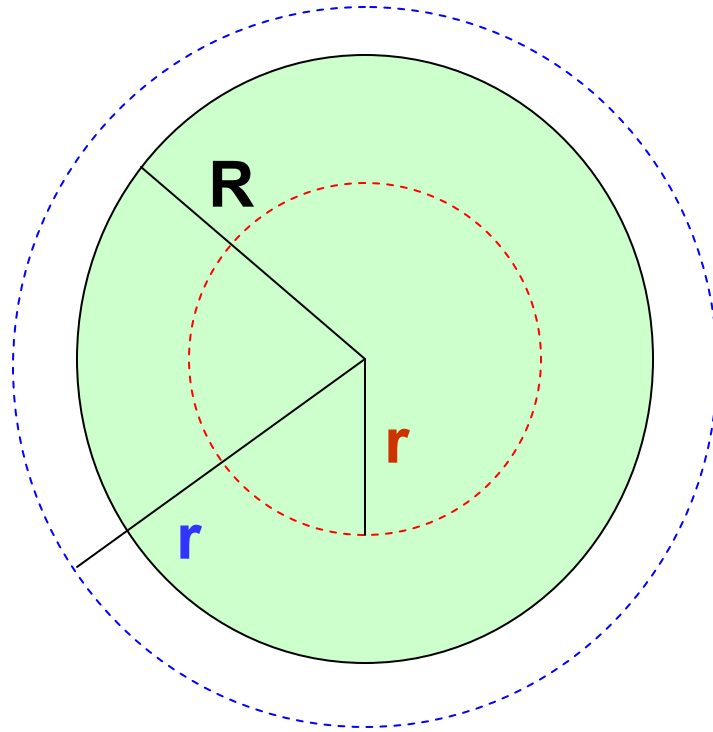


Uniformly charged sphere



tot. charge = Q

Q1: what is the electric field for $r > R$

Q2: what is the electric field for $r < R$

Q3: what is the electric potential $V(r)$ for $r > R$

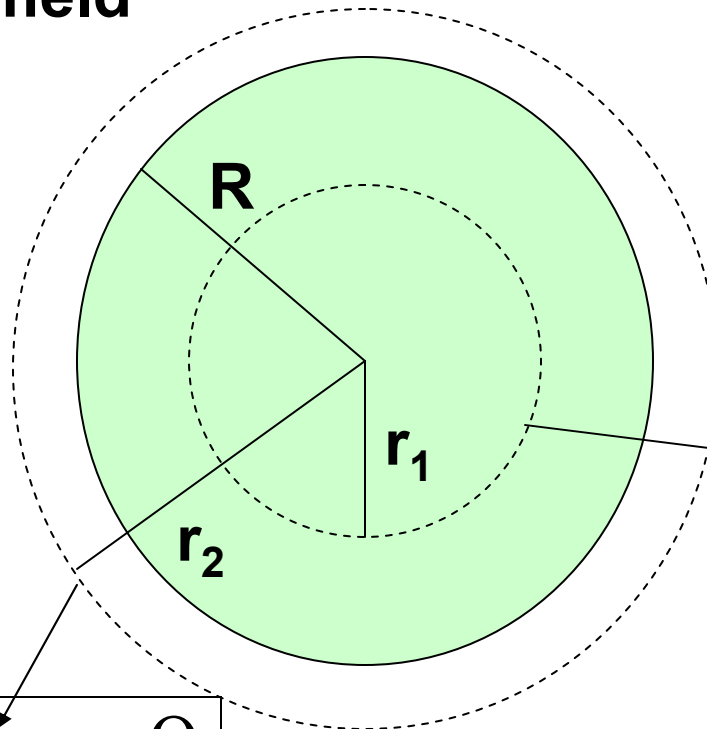
Note $V(r = \infty) = 0$

Q3: what is the electric potential $V(r)$ for $r < R$

Note $V(r)$ must be continuous

Uniformly charged sphere

E-field



charged density $\rho = \frac{Q}{\frac{4}{3}\pi R^3}$ tot. charge

$$\oint \mathbf{E}_{\perp} dA = \frac{Q_{in}}{\epsilon_0}$$

$$E 4\pi r_1^2 = \frac{(\rho \pi r_1^3 \frac{4}{3})}{\epsilon_0} \Rightarrow$$

$$E = \frac{\rho r_1}{3\epsilon_0} \quad \text{or} \quad E = \frac{Q}{4\pi R^3} \frac{r_1}{\epsilon_0}$$

