251.c)

(1)

$\vec{r}_1 = -1\hat{x} + 2\hat{y}$

$\vec{r}_2 = 1\hat{x} + 2\hat{y}$

$\vec{r}_3 = 0\hat{x} + 0\hat{y}$

$\vec{r}_p = 5\hat{x} + 4\hat{y}$

$$\vec{r}_{1p} = \vec{r}_p - \vec{r}_1 = (5 - -1)\hat{x} + (4-2)\hat{y}$$
$$= 6\hat{x} + 2\hat{y}$$

$$\vec{r}_{2p} = \vec{r}_p - \vec{r}_2 = (5-1)\hat{x} + (4-2)\hat{y}$$
$$= 4\hat{x} + 2\hat{y}$$

$$\vec{r}_{3p} = \vec{r}_p - \vec{r}_3 = (5-0)\hat{x} + (4-0)\hat{y}$$
$$= 5\hat{x} + 4\hat{y}$$

$\vec{r}_{1p} = \vec{r}_p - \vec{r}_1 = (5-(-1))\hat{x} + (4-2)\hat{y}$

$= 6\hat{x} + 2\hat{y}$

$\vec{r}_{2p} = \vec{r}_p - \vec{r}_2 = (5-1)\hat{x} + (4-2)\hat{y}$

$= 4\hat{x} + 2\hat{y}$

$\vec{r}_{3p} = \vec{r}_p - \vec{r}_3 = (5-0)\hat{x} + (4-0)\hat{y}$

$= 5\hat{x} + 4\hat{y}$

example: $\hat{r}_{1p} = \dfrac{\vec{r}_{1p}}{|\vec{r}_{1p}|} = \dfrac{6\hat{x}+2\hat{y}}{\sqrt{36+4}}$

$= \dfrac{6\hat{x}}{6.3} + \dfrac{2\hat{y}}{6.3} = .95\hat{x} + .32\hat{y}$

$$\vec{E}_p = k\mu\Bigg[(+1)\frac{6\hat{x}+2\hat{y}}{[6^2+2^2]^{3/2}} + (-2)\frac{4\hat{x}+2\hat{y}}{[4^2+2^2]^{3/2}} + (+4)\frac{5\hat{x}+4\hat{y}}{[5^2+4^2]^{3/2}}\Bigg]$$

$\boxed{\dfrac{\hat{r}_{1p}}{r_{1p}^2}}$

$\dfrac{\vec{r}_{1p}}{(r_{1p}^2)^{3/2}}$

$[-1^2 + 5^2] = -1 \cancel{+} 25 \quad \underline{26}$

$\vec{r}_{2p} = \vec{r}_p - \vec{r}_2 = (5-1)\hat{x} + (4-2)\hat{y}$
$= 4\hat{x} + 2\hat{y}$

$\vec{r}_{3p} = \vec{r}_p - \vec{r}_3 = (5-0)\hat{x} + (4-0)\hat{y}$
$= 5\hat{x} + 4\hat{y}$

example: $\hat{r}_{1p} = \dfrac{\vec{r}_{1p}}{|\vec{r}_{1p}|} = \dfrac{6\hat{x} + 2\hat{y}}{\sqrt{36+4}}$

$= \dfrac{6\hat{x}}{6.3} + \dfrac{2\hat{y}}{6.3} = .95\hat{x} + .32\hat{y}$

$\vec{E}_p = k\mu\left[(+1)\dfrac{6\hat{x} + 2\hat{y}}{[6^2+2^2]^{3/2}}\right.$

$\boxed{\dfrac{\hat{r}_{ip}}{r_{ip}^2}}$

$+ (-2)\dfrac{4\hat{x} + 2\hat{y}}{[4^2+2^2]^{3/2}}$

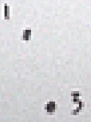
$\dfrac{\vec{r}_{ip}}{(r_{ip}^2)^{3/2}}$

$\left. + (+4)\dfrac{5\hat{x} + 4\hat{y}}{[5^2+4^2]^{3/2}}\right]$

$[-1^2 + 5^2] = \cancel{-1+25}$ 26

$$V_p = \sum_{i=1}^{n} k \frac{q_i}{|\vec{r}_{i,p}|}$$

$$= k\mu \left[\frac{(+1)}{\sqrt{6^2+2^2}} + \frac{(-2)}{\sqrt{4^2+2^2}} + \frac{(+4)}{\sqrt{5^2+4^2}} \right]$$



$$W_1 = 0$$

$$W_2 = q_2 V_{\substack{\text{at } 2 \\ \text{from } 1}}$$

$$W_3 = q_3 V_{\substack{\text{at } 3 \\ \text{from } 1}} + q_3 V_{\substack{\text{at } 3 \\ \text{from } 2}}$$

