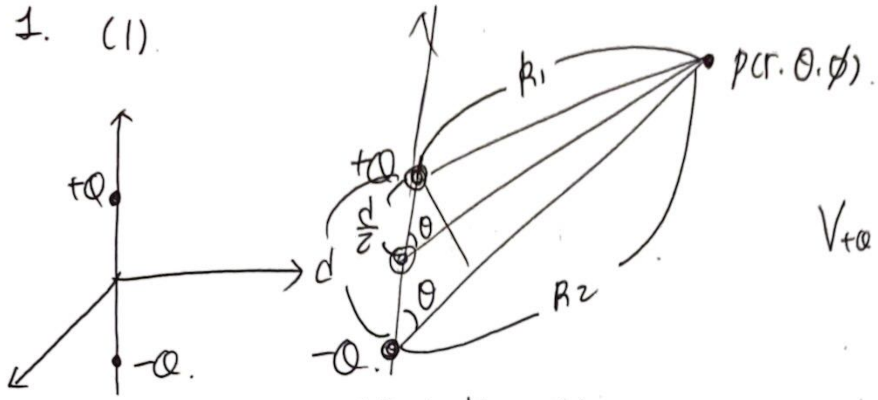
"나는 시험에 정직하게 응할것을 서약합니다."

12201856 김다영



1. (1)




+Q에의한 전기장.

$V_{+Q} =$

~~+Q에의한 전기장~~

$\cancel{\mathbb{r}' = \frac{d}{2} a_z}$

$\cancel{\mathbb{r} = x a_x + y a_y + z a_z}$

~~-Q에의한 전기장.~~

$\mathbb{E}_{+Q} = \frac{Q}{4\pi\varepsilon_0 R_1^2} a_{R_1}$

-Q에의한전기장

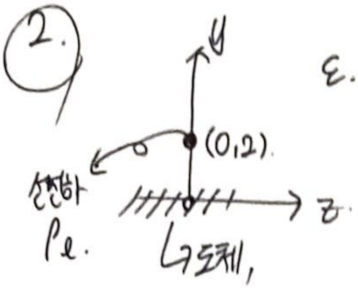
$\mathbb{E}_{-Q} = \frac{-Q}{4\pi\varepsilon_0 R_2^2} a_{R_2}.$

$\ln\left(\frac{R_1 - R_2}{r^2}\right)$

r>>d.) $R_1 \approx R_2 \approx r.$

$R_2 - R_1 = d\cos\theta$

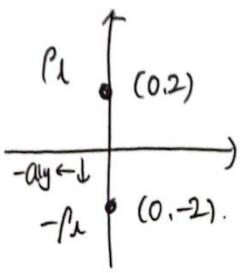
2.




ε.

영상전하 설정. $\begin{pmatrix} x=0 \\ y=-2 \end{pmatrix}$을 관통하는 선전하.

$\cancel{E = \frac{\rho_l}{2\pi\varepsilon_0 \rho}}$. $\quad E = \frac{\rho_l}{2\pi\varepsilon_0 \rho} a_\rho$.




(1). $E_{\rho_l} = \frac{\rho_l}{2\pi\varepsilon_0 \cdot 2}(-a_y)$

$E_{-\rho_l} = \frac{\rho_l}{2\pi\varepsilon_0 \cdot 2}(-a_y)$

$E = E_{\rho_l} + E_{-\rho_l} = -\frac{\rho_l}{2\pi\varepsilon_0} a_y$.

~~(2)~~.

① $\rho_l$에의한 $E$.

(1). $r = 0$. $\quad r - r_1' = -2a_y$. $\quad \cancel{E = \frac{\rho_l}{4\pi\varepsilon_0 r^2}}$

$r' = 2a_y$. $\quad |r - r_1'| = 2$. $\quad \cancel{E = \frac{}{4}} \rightarrow E_1 = \frac{\rho_l(-2a_y)}{2\pi\varepsilon \cdot 4}$

② $\rho_l$에의한 $E$

$r = 0$ $\quad r - r_2' = 2a_y$.

