General Physics (II) **期中考 I** **Apr. 13, 2018**

試卷請註明、姓名、班級、學號，請遵守考場秩序

I.計算題(55 points) (所有題目必須有計算過程,否則不予計分)

1. (10 pts) Fig. 1 shows a cross sectional view of uniform charge distribution in an infinitely long cylindrical shell. The charge density is ρ (ρ > 0), the inner radius is 2R, and the outer radius 3R, the axis of the shell coincides with the z-axis. A second uniform cylindrical charge distribution is added to the system, with the axis of symmetry parallel to the z-axis but passing (R,0,0). The radius of the cylinder is R, and the charge density is –ρ, Determine the magnitude and direction of the E-field along the x-axis ($0 \le x < 3R$).

2. (a) (5 pts) As shown in Fig.2(a), two conducting coaxial cylinders with inner and outer radius ***a***, ***6a*** and length ***ℓ***. Calculate the capacitance of this device. Ignore the end effects.

   (b)(5 pts) Now the region between the radii 3***a*** and 4***a*** is filled with a metal shell, as shown in Fig. 2(b). What is the capacitance of this new device?

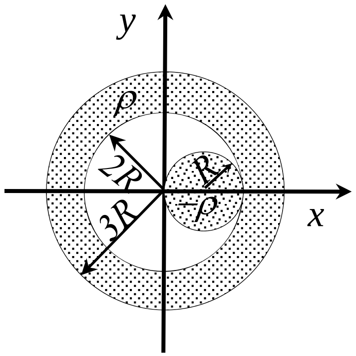


Fig. 1

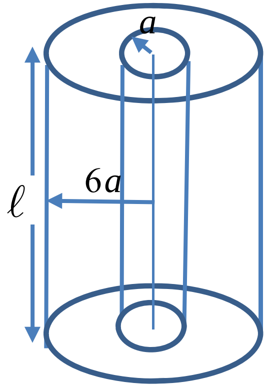


Fig. 2(a)

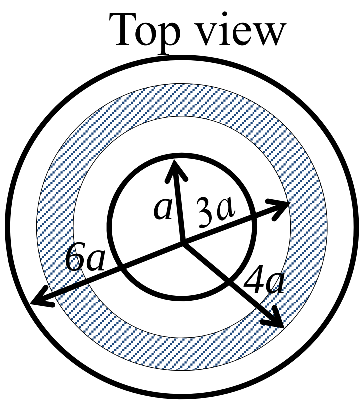


Fig. 2(b)

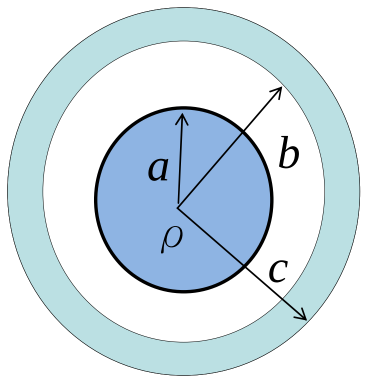


Fig. 3

3. (15 pts) As shown in Fig. 3, the volume charge density ρ within the sphere of radius ***a*** is distributed in spherically symmetric fashion with $\rho(r) = \rho_0[1- r^2/\boldsymbol{a}^2]$, and it is concentric with a spherical conducting shell of inner radius b and outer radius c. This conducting shell has no charge. Determine **the electric field E (magnitude and direction)**, **the electric potential V**, as a function of the radial distance ***r*** in the regions of (1) $\boldsymbol{r} > \boldsymbol{c}$; (2) $\boldsymbol{b} < \boldsymbol{r} < \boldsymbol{c}$, (3) $\boldsymbol{a} < \boldsymbol{r} < \boldsymbol{b}$, (4) $\boldsymbol{r} < \boldsymbol{a}$, and **the total charges** on the inner and outer surfaces of the conducting shell,respectively. Let electric potential V=0 at infinity.