$\vec{r}_{12} = r_2 - r_1 =$

$(1\hat{x} + 2\hat{y}) - (-1\hat{x} + 2\hat{y})$

$= 2\hat{x}$

$V_{\text{at } 2 \text{ from } 1} = k\mu \cdot \frac{(+1)}{2}$

$W_2 = k\mu \frac{(+1)}{2} \cdot (-2\mu)$

$V_{@3 \text{ from } 1} =: \vec{r}_{13} = \vec{r}_3 - \vec{r}_1 = -1\hat{x} + 2\hat{y}$

$|\vec{r}_{13}| = \sqrt{1^2 + 2^2} = \sqrt{5}$

$= 2.4$

$|\vec{r}_{23}| = |-1\hat{x} - 2\hat{y}| = 2.4$

$\frac{(1)}{2} \cdot (-2\mu)$

$V_{@3}$ from 1 $=:$ $\vec{r}_{13} = \vec{r}_3 - \vec{r}_1 = -1\hat{x} + 2\hat{y}$

$|\vec{r}_{13}| = \sqrt{1^2 + 2^2} = \sqrt{5} = 2.4$

$|\vec{r}_{23}| = |-1\hat{x} - 2\hat{y}| = 2.4$

$W = 0$

$+ -2\mu\mu k\left(\frac{1}{2}\right)$

$+ 4\mu\mu k\left[\left(\frac{(+1)}{2.4}\right) + \frac{(-2)}{2.4}\right]$

$W \cdot [J]$

$V \ \left[\frac{J}{C}\right] \ V.$

$E \ \left[\frac{N}{C}\right] \left[\frac{V}{m}\right] \left[\frac{J}{mC}\right]$

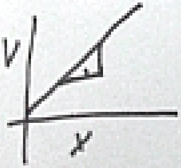
$V = ax + by + c$

$\cancel{V = a\hat{x} + b\hat{y}} + c$

$V = ax + b\,||$

$$\vec{E} = -\frac{\Delta V}{\Delta x}\hat{x} = -a\hat{x}$$

$$\vec{E} = -\frac{\Delta V}{\Delta x}\hat{x} - \frac{\Delta V}{\Delta y}\hat{y}$$



$$= -a\hat{x} - b\hat{y}$$

$V = ax^2 + by^2$ $\quad \partial$

$$\vec{E} = -\vec{\nabla} V = -\left[\frac{\partial V}{\partial x}\hat{x} + \frac{\partial V}{\partial y}\hat{y}\right]$$

$$= -\left[2x\hat{x} + 3by^2\hat{y}\right]$$

#3: 22.0

$r > a$

$$\rho(\vec{r}) = \frac{Q}{\frac{4}{3}\pi a^3}$$

$$\Phi_E = \frac{Q_{enc}}{\varepsilon_0}$$

outside $Q_{enc} = \rho V_{sphere}$

$$= \frac{Q}{\frac{4}{3}\pi a^3}\left(\frac{4}{3}\pi a^3\right)$$

$$= Q$$

$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i = \sum_{\Delta A_i} E_i \cdot \Delta A_i$$

$$= E \sum_{\Delta A_i} \Delta A_i = E(4\pi r^2)$$

$$E(4\pi r^2) = \frac{Q}{\varepsilon_0} \Rightarrow \vec{E} = \frac{Q}{4\pi\varepsilon_0 r^2}\hat{r}$$

$\frac{4}{3}\pi a^3$

$= Q$

$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta \vec{A}_i = \sum_{\Delta A_i} E_i \cdot \Delta A_i$$

$$= E \sum_{\Delta A_i} \Delta A_i = E(4\pi r^2)$$

$$E(4\pi r^2) = \frac{Q}{\varepsilon_0} \Rightarrow \vec{E} = \frac{Q}{4\pi\varepsilon_0 r^2}\hat{r}$$