$$E 4\pi r_2^2 = \frac{Q}{\epsilon_0}$$

$$\Rightarrow$$

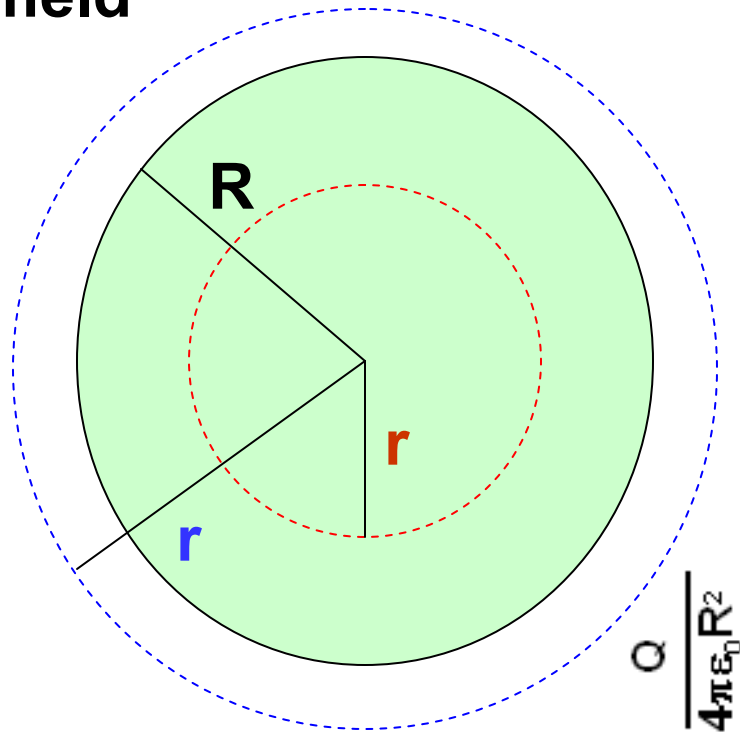
$$E = \frac{Q}{4\pi \epsilon_0 r_2^2}$$

$$E = \begin{cases} r \leq R & \frac{Q}{4\pi R^3} \frac{r}{R\epsilon_0} = \left[\frac{Q}{4\pi \epsilon_0 R^2} \right] \frac{r}{R} \\ r \geq R & \frac{Q}{4\pi \epsilon_0 r^2} = \left[\frac{Q}{4\pi \epsilon_0 R^2} \right] \left(\frac{R}{r} \right)^2 \end{cases}$$