4. (20 pts) Fig. 4 shows two line charge distributions in the ***x-y*** plane. The charge density is $\boldsymbol{\lambda_1 = \lambda_0(1 - x/a)}$ for the rod on ***x***-axis (***-a*** < ***x*** < ***a***) and $\boldsymbol{\lambda_2 = \lambda_0 \sin\theta}$ for the semicircle. Here ***a*** is the radius of the semi-circle, λ_0 is a positive constant and θ is the angle from +***x***-axis.
(a) (11 pts) Evaluate the electric field (***x-, y-,*** and ***z***-components) and the potential at point ***P*** on the ***z***-axis due to the AB line segment .
(b) (9 pts) Evaluate the electric field (***x-, y-,*** and ***z***-components) and the potential at point ***P*** on the ***z***-axis due to the semicircle in Fig. 4.

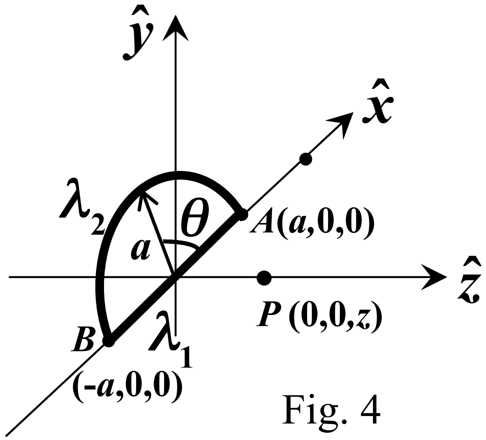


Fig. 4

Integration Formula for reference

$$\int \frac{dx}{\sqrt{x^2 \pm b^2}} = \ln\left(x + \sqrt{x^2 \pm b^2}\right) \qquad \int \frac{x^2 dx}{\sqrt{x^2 \pm b^2}} = \frac{x\sqrt{x^2 \pm b^2}}{2} - \frac{b^2}{2}\ln\left(x + \sqrt{x^2 \pm b^2}\right)$$

$$\int \frac{dx}{\left(x^2 \pm b^2\right)^{3/2}} = \frac{\pm x}{b^2\sqrt{x^2 \pm b^2}} \qquad \int \frac{x^2 dx}{\left(x^2 \pm b^2\right)^{3/2}} = \frac{-x}{\sqrt{x^2 \pm b^2}} + \ln\left(x + \sqrt{x^2 \pm b^2}\right)$$

Fig. 5

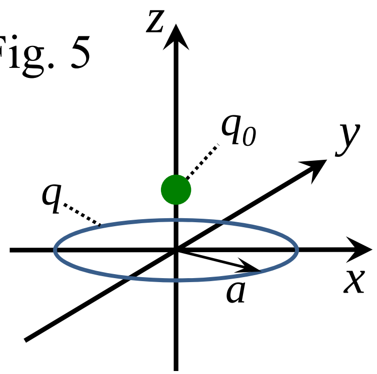
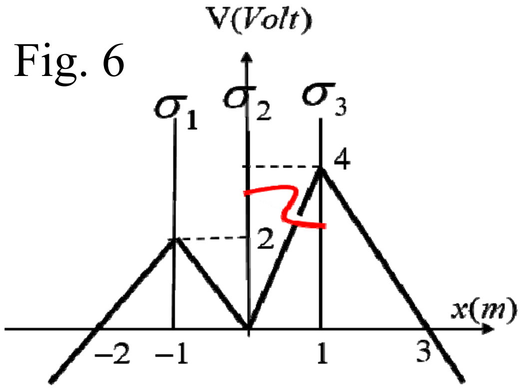


Fig. 6



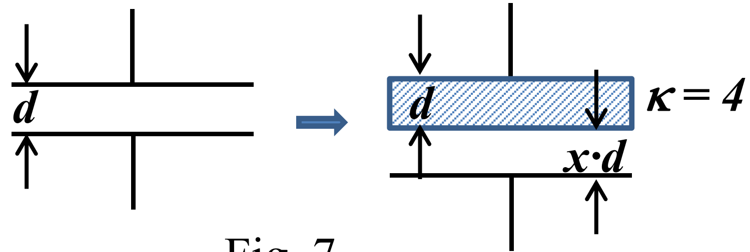


Fig. 7

II.選擇題(45 points)