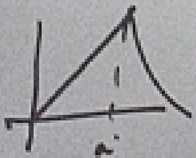
$r < a$

$\vec{E} \parallel \vec{A}$

E uniform

$$Q_{enc} = \rho \cdot V_{G.S.}$$

$$= \frac{Q}{\frac{4}{3}\pi a^3}\left(\frac{4}{3}\pi r^3\right)$$



$$Q_{enc} = Q\left(\frac{r}{a}\right)^3$$

$$\Phi_E = (E \cdot 4\pi r^2)$$

$$E(4\pi r^2) = \frac{Q}{\varepsilon_0}\left(\frac{r}{a}\right)^3$$

$$\vec{E} = \frac{Q r}{\varepsilon_0 a^3} \cdot \frac{1}{4\pi}\hat{r}$$

$$\rho = \rho_0 \frac{r}{a}$$

$$Q = 4\pi \int_0^a \rho_0 \frac{r}{a} \cdot r^2 dr$$

$$= \frac{4\pi}{a} \rho_0 \int_0^a r^3 dr$$

$$= \frac{4\pi}{a} \rho_0 \frac{r^4}{4} \Big|_0^a = \pi \rho_0 a^3$$

$$\rho_0 = \frac{Q}{\pi a^3}$$

$a \quad r_0 \quad \frac{1}{4} \quad r_0 -$

$$\rho_0 = \frac{Q}{\pi a^3}$$

$$\rho = \rho_0 \frac{r}{a}$$

tside $\vec{E}$ $d\vec{A}$

$$\phi_E = \frac{Q_{enc}}{\varepsilon_0}$$

$\parallel \vec{A}$

|const

$$\Phi_E = \oiint \vec{E} \cdot d\vec{A}$$

$$= \oiint E\,dA = E \oiint dA$$

$$= E(4\pi r^2)$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0 r^2} Q \; ; \; \rho_0 = \frac{Q}{\pi a^3}$$

$$\rho_0 = \frac{Q}{\pi a^3}$$

$$\rho = \rho_0 \frac{r}{a}$$

$$\phi_E = \frac{Q_{enc}}{\varepsilon_0}$$

outside

$\vec{E} \parallel \vec{A}$

$|\vec{E}|$ const

$$\phi_E = \oiint \vec{E} \cdot d\vec{A}$$

$$= \oiint E\,dA = E \oiint dA$$

$$= E(4\pi r^2)$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0 r^2} Q \; ; \; \rho_0 = \frac{Q}{\pi a^3}$$

on GS:

$\vec{E} \parallel \vec{A}$

$|\vec{E}|$ uniform

$$Q_{enc} = 4\pi \int_0^r \rho_0 \frac{r}{a} \cdot r^2 \, dr$$

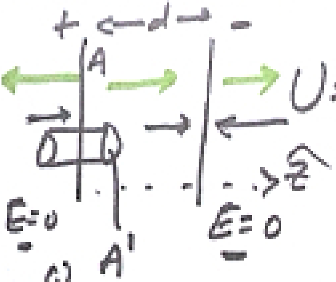
$$= \frac{4\pi\rho_0}{a} \int_0^r r^3 \, dr$$

$$= \frac{4\pi\rho_0}{a} \frac{r^4}{4}$$

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \oint E \, dA = E \oint dA$$

$$\Phi_E = E(4\pi r^2)$$

$$E = \frac{1}{4\pi\epsilon_0} \frac{\pi\rho_0 r^4}{r^2} \qquad r, \; \rho_0 = \frac{Q}{\pi a^3}$$



$$U = \frac{1}{2} C V^2$$

$$\Phi_E = \frac{q_{enc}}{\varepsilon_0}$$

$$\sigma = \frac{q}{A}$$

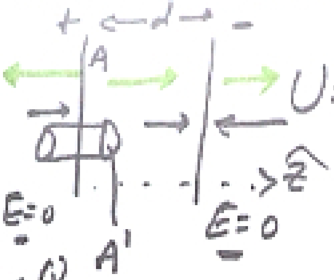
$$\Phi_E = \underline{EA'} \qquad q_{enc} = \sigma A'$$

$$\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{z} \qquad \therefore\ EA' = \frac{\sigma A'}{\varepsilon_0} \Rightarrow \vec{E} = \frac{\sigma}{\varepsilon_0}\hat{z}$$

$$\vec{E} = -\frac{\Delta V}{\Delta z}\hat{z} \qquad V = Ed \quad \left(E = -\frac{dV}{dx} = -\frac{\Delta V}{d}\right)$$

$$C \equiv \left|\frac{q}{V}\right| = \frac{\sigma A}{\frac{\sigma}{\varepsilon_0} d} = \underline{\underline{\varepsilon_0 \frac{A}{d}}}$$