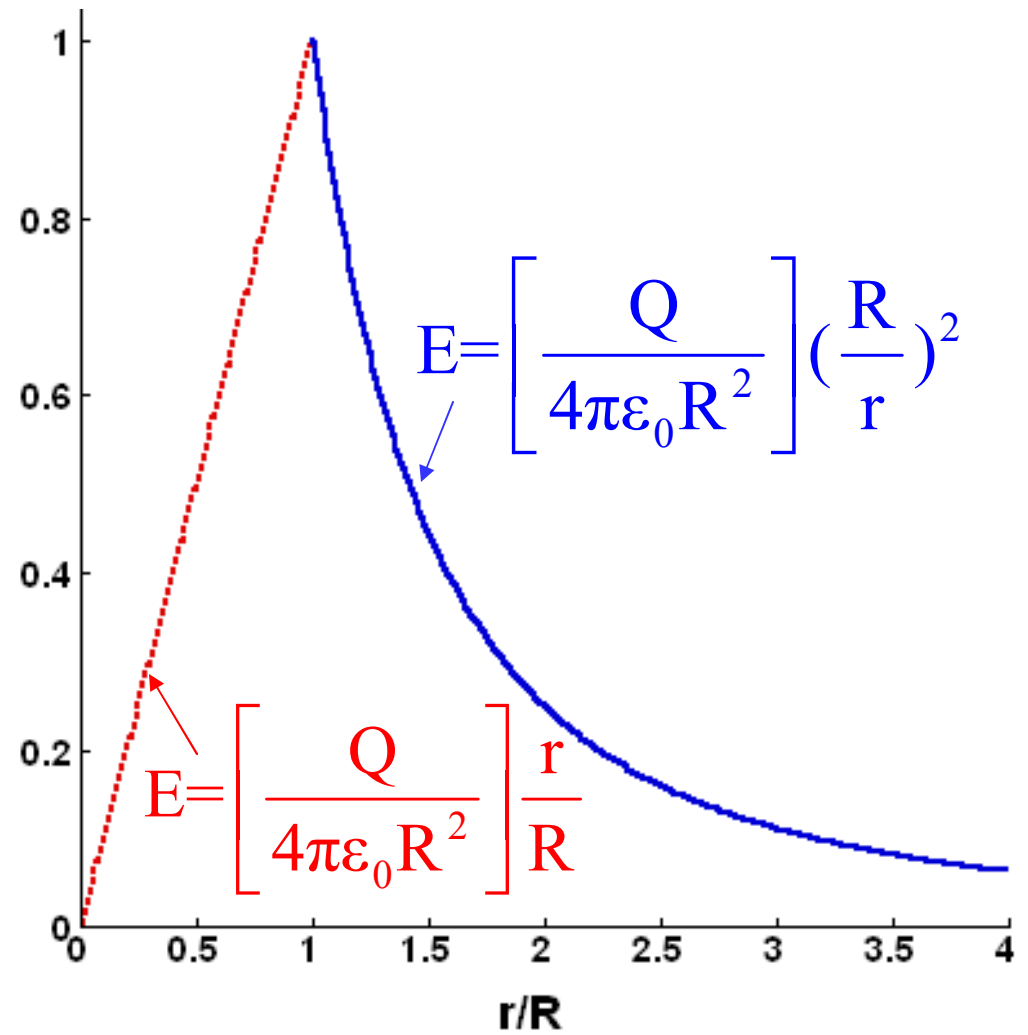
Uniformly charged sphere

E-field

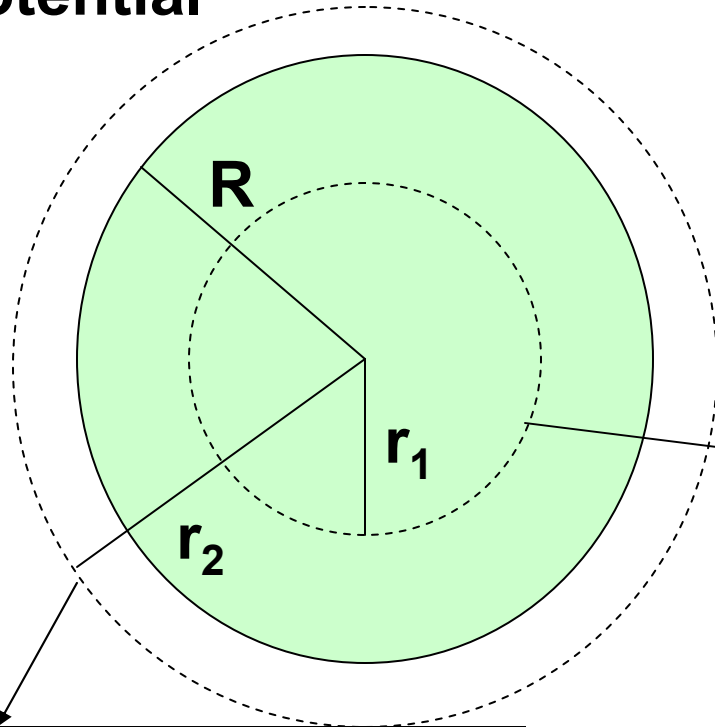
tot. charge = Q



sph-3



Uniformly charged sphere potential



$$r \geq R \quad V(r) = -\int E \, dr \Rightarrow$$

$$V(r) = \left[\frac{Q}{4\pi\epsilon_0} \right] \left(\frac{1}{r} \right)$$

$$r \leq R \quad V(r) = -\int E \, dr + C$$

$$\Rightarrow V(r) = -\left[\frac{Q}{4\pi\epsilon_0} \right] \frac{r^2}{2R^3} + C$$

$$V(r) = \left[\frac{Q}{4\pi\epsilon_0} \right] \frac{1}{2R} \left\{ 3 - \frac{r^2}{R^2} \right\}$$