1. (5 pts) Fig. 5 shows a uniformly charged ring in the ***x-y*** plane, centered at the origin, with radius ***a*=0.1m** and total charge $\boldsymbol{q=10^{-7}}$**C**. Imagine a small ball of mass **0.001kg** and negative charge $\boldsymbol{q_0= -10^{-8}}$**C**. The ball is released from rest at the point $\boldsymbol{d=10^{-3}}$**m** and constrained to move along the *z* axis only, with no damping. The ball oscillates along the *z* axis between ***z=d*** and ***z=-d*** in a simple harmonic motion. What is the period ***T*** of this oscillation (in SI unit and ignore the gravitation)?

(A) $T < 0.1$ **(B)** $0.1 \le T < 0.3$ **(C)** $0.3 \le T < 0.5$ **(D)** $0.5 \le T < 0.8$ **(E)** $0.8 \le T < 1.0$
(F) $1.0 \le T < 3.0$ **(G)** $3 \le T < 5$ **(H)** $5 \le T < 7$ **(J)** $7 \le T < 9$ **(K)** $9 \le T < 10$
(L) $10 \le T < 30$ **(M)** $30 \le T < 50$ **(N)** $50 \le T < 70$ **(O)** $70 \le T < 90$ **(P)** $90 \le T < 100$

2. (5 pts) Three uniformly charged planes are located at x = -1 *m*, x =0, and x = 1 *m* with surface charge density σ_1, σ_2 and σ_3, respectively. The potential as a function of the x-cooridnate is shown in Fig. 6. Now the surfaces with σ_2 and σ_3 are connected with a conducting wire (the curved line in Fig. 6) and wait till the charge is redistributed. The new charge densities σ_2' and σ_3' on the corresponding planes are

(A) $(3\ \varepsilon_0, -3\ \varepsilon_0)$ (B) $(-3\ \varepsilon_0, 3\ \varepsilon_0)$ (C) $(2\ \varepsilon_0, -2\ \varepsilon_0)$ (D) $(-2\ \varepsilon_0, 2\ \varepsilon_0)$ (E) $(\varepsilon_0, -\varepsilon_0)$
(F) $(-\varepsilon_0, \varepsilon_0)$ (G) (0, 0) (H) $(3\ \varepsilon_0, 3\ \varepsilon_0)$

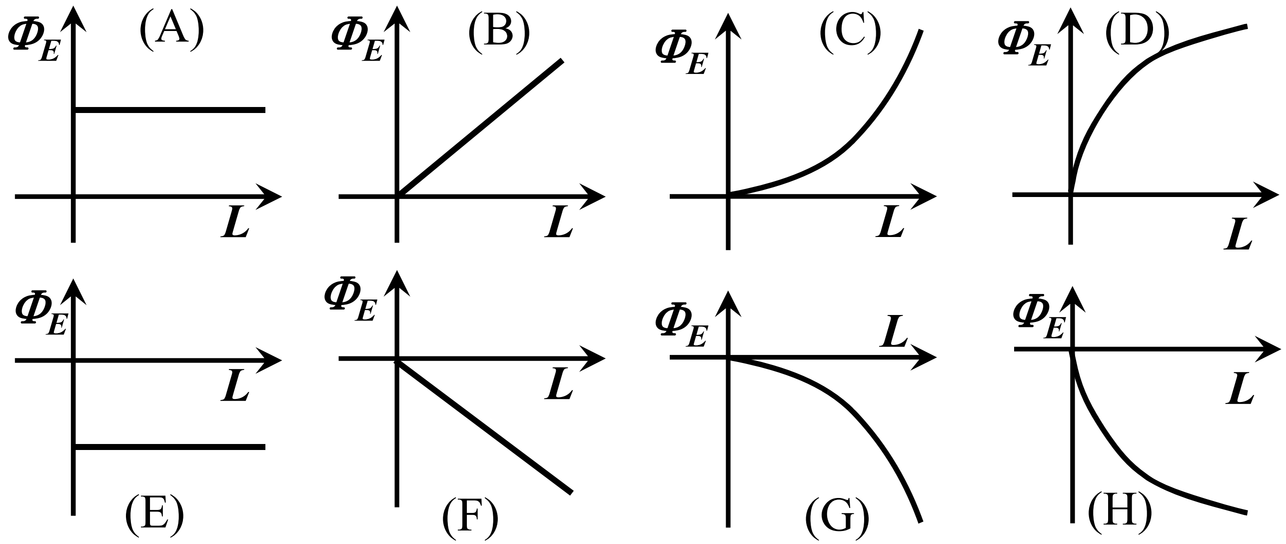
3. (5 pts) A particle with mass 0.14 g and a charge of 5.0×10^{-6} C is placed in a region of space where the potential is given by $V(x) = (2\ V/m^2)\ x^2 - (3\ V/m^3)x^3$. If the particle starts at $x = 2$ m, the initial acceleration in x direction in unit m/s^2 of will be