So:



$U = \frac{1}{2} C V^2$

$E = 0$ $\qquad$ $E = 0$ $\qquad$ $\Phi_E = \frac{q_{enc}}{\varepsilon_0}$

$\sigma = \frac{q}{A}$

$\Phi_E = \underline{EA'}$ $\qquad$ $q_{enc} = \sigma A'$

$\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{z}$ $\qquad$ $\therefore EA' = \frac{\sigma A'}{\varepsilon_0} \Rightarrow \vec{E} = \frac{\sigma}{\varepsilon_0}\hat{z}$

$\vec{E} = -\frac{\Delta V}{\Delta x}$ $\qquad$ $V = Ed$ $\quad \left(E = -\frac{\Delta V}{\Delta x} = -\frac{\Delta V}{d} \right)$

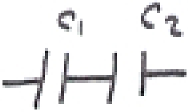
$$C = \left| \frac{q}{V} \right| = \frac{\sigma A}{\frac{\sigma}{\varepsilon_0} d} = \underline{\underline{\varepsilon_0 \frac{A}{d}}}$$

So:

$$C = K C_{geo} = 200 \times 8.8\mu f$$
$$= 17.6 \times 10^{-4} f \quad 10^{-6}$$

$$C_1 = 1760\mu f$$

$$C_2 = 1760\mu f$$



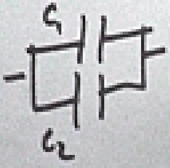
Series: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$

$$= \frac{2}{1760} \Rightarrow C = \frac{1760}{2}$$

Series: $= 8.8\mu f$

Parallel: $C = C_1 + C_2 = 3520\mu f$

$$3.5 \times 10^{-3} f$$



$\varepsilon_0 = 8.854 \times 10^{-12}$

$$C_{geo} = 8.854^{\times 10^{-12}} \left(\frac{1000\, m^2}{1 \times 10^{-3} m} \right)^{\times 10^{-3}}$$

$$= 8.854 \times 10^{-12} (1 \times 10^3 \times 1 \times 10^3)$$

$$= 8.854 \times 10^{-6} f = \underline{8.854} \mu F$$

U: $E = \frac{V}{d} = \frac{100\, V}{1 \times 10^{-3} m}$ $\left(u_E = \frac{1}{2} \varepsilon_0 E^2 \right)$

$$= 1 \times 10^2 \times 10^3 = 1 \times 10^5 \frac{V}{m}$$

$$U = \frac{1}{2} CV^2 = 4.42 \times 10^{-6} (100)^2$$

$$= 4.4 \times 10^{-6} \times 1 \times 10^4$$

$\boxed{U_{01}}$ $= 4.4 \times 10^{-2}\, J$

$\varepsilon_0 = 8.854 \times 10^{-12}$

$$C_{geo} = 8.854^{\times 10^{-12}} \left(\frac{1000\ m^2}{1 \times 10^{-3} m} \right)^{\times 10^{-1}}$$

$$= 8.854 \times 10^{-12} (1 \times 10^{3} \times 1 \times 10^{3})$$

$$= 8.854 \times 10^{-6} f = \underline{8.854} \mu F$$

$$U: \quad E = \frac{V}{d} = \frac{100\ V}{1 \times 10^{-3} m} \quad \left(u_E = \frac{1}{2} \varepsilon_0 E^2 \right)$$

$$= 1 \times 10^{2} \times 10^{3} = 1 \times 10^{5} \frac{V}{m}$$

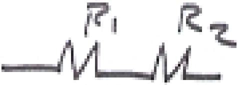
$$U = \frac{1}{2} C V^2 = 4.42 \times 10^{-6} (100)^2$$

$$= 4.4 \times 10^{-6} \times 1 \times 10^{4}$$

$$= 4.4 \times 10^{-2}\ J$$

u01

$R_1 = 100\,\Omega$ $R_2 = 300\,\Omega$

R_{Series}: 

$R_1 + R_2 = 400\,\Omega$

R_{par}: 

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R} = \frac{1}{300} + \frac{1}{100} \Rightarrow$