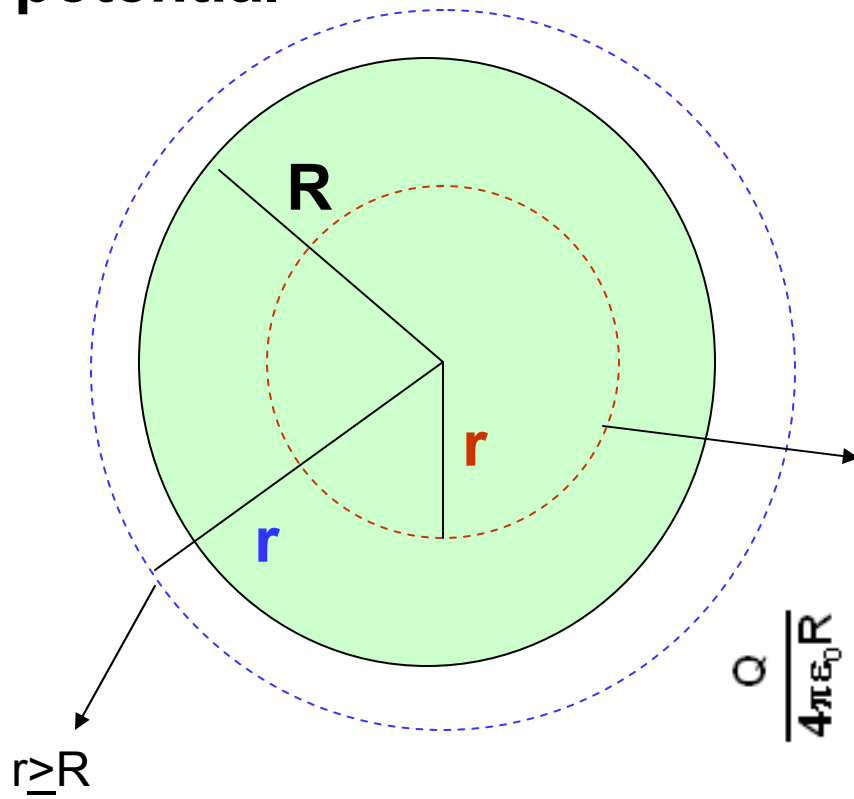
$$r = R \quad \left[\frac{Q}{4\pi\epsilon_0} \right] \left(\frac{1}{R} \right) = -\left[\frac{Q}{4\pi\epsilon_0} \right] \frac{R^2}{2R^3} + C$$

$$C = \left[\frac{Q}{4\pi\epsilon_0} \right] \frac{3}{2R}$$

$$V(r) = \begin{cases} r \leq R & \left[\frac{Q}{4\pi\epsilon_0} \right] \frac{1}{2R} \left\{ 3 - \frac{r^2}{R^2} \right\} \\ r \geq R & \left[\frac{Q}{4\pi\epsilon_0} \right] \left(\frac{1}{r} \right) \end{cases}$$

