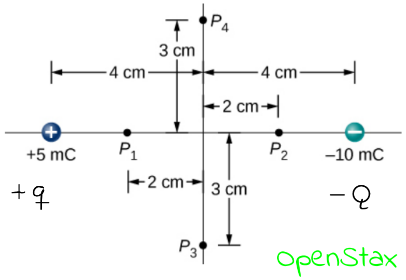
① 11-07-52



$q = 5\,mC$

$Q = 10\,mC$

we need to find the electric potential $V(x,y)$

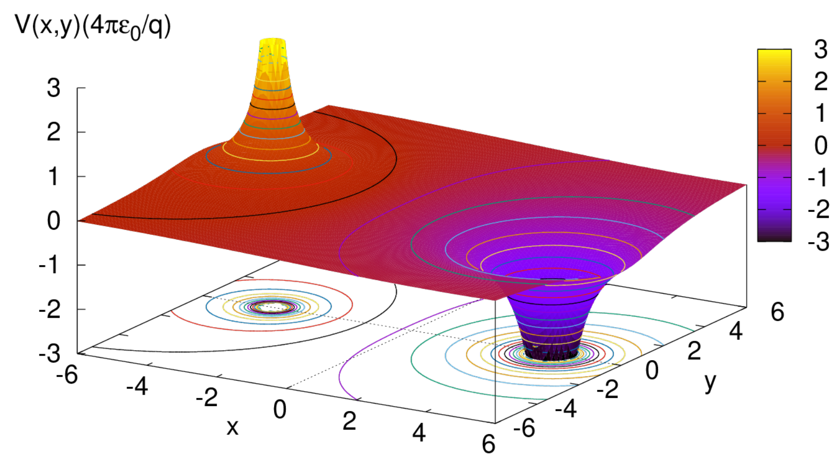
$$V(x,y) = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{4}\frac{q_i}{|\bar{x}_i - \bar{x}|} = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{4}\frac{q_i}{\sqrt{(x_i-x)^2+(y_i-y)^2}}$$

$$= \frac{1}{4\pi\epsilon_0}\left[\frac{q}{\sqrt{(-4-x)^2+(0-y)^2}} - \frac{Q}{\sqrt{(4-x)^2+(0-y)^2}}\right]$$

$$= \frac{q}{4\pi\epsilon_0}\left[\frac{1}{\sqrt{(-4-x)^2+y^2}} - \frac{2}{\sqrt{(4-x)^2+y^2}}\right]$$

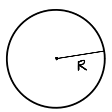
②

P_1 : $V(-2,0) = \frac{q}{4\pi\epsilon_0}\,0{,}1667$ see figure ↓



③ 11-07-62

Long aluminum cylinder (conducting)



L, line charge λ

$\rightarrow Q_T = \lambda L$

a) Find $\bar{E}$ inside and outside,

$$\oint \bar{E}\cdot d\bar{A} = \frac{Q_{enc}}{\epsilon_0}$$

$r > R$:

$$L\cdot 2\pi r\, E_r = \frac{\lambda L}{\epsilon_0}$$

$$\rightarrow E_r = \frac{\lambda}{2\pi\epsilon_0 r} \quad \rightarrow \quad \bar{E} = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r}, \quad r > R$$

$r < R$: $Q_{enc} = 0 \rightarrow \bar{E} = 0$ inside the cylinder

b) We use here $\bar{E} = -\bar{\nabla} V$, we only need $(\bar{\nabla})_r$ due to the cylinder symmetry

$$(\bar{\nabla})_r = \frac{\partial}{\partial r}$$

④

$r < R$: $E_r = -\frac{\partial}{\partial r}V(r)$, $E_r = 0$

$\rightarrow V(r) = V_i$: Const.

$r > R$: $V(r) = -\frac{\lambda}{2\pi\epsilon_0}\ln(r) + V_0$ ← Const.

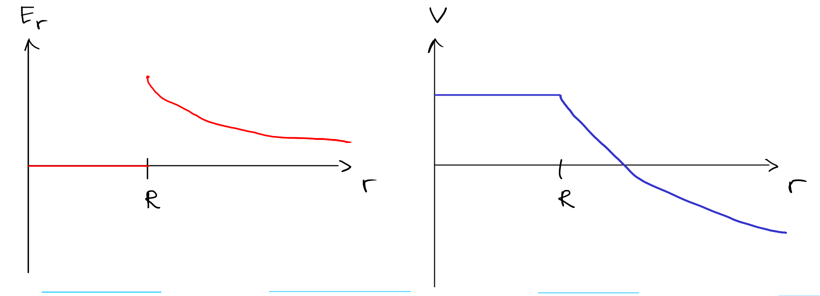
$V(r)$ must be continuous in $r = R$

$\rightarrow V(R) = V_i \rightarrow -\frac{\lambda}{2\pi\epsilon_0}\ln(R) + V_0 = V_i$

$\rightarrow V_0 = \frac{\lambda}{2\pi\epsilon_0}\ln(R) + V_i$

$$\rightarrow \quad V(r) = -\frac{\lambda}{2\pi\epsilon_0}\ln\left(\frac{r}{R}\right) + V_i \qquad r > R$$

$$V(r) = V_i \qquad r < R$$



11-08-42

Find the energy in a single-sphere capacitor, $R = 2.0\,m$, $V = 10.0\,V$

Spherical capacitor

$$C = 4\pi\epsilon_0 \frac{R_1 R_2}{R_2 - R_1}, \quad \text{Check Ex. 8.3}$$

or take the Limit $R_2 \to \infty$

$$C = 4\pi\epsilon_0 \frac{R_1}{1 - \frac{R_1}{R_2}} \xrightarrow[R_2 \to \infty]{} 4\pi\epsilon_0 R_1$$

So, for a single sphere capacitor we have

$$C = 4\pi\epsilon_0 R, \qquad U_C = \frac{1}{2}V^2 C = \frac{1}{2}V^2 4\pi\epsilon_0 R$$

$$= \frac{1}{2}\, 10^2\, V^2\, 4\pi\epsilon_0 \cdot 2.0\, m$$

$\epsilon_0 = 8.85 \cdot 10^{-12} \frac{C^2}{N m^2}$

$$= 1.1 \cdot 10^{-8}\, J$$

11-09-60

12 V and 100 Ah, 80 W Lights

$80\,W$ at $12\,V$ $\to$ $P = I \cdot V$ $\to$ $I = \frac{P}{V} = \frac{80}{12} = 6.667\,A$

$$\to T = \frac{100\,Ah}{6.667} = 15\,h$$