$r' = -2a_y$. $\quad |r - r_2'| = 2$. $\rightarrow E_2 = \frac{-\rho_l(2a_y)}{2\pi\varepsilon_0 \cdot 4}$

$\cancel{D_1 = \varepsilon E_1}$

$E = E_1 + E_2 = \frac{\rho_l(-2a_y)}{2\pi\varepsilon \cdot 4} - \frac{\rho_l(2a_y)}{2\pi\varepsilon_0 \cdot 4}$

$= \frac{-\rho_l a_y}{4\pi\varepsilon} - \frac{\rho_l a_y}{4\pi\varepsilon_0}$

(2). $D = \varepsilon E_1 + \varepsilon_0 E_2 = -\frac{\rho_l}{4\pi} a_y \cdot 2 = -\frac{\rho_l}{2\pi} a_y$.

by, 경계조건

$\rho_s = -\frac{\rho_l}{2\pi}$ 이다!

3.

(1). $V = -\int_{\pi}^{0} \mathbf{E}\cdot d\mathbf{L} = -\int_{\pi}^{0} \frac{1}{2\rho}\mathbf{a}_\phi \cdot \rho \cdot \mathbf{a}_\phi \, d\phi = \int_{0}^{\pi} \frac{1}{2}\, d\phi = \underline{\frac{\pi}{2}}$

(2) $I = \int \mathbf{J}\cdot d\mathbf{S} = \int \sigma \cdot \mathbf{E}\, d\mathbf{S} = \int \sigma \cdot \frac{1}{2\rho}\mathbf{a}_\phi \cdot \mathbf{a}_\phi \, d\rho\, dz$

$d\mathbf{S}$ $d\mathbf{S} = d\rho\, dz \cdot \mathbf{a}_\phi$

$$= \frac{\sigma}{2}\int_{0}^{d}\int_{a}^{b} \frac{1}{\rho}\, d\rho\, dz$$

$$= \frac{\sigma}{2}\, d \cdot \ln\frac{b}{a} = \frac{\sigma}{2} d \ln\frac{b}{a}$$

(3). $R = \frac{V}{I} = \frac{\frac{\pi}{2}}{\frac{\sigma}{2} d\ln\frac{b}{a}} = \underline{\frac{\pi}{\sigma d\ln\frac{b}{a}}}$

4.

~~① $\varepsilon_{r1}=1$~~

② $\varepsilon_{r2}=2.$

~~$z=5$~~ . $z>5$

~~① $\varepsilon_{r1}=1$~~

~~②~~

~~$\varepsilon_{r2}=2$~~


$z<5$ ↓

~~① $\rho$~~

~~① $\varepsilon_{r1}=2.$~~

$\mathbb{E}_1=a_x+a_y-a_z.$

① $\varepsilon_{r1}=1.$

$\mathbb{E}_{1,t}=a_x+a_y.$

$\therefore \mathbb{D}_1=\varepsilon\mathbb{E}=\varepsilon_r\varepsilon_0\mathbb{E}=\varepsilon_0\mathbb{E}$

$\mathbb{E}_{1,N}=-a_z.$

$=\varepsilon_0(a_x+a_y-a_z)$

경계조건에 의해. $\mathbb{E}_{1,t}=\mathbb{E}_{2,t}=a_x+a_y$

$\therefore \mathbb{P}_1=\varepsilon_0(\varepsilon_r-1)\mathbb{E}_1=0.$

~~$\mathbb{D}_{2,N}-\mathbb{D}_{1,N}=\rho_s=1.$~~

$1+\chi_e=\varepsilon_r.$

$\chi_e=\varepsilon_r-1.$

$n\cdot(\mathbb{D}_{1,N}-\mathbb{D}_{2,N})=1.\ ,\ n=-a_z.$

$\mathbb{D}_{2,N}=\mathbb{D}_{1,N}+a_z.$

$\therefore \mathbb{E}_2$

$\varepsilon_{r2}\varepsilon_0\mathbb{E}_{2,N}=\varepsilon_{r1}\varepsilon_0\mathbb{E}_{1,N}-a_z.$

~~$2\varepsilon_0\mathbb{E}_{2,N}=\varepsilon_0\mathbb{E}_{1,N}-1.$~~

~~$\mathbb{E}_{2,N}=\frac{1}{2}\mathbb{E}_{1,N}-\frac{1}{2\varepsilon_0}=\frac{1}{2}\left(\mathbb{E}_{1,N}-\frac{1}{\varepsilon_0}\right)=\frac{1}{2}\left(-a_z-\frac{1}{\varepsilon_0}\right).$~~

~~$\mathbb{E}_2=\mathbb{E}_{2,t}+\mathbb{E}_{2,N}=a_x+a_y+\frac{1}{2}\left(-a_z-\frac{1}{\varepsilon_0}\right).$~~