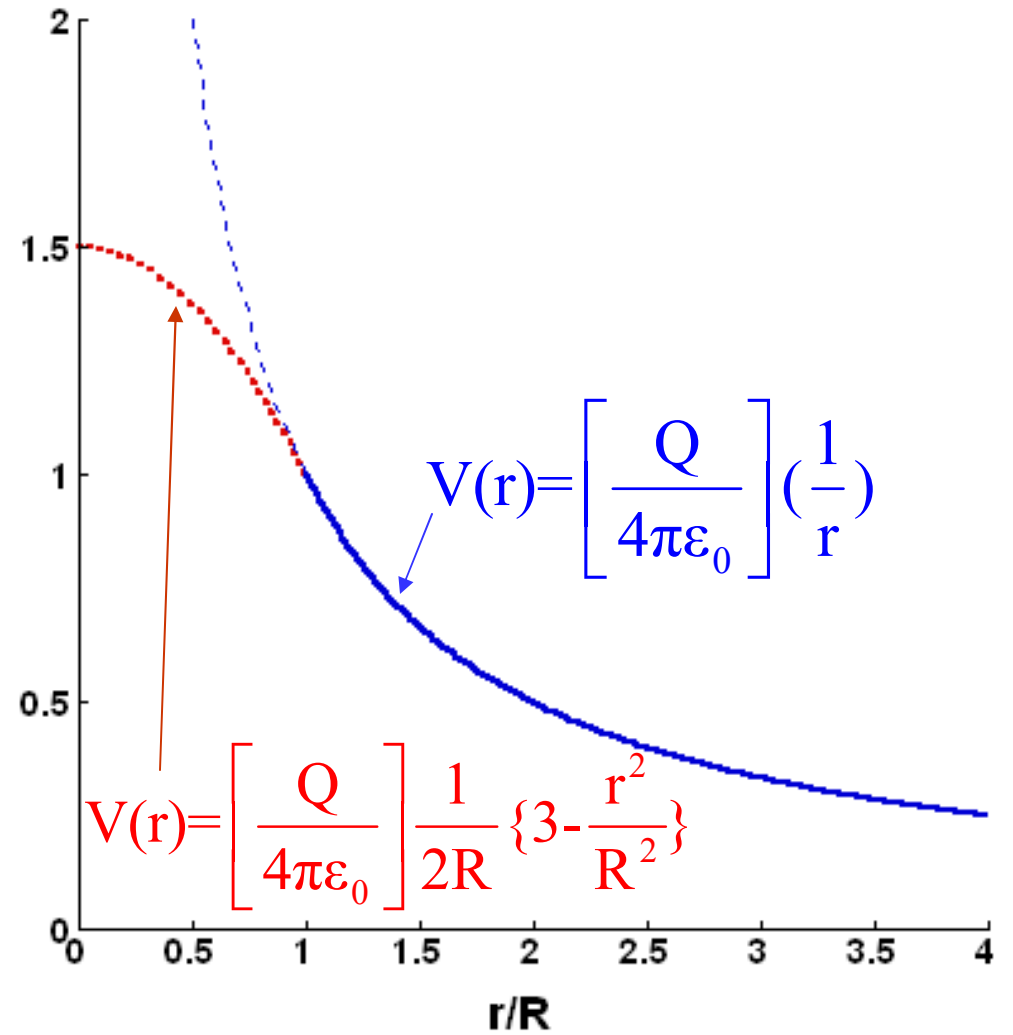
Uniformly charged sphere potential

