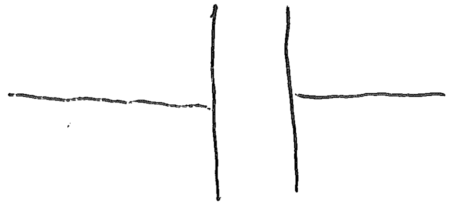


parallel plate capacitor

$$C = \frac{\varepsilon_0 A}{d}.$$

Put

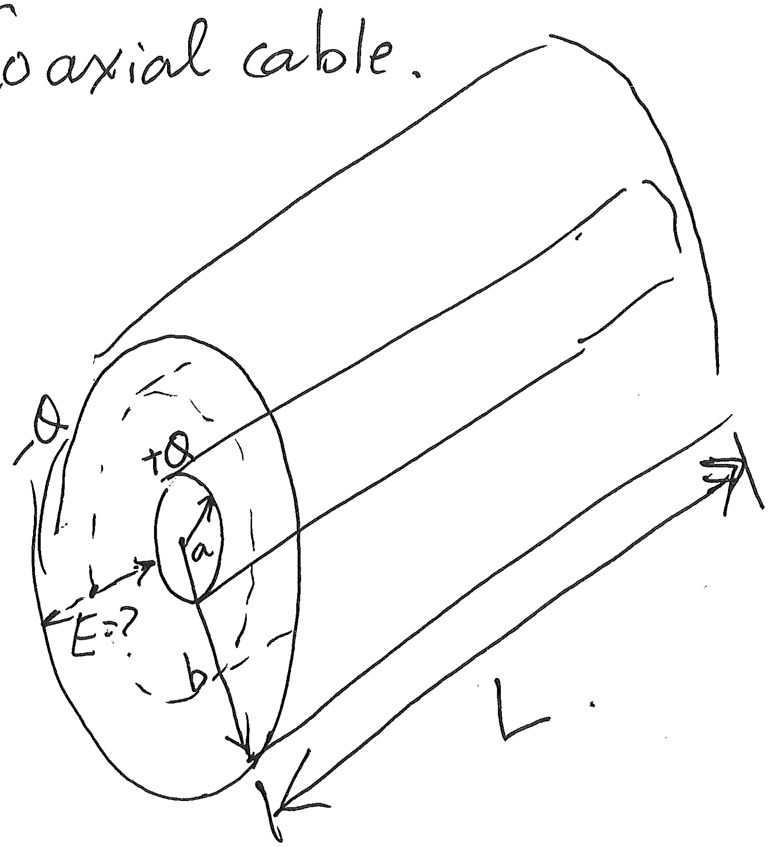
1). ~~Pout~~ some charges Q to the conductor.

2). Calculate E (most likely use Gauss's Law)

3). Calculate $V = -\int \vec{E} \cdot d\vec{l}$

4). Calculate $C = \frac{Q}{V}.$

Coaxial cable.



$$E = \frac{Q}{\varepsilon_0 (2\pi r L)}$$

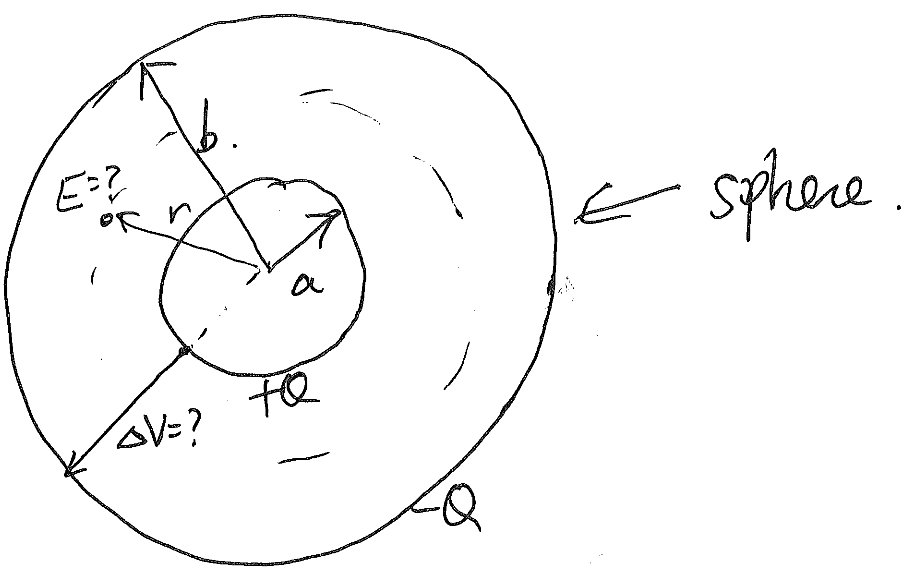
$$V = -\int \vec{E} \cdot d\vec{r}$$

$$|V| = \int \frac{Q}{\varepsilon_0 (2\pi r L)} \, dr \cos 0^\circ .$$

$$= \frac{Q}{2\pi \varepsilon_0 L} \left[\ln r \right]_a^b = \frac{Q}{2\pi \varepsilon_0 L} \ln\left(\frac{b}{a}\right).$$