$\therefore R_{\parallel} \cong 75\,\Omega$

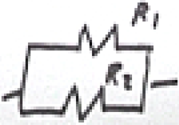
$$\frac{R_{ser}}{R_{par}} = \frac{400}{75} = 5.33$$

$R_1 = 100\Omega \quad R_2 = 300\Omega$

R_{series}:

$R_1 + R_2 = 400\Omega$

R_{par}:



$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R} = \frac{1}{300} + \frac{1}{100} \Rightarrow$

$\therefore R_{\parallel} \cong 75\Omega$

$\frac{R_{ser}}{R_{par}} = \frac{400}{75} = 5.33$

$$V = k\frac{Q}{r} \rightarrow V = k\frac{Q}{a}$$

$$C = \frac{Q}{V} = \frac{Q}{Qk/a} = \frac{a}{k}$$

$s = \text{radius}$

$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta \vec{A}_i$$
$$= E(2\pi s h)$$

$$\cancel{Q_{enc}} = \oint \vec{E} \cdot d\vec{A}$$

$\lambda = \frac{q}{h}$

$$= E(2\pi s h)$$

$$Q_{enc} = \lambda h$$

$$\vec{E} = \frac{\lambda}{2\pi \epsilon_0 s} \hat{s}$$

$$\cancel{Q_{enc}} = \oiint \vec{E}\, d\vec{A}$$

$$= E(2\pi s h)$$

$$\Delta V = \sum \vec{E} \cdot \Delta \vec{S}$$

$$= \int \vec{E} \cdot d\vec{s}$$

$$= \sum \frac{\lambda}{2\pi\varepsilon_0} \frac{\Delta s}{s} = \frac{\lambda}{2\pi\varepsilon_0} \sum \frac{\Delta s}{s}$$

$$= \frac{\lambda}{2\pi\varepsilon_0} \ln\left(\frac{b}{a}\right)$$

$$\Delta V = \int_a^b \frac{\lambda}{2\pi\varepsilon_0} \frac{ds}{s} = \frac{\lambda}{2\pi\varepsilon_0} \ln\left(\frac{b}{a}\right)$$

$$C = \frac{Q}{V} = \frac{\lambda h}{\frac{\lambda}{2\pi\varepsilon_0} \ln\left(\frac{b}{a}\right)}$$

s = radius

$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \vec{\Delta A}_i$$
$$= E(2\pi s h)$$

$$\lambda = \frac{q}{h} \qquad \cancel{Q_{enc}} = \oiint \vec{E}\, d\vec{A}$$
$$= E(2\pi s h)$$

$$Q_{enc} = \lambda h$$

$$\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 s}\,\hat{s}$$

$$\frac{\lambda h}{\varepsilon_0} \; \cancel{Q_{enc}} = \oint \vec{E}\, d\vec{A}$$

$$= E(2\pi s h)$$

$$Q_{enc} = \lambda h$$

$$\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 s}\hat{s}$$

$$\Delta V = \sum \vec{E}\cdot\Delta\vec{s}$$

$$= \underline{\int \vec{E}\cdot d\vec{s}}$$

$$= \sum \frac{\lambda}{2\pi\varepsilon_0 s}\Delta s = \frac{\lambda}{2\pi\varepsilon_0}\sum\frac{\Delta s}{s}$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)$$

$$\Delta V = \int_a^b \frac{\lambda}{2\pi\varepsilon_0}\frac{ds}{s} = \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)$$

$$C = \frac{Q}{V} = \frac{\lambda h}{\frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)}$$

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

Q_{enc}

$$\Delta V = \int_a^b \frac{\lambda}{2\pi\varepsilon_0} \frac{ds}{s} = \frac{\lambda}{2\pi\varepsilon_0}$$

$\vec{E}.$

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

$$U = \frac{1}{2} C V^2$$

$$= \frac{1}{\cancel{2}} \frac{\cancel{2\pi\varepsilon_0} h}{\ln\left(\frac{b}{a}\right)} \cdot \left[\frac{\lambda}{2\pi\varepsilon_0} \ln\left(\frac{b}{a}\right)\right]^2$$

$$= \frac{1}{2} \frac{h}{1} \cdot \frac{\lambda^2}{2\pi\varepsilon_0} \cdot \ln\left(\frac{b}{a}\right)$$

$$U = \frac{1}{2} C V^2 \qquad u_E = \frac{1}{2}\varepsilon_0 E^2$$