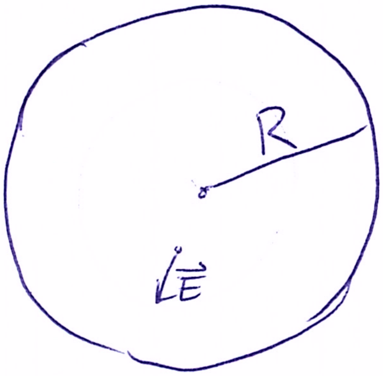


solid insulating ball

$$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$$

$$E_r = \frac{\rho r}{3\epsilon_0}$$

$$V_{in}(r) = -\int_0^r \frac{\rho r}{3\epsilon_0}\, dr \qquad \left(\vec{E}\cdot d\vec{r} = E_r\, dr = \frac{\rho r}{3\epsilon_0}\, dr\right)$$

$$= -\frac{\rho}{3\epsilon_0}\frac{1}{2}r^2\Big|_0^r + V_0$$

$$V_{in}(r) = \frac{-\rho}{3\epsilon_0}\frac{r^2}{2} + V_0$$

potential has to be continuous.

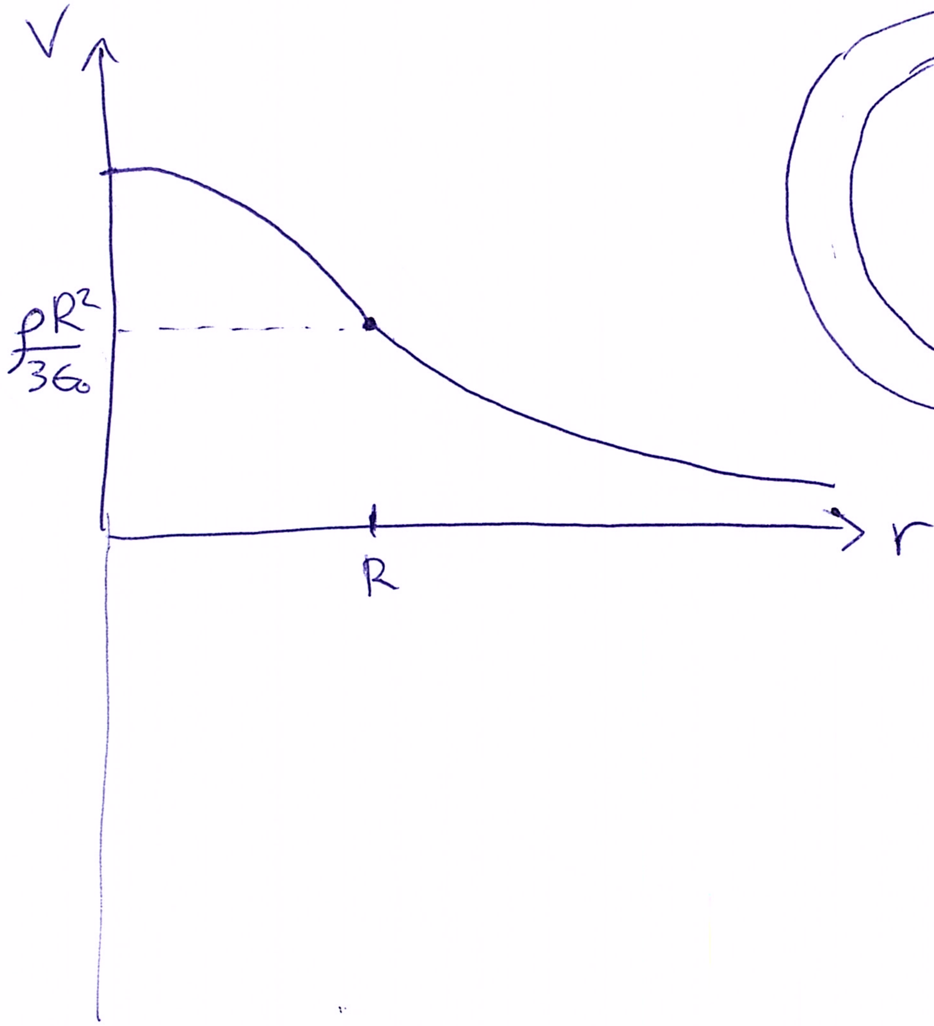
V_0 is because we set $V=0$ at $r=\infty$

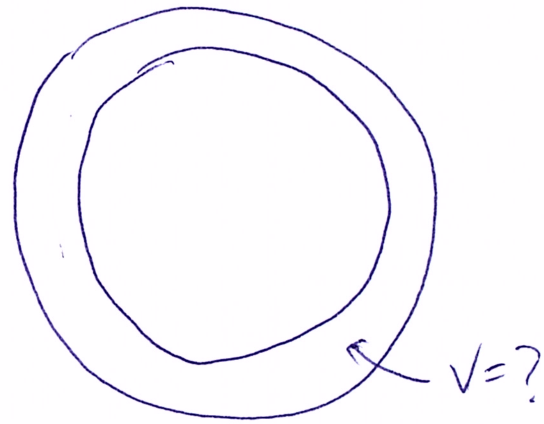
At $r=R$: $$V_s(R) = \frac{1}{4\pi\epsilon_0}\frac{Q}{R} = \frac{1}{\cancel{4\pi}\epsilon_0}\frac{\frac{\cancel{4}}{3}\cancel{\pi}R^{\cancel{3}\,2}\rho}{\cancel{R}}$$

$$V_{in}(R) = V_s(R)$$

$$\frac{-\rho}{3\epsilon_0}\frac{R^2}{2} + V_0 = \frac{\rho}{3\epsilon_0}R^2 \Rightarrow V_0 = \frac{\rho}{2\epsilon_0}R^2$$

$$\boxed{V_{in}(r) = \frac{\rho}{2\epsilon_0}R^2 - \frac{\rho}{6\epsilon_0}r^2}$$


V
$\frac{\rho R^2}{3\epsilon_0}$
R
r


V=?