$$\cancel{C = \frac{|Q|}{|V|} = Q \frac{1}{2\pi \varepsilon_0 L} \ln\left(\frac{b}{a}\right).}$$

$$C = \frac{|Q|}{|V|} = \cancel{\frac{2\pi\varepsilon_0}{Q}} \frac{2\pi \varepsilon_0 L}{\ln\left(\frac{b}{a}\right)}$$



$$E = \frac{Q}{\varepsilon_0 \cdot 4\pi r^2}.$$

$$|\Delta V| = \int_b^a \frac{Q}{\varepsilon_0 \cdot 4\pi r^2} dr \cos 0^\circ$$

$$= \left[\frac{Q}{\varepsilon_0 4\pi r}\right]_b^a$$

$$= \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right).$$

$$\therefore \cancel{Q E}\ C = \frac{Q}{|\Delta V|} \cancel{= \frac{1}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)}.$$

$$= \frac{Q}{\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)}.$$

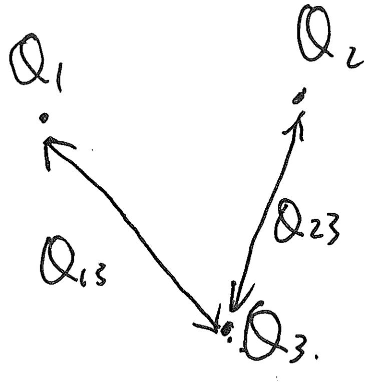
$$= 4\pi\varepsilon_0 \cdot \frac{ab}{(b-a)}. \ //$$

$$b \to \infty, \quad C \to 4\pi\varepsilon_0 \frac{ab}{b}.$$

$$= 4\pi\varepsilon_0 a \ //$$

Energy required

$$= \left(\frac{1}{4\pi\varepsilon_0} \frac{Q_1}{r_{12}} \right) Q_2$$



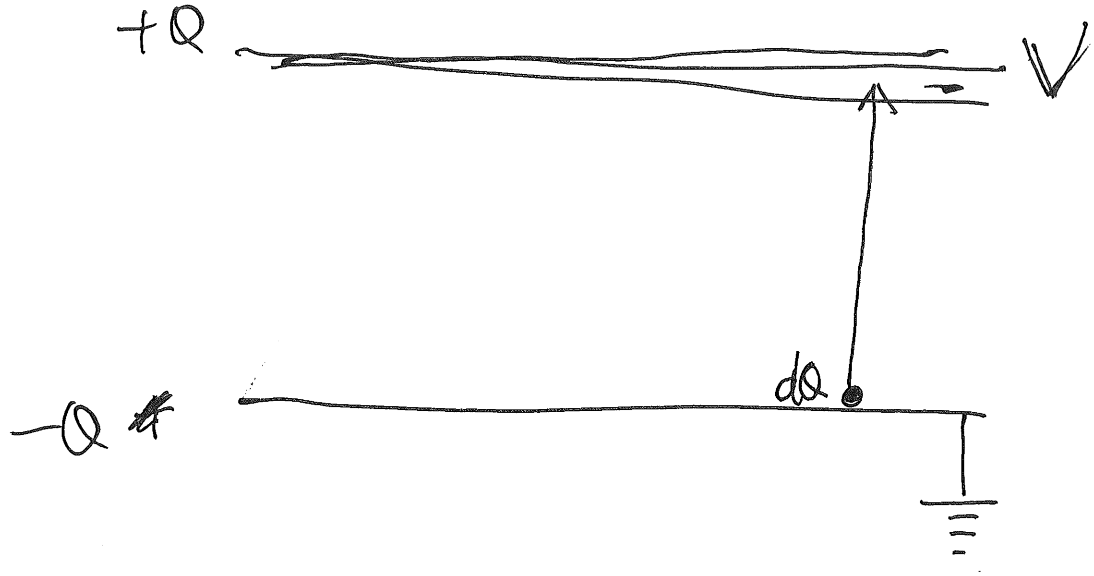
~~Equ~~ Energy required

$$= \left(\frac{1}{4\pi\varepsilon_0} \frac{Q_1}{r_{13}} \right) Q_3 + \left(\frac{1}{4\pi\varepsilon_0} \frac{Q_2}{r_{23}} \right) Q_3$$

Total Energy required.

$$= \left(\frac{1}{4\pi\varepsilon_0} \frac{Q_1}{r_{12}} \right) Q_2 + \left(\frac{1}{4\pi\varepsilon_0} \frac{Q_1}{r_{13}} \right) Q_3$$

$$+ \left(\frac{1}{4\pi\varepsilon_0} \frac{Q_2}{r_{23}} \right) Q_3$$



$$dE = V\,dQ.$$

$$E = \int V\,dQ.$$

$$= \int_0^{Q_f} \frac{Q}{C}\,dQ.$$

$$= \frac{1}{2C} Q_f^2.$$ ← Energy needed to charge the capacitor to Q_f.

or Energy stored in a capacitor

Energy stored in acapacitor

$$= \frac{Q^2}{2C} = \frac{1}{2}CV^2.$$

$$\updownarrow$$

Energy stored in a spring $= \frac{1}{2}kx^2.$

$$C \leftrightarrow \frac{1}{k}.$$

$$Q \leftrightarrow x.$$