(A) -3 (B) -2 (C) -1 (D) 0 (E) 1 (F) 2 (G) 3

4. (5 pts) As shown in Fig. 7 ,A capacitor C_0 is consisted of two parallel plates with separation distance ***d***. Now the space between two plates is filled with dielectric material with dielectric constant $\boldsymbol{\kappa = 4}$. Then the separation distance increases by a distance of $\boldsymbol{x \cdot d}$. The new capacitance of this new capacitor is still C_0. What is the value of ***x***?

(A) 1/4 (B) 1/3 (C) 1/2 (D) 2/3 (E) 3/4 (F) 1 (G) 4/3 (H) 5/4

5. (5 pts) Fig. 8 shows a cylindrical Gaussian surface ***S,*** whose axis of symmetry coincides with the x-axis. The left end of ***S*** is fixed at $\boldsymbol{x} = 0$, and the other end is adjustable. If there is a continuous charge distribution with charge density $\rho(\vec{r}) = \boldsymbol{A}x^2$, where ***A*** is a positive constant. Let $\boldsymbol{\Phi_E}$ be the electric flux through ***S***, Which of the following shows the correct relation between $\boldsymbol{\Phi_E}$ and ***L***?



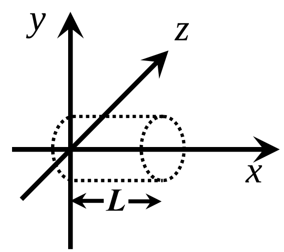
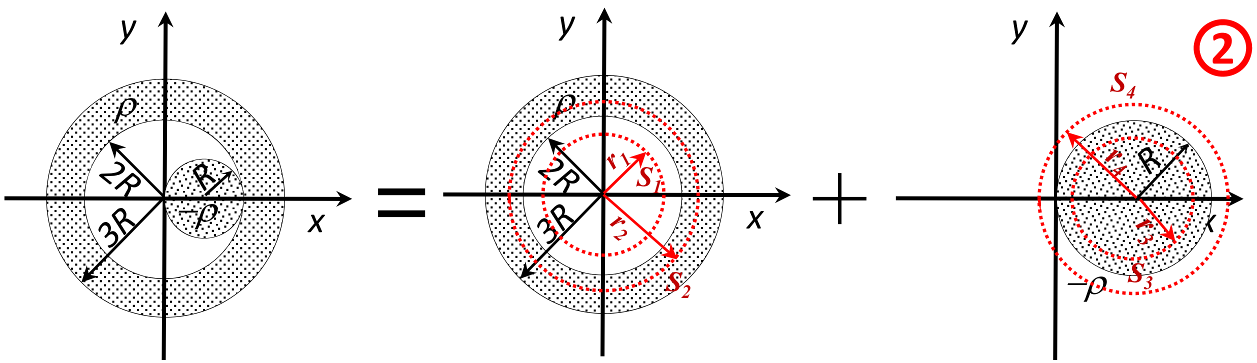


