$

$$\boxed{\therefore \; E_1 = 0}$$

for $a < r < b$ the left hand side of the previous solution stays the same

$$E_2 4\pi r^2 = \int \frac{\rho}{\varepsilon_0} d\tau$$

$$= \frac{1}{\varepsilon_0} q$$

$$\therefore E_2 = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

for $r > b$ the left hand side is the same again

$$E_3 \, 4\pi r^2 = \int \frac{\rho}{\varepsilon_0} d\tau$$

$$= \frac{1}{\varepsilon_0}\left(q + (-q)\right)$$

$$= 0$$

$$\therefore E_3 = 0$$

$$W = \frac{\varepsilon_0}{2} \int_{\substack{\text{all} \\ \text{space}}} E^2 \, d\tau \qquad d\tau = r^2 \, dr \, d\cos\theta \, d\phi$$

$$= \frac{\varepsilon_0}{2} \int_0^{2\pi} \int_{-1}^{1} \int_a^b \left(\frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \right)^2 r^2 \, dr \, d\cos\theta \, d\phi$$

$$= \frac{\cancel{\varepsilon_0}}{\cancel{2}} (\cancel{2}) (2\pi) \left(\frac{1}{4\pi\varepsilon_0} \right)^{\cancel{2}\,1} q^2 \int_a^b \frac{1}{r^{\cancel{4}\,2}} \cancel{r^2} \, dr$$

$$= \frac{1}{2} \left(\frac{1}{4\pi\varepsilon_0} \right) q^2 \left(\frac{r^{-1}}{-1} \right)_a^b$$

$$\boxed{W = \frac{q^2}{8\pi\varepsilon_0} \left(\frac{1}{a} - \frac{1}{b} \right)}$$