tot. charge = Q



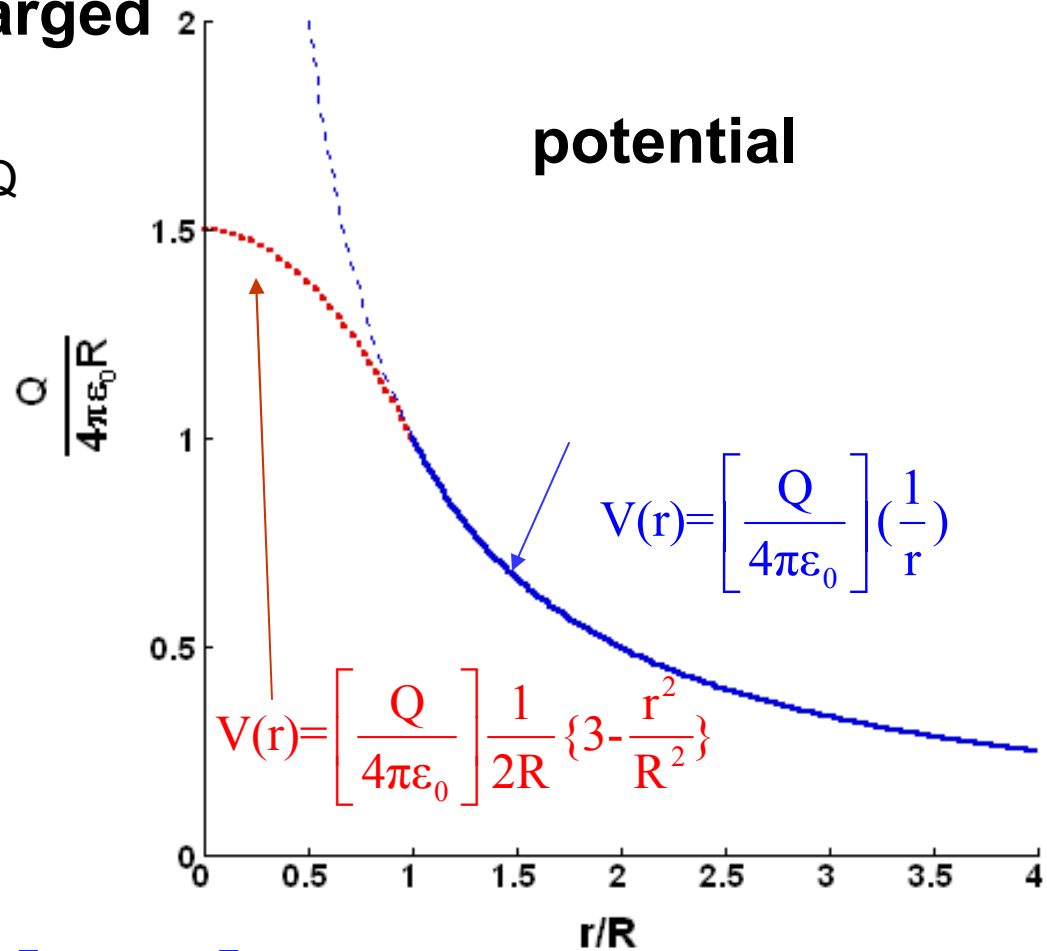