$D_{1,N}-D_{2,N}=1.$

$D_{1,N}-D_{2,N}=-a_z.$

$\mathbb{E}_{1,N}=-a_z.$

$\mathbb{D}_{2,N}=\mathbb{D}_{1,N}+a_z \Rightarrow 2\varepsilon_0\mathbb{E}_{2,N}=\varepsilon_0\mathbb{E}_{1,N}+a_z=(1-\varepsilon_0)a_z.$

~~$\frac{1}{\varepsilon}\mathbb{D}_{2,N}=$~~

$\therefore \mathbb{P}_2=\varepsilon_0(2-1)\mathbb{E}_2$

$\mathbb{E}_{2,N}=\frac{(1-\varepsilon_0)}{2\varepsilon_0}a_z.$

$=\varepsilon_0\left(a_x+a_y+\frac{1-\varepsilon_0}{2\varepsilon_0}a_z\right)$

$\mathbb{E}_2=\mathbb{E}_{2,t}+\mathbb{E}_{2,N}=a_x+a_y+\frac{1-\varepsilon_0}{2\varepsilon_0}a_z.$

$\therefore \mathbb{D}_2=2\varepsilon_0\left(a_x+a_y+\frac{1-\varepsilon_0}{2\varepsilon_0}a_z\right)$

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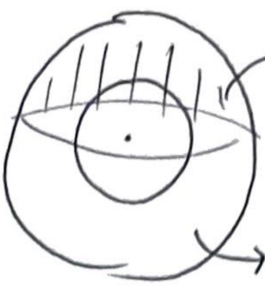
#5.

구면도체 사이 전위차 $V_0$.

$0<\theta<\frac{\pi}{2}$. $\varepsilon_1=\varepsilon_0$.

$\frac{\pi}{2}<\theta<\pi$. $\varepsilon_2=2\varepsilon_0$.




(1). $\nabla^2 V=0$. r에만 의존.

$$\nabla^2 V=\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right)=0.$$

$\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right)=0$. $r^2\frac{\partial V}{\partial r}=A$. $\frac{\partial V}{\partial r}=\frac{A}{r^2}$. $\underline{V_{(r)}=-\frac{A}{r}+B}$.

(2). $r=a \to V=V_0$

$r=b \to V=0$. $\cancel{\oint_S D\cdot dS=}$

$V(a)=-\frac{A}{a}+B=V_0$.

$V(b)=-\frac{A}{b}+B=0$.

$-\frac{A}{a}+\frac{A}{b}=V_0$. $A\left(\frac{1}{b}-\frac{1}{a}\right)=V_0$. $A=\frac{V_0}{\frac{1}{b}-\frac{1}{a}}$,

$B=\frac{A}{b}=\frac{V_0}{\frac{1}{b}-\frac{1}{a}}\cdot\frac{1}{b}$

$$V=-\frac{1}{r}\left(\frac{V_0}{\frac{1}{b}-\frac{1}{a}}\right)+\frac{1}{b}\left(\frac{V_0}{\frac{1}{b}-\frac{1}{a}}\right)$$
$$=\frac{V_0}{\left(\frac{1}{b}-\frac{1}{a}\right)}\left(\frac{1}{b}-\frac{1}{r}\right).$$

$E=-\nabla V$

$$=\frac{-V_0}{\left(\frac{1}{b}-\frac{1}{a}\right)}\cdot\left(\frac{1}{r^2}\right)a_r=\frac{V_0}{\frac{1}{a}-\frac{1}{b}}\cdot\frac{1}{r^2}a_r.$$

$\cancel{D=\varepsilon E}=$

$$D=\varepsilon E.=\begin{cases}\varepsilon_0 E \longleftarrow \left(0<\theta<\frac{\pi}{2}\right)\\ 2\varepsilon_0 E \longleftarrow \left(\frac{\pi}{2}<\theta<\pi\right).\end{cases}=\begin{cases}\frac{\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}}\cdot\frac{1}{r^2}a_r\\ \frac{2\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}}\cdot\frac{1}{r^2}a_r\end{cases}$$

(3). by. 경계조건.

(4) $C=\frac{Q}{V}=\frac{\rho}{V_0}$

7page에 작성.

#5. (3). by. 경계조건

안쪽 도체.
$$\rho_{sa} = \begin{cases} \frac{\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{a^2} & (0<\theta<\frac{\pi}{2}) \\ \frac{2\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{a^2} & (\frac{\pi}{2}<\theta<\pi) \end{cases}$$

$$\rho_{sb} = \begin{cases} \frac{\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{b^2} & (0<\theta<\frac{\pi}{2}) \\ \frac{2\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{b^2} & (\frac{\pi}{2}<\theta<\pi) \end{cases}$$

(4). $C = \frac{Q}{V} = \frac{\Sigma \rho_s \cdot S}{V_0} = \frac{\cancel{QQQ}}{V_0}$

$$Q = \Sigma \rho_s \cdot S = \left( \frac{\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{a^2} + \frac{2\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \frac{1}{a^2} \right) \cdot 2\pi a^2 \cancel{- \left( \frac{\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{b^2} + \frac{2\varepsilon_0 V_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{b^2} \right) \cdot 2\pi b^2}$$

$$C = \left( \frac{\varepsilon_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{a^2} + \frac{2\varepsilon_0}{\frac{1}{a}-\frac{1}{b}} \frac{1}{a^2} \right) 2\pi a^2 \cancel{- \left( \frac{\varepsilon_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{b^2} + \frac{2\varepsilon_0}{\frac{1}{a}-\frac{1}{b}} \cdot \frac{1}{b^2} \right) 2\pi b^2}$$

$$= \frac{3\varepsilon_0}{\frac{1}{a}-\frac{1}{b}} \cdot 2\pi \cancel{- \frac{3\varepsilon_0 \cdot 2\pi}{\frac{1}{a}-\frac{1}{b}}} = \frac{6\pi\varepsilon_0}{\frac{1}{a}-\frac{1}{b}}$$

(5) $W_E = \frac{1}{2} \int_{vol} \mathbf{D} \cdot \mathbf{E} \, dV = \frac{1}{2} \int_0^{2\pi} \int_0^{\frac{\pi}{2}} \int_b^a \frac{\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \cdot \frac{1}{r^4} \cdot r^2 \sin\theta \, dr d\theta d\phi$

$$\boxed{\mathbf{D} \cdot \mathbf{E} = \begin{cases} \frac{\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \cdot \frac{1}{r^4} & (0<\theta<\frac{\pi}{2}) \\ \frac{2\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \cdot \frac{1}{r^4} & (\frac{\pi}{2}<\theta<\pi) \end{cases}}$$

$+ \frac{1}{2} \int_0^{2\pi} \int_{\frac{\pi}{2}}^{\pi} \int_b^a \frac{2\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \frac{1}{r^4} r^2 \sin\theta \, dr d\theta d\phi$

$= \frac{1}{\cancel{2}} \cdot \cancel{2}\pi \cdot 1 \cdot \frac{\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \left[ +\frac{1}{r} \right]_a^b \rightarrow \ln\frac{b}{a}$

$+ \frac{1}{\cancel{2}} \cdot \cancel{2}\pi \cdot 1 \cdot \frac{2\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \cdot \left[ +\frac{1}{r} \right]_a^b$

$$= \frac{\pi\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \left( 3 \ln\frac{b}{a} \right) = \frac{3\pi\varepsilon_0 V_0^2}{(\frac{1}{a}-\frac{1}{b})^2} \ln\frac{b}{a}$$

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#6.

$\uparrow \rho d\phi$.

$\nabla V$, V는 $\phi$에 의존.

$\nabla^2 V = 0$.

$$\frac{1}{\rho^2} \cdot \frac{\partial^2 V}{\partial \phi^2} = 0.$$

(a)

$$\frac{\partial^2 V}{\partial \phi^2} = 0. \quad V = A\phi + B.$$

$\phi = 0$. $B = 0$.

$\phi = \alpha$. $V = A\alpha = V_0$. $A = \frac{V_0}{\alpha}$

$$\Rightarrow V = \frac{V_0}{\alpha}\phi.$$

$$\mathbf{E} = -\nabla V = -\frac{1}{\rho} \cdot \frac{\partial}{\partial \phi}\left(\frac{V_0 \phi}{\alpha}\right) a_\phi = -\frac{V_0}{\rho\alpha} a_\phi.$$

$$\mathbf{D} = \varepsilon_0 \mathbf{E} = -\frac{\varepsilon_0 V_0}{\rho \alpha} a_\phi.$$

$$\rho_s = -\frac{\varepsilon_0 V_0}{\rho \alpha}.$$