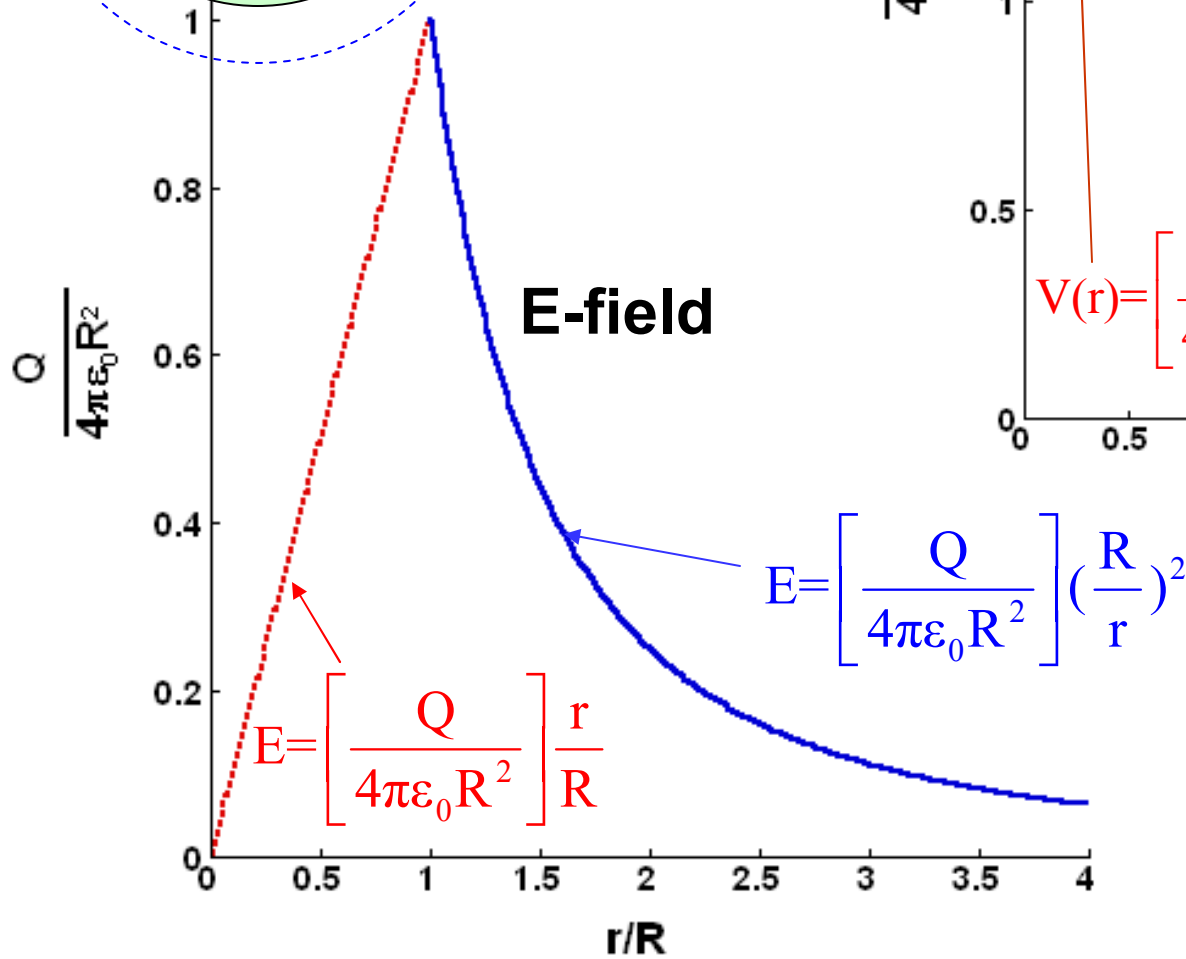
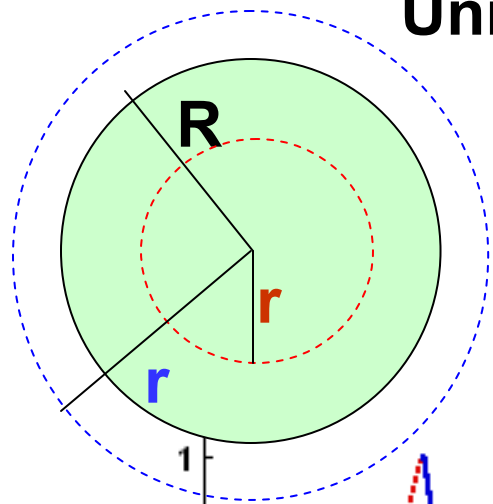
sph-5

$$\frac{Q}{4\pi\epsilon_0 R}$$



Uniformly charged sphere

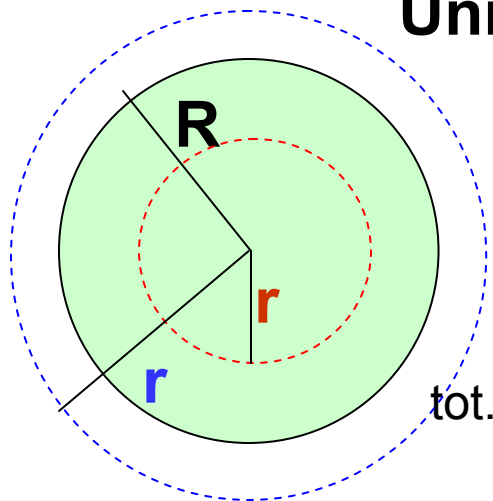
tot. charge = Q



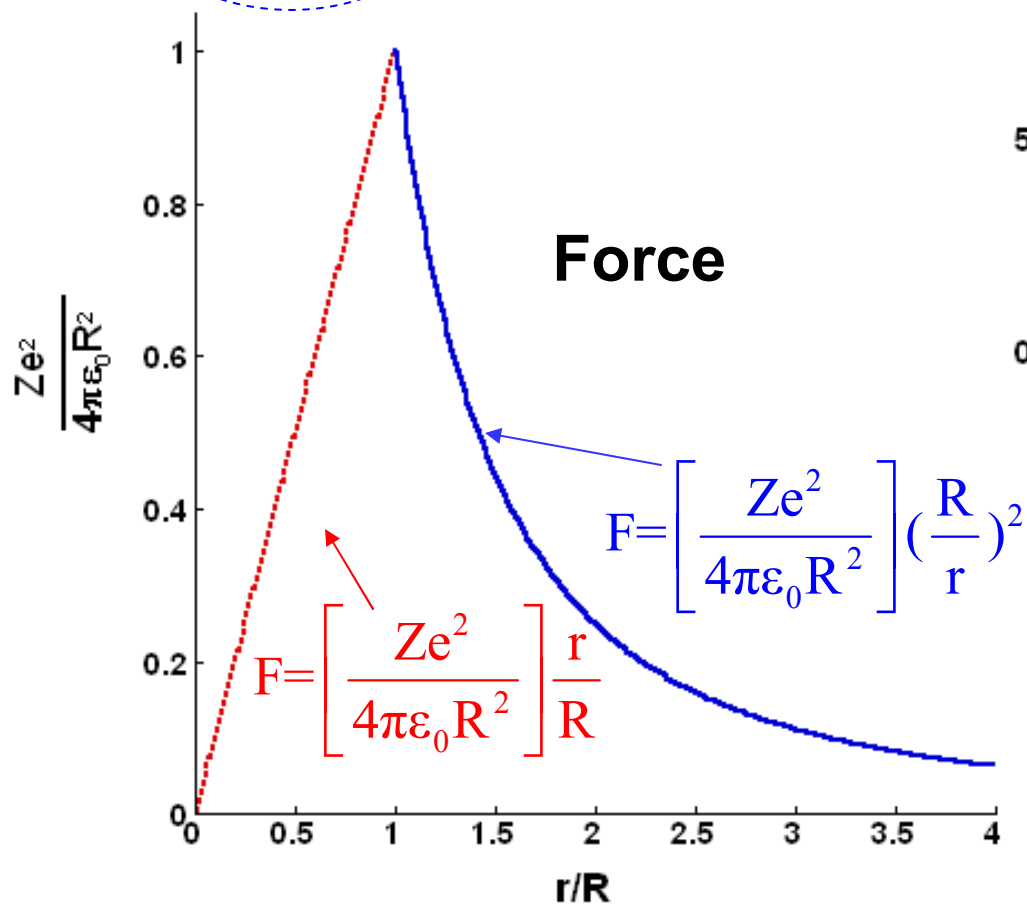
Uniformly charged sphere

Place charge e at r

tot. charge = Q



$$\frac{Ze^2}{4\pi\epsilon_0 R}$$



Potential Energy