Fig. 8

1	2	3	4	5	6	7	8	9	10
F	D	E	E	C	L	C	C	B	D
11	12	13	14	15					
H	F	F	B	A					

1. (10 pts) Fig. 1 shows a cross sectional view of uniform charge distribution in an infinitely long cylindrical shell. The charge density is ρ (ρ > 0), the inner radius is 2*R*, and the outer radius 3*R*, the axis of the shell coincides with the z-axis. A second uniform cylindrical charge distribution is added to the system, with the axis of symmetry parallel to the z-axis but passing (*R*,0,0). The radius of the cylinder is *R*, and the charge density is −ρ, Determine the magnitude and direction of the E-field along the x-axis (0 ≤ x< 3*R*).



For outer shell, and x<2R,
Choose a cylindrical surface S_1 with length ℓ_1, and apply Gauss's law, i.e.

$$\Phi_E = \oiint_{S_1} \vec{E}\cdot d\vec{A} = E(r_1)2\pi r_1\ell = 0$$ ①

$$\Rightarrow E(r_1)=0 \quad \Rightarrow E(x)=0, \text{ for } 0\le x<2R$$

For x≥2R, Choose a cylindrical surface S_2 with length ℓ_2.

$$\Phi_E = \oiint_{S_2} \vec{E}\cdot d\vec{A} = E(r_2)2\pi r_2\ell = \frac{\rho\pi(r_2^2-4R^2)\ell}{\varepsilon_0}$$

$$\Rightarrow E(r_2) = \frac{\rho(r_2^2-4R^2)}{2\pi r_2\varepsilon_0} \quad \Rightarrow \vec{E}(x) = \frac{\rho(x^2-4R^2)}{2x\varepsilon_0}\hat{x}$$ ① ①

For inner cylinder, and |x-R|<R,
Choose a cylindrical surface S_3 with radius r_3 length ℓ_3, and apply Gauss's law, i.e.

$$\Phi_E = \oiint_{S_3} \vec{E}\cdot d\vec{A} = E(r_3)2\pi r_3\ell = \frac{\rho\pi(r_3^2)\ell}{\varepsilon_0}$$

$$\Rightarrow E(r_3) = \frac{\rho r_3}{2\varepsilon_0} \quad \Rightarrow E(x) = \frac{\rho|x-R|}{2\varepsilon_0}$$ ①

For $0 \le x<R$, $|x-R| = -(x-R)$

$$\Rightarrow \vec{E}(x) = \frac{-\rho(x-R)}{2\varepsilon_0}\hat{x}$$ ①

For $R \le x<2R$, $|x-R| = (x-R)$

$$\Rightarrow \vec{E}(x) = \frac{-\rho(x-R)}{2\varepsilon_0}\hat{x}$$ ①

For inner cylinder, and |x-R|≥R,
Choose a cylindrical surface S_4 with radius r_4 length ℓ_4, and apply Gauss's law, i.e.

$$\Phi_E = \oiint_{S_4} \vec{E} \cdot d\vec{A} = E(r_4)2\pi r_4 \ell = \frac{\rho\pi(R^2)\ell}{\varepsilon_0}$$

$$\Rightarrow E(r_4) = \frac{\rho R^2}{2\varepsilon_0 r_4} \quad ① \quad \Rightarrow E(x) = \frac{\rho R^2}{2\varepsilon_0 |x-R|}$$

For $2R \le x < 3R$, $|x - R| = (x - R)$

$$\Rightarrow E(x) = \frac{-\rho R^2}{2\varepsilon_0 (x-R)} \hat{x} \quad ①$$

For the total E-field with $0 \le x < R$,

$$\vec{E}(x) = \frac{-\rho(x-R)}{2\varepsilon_0} \hat{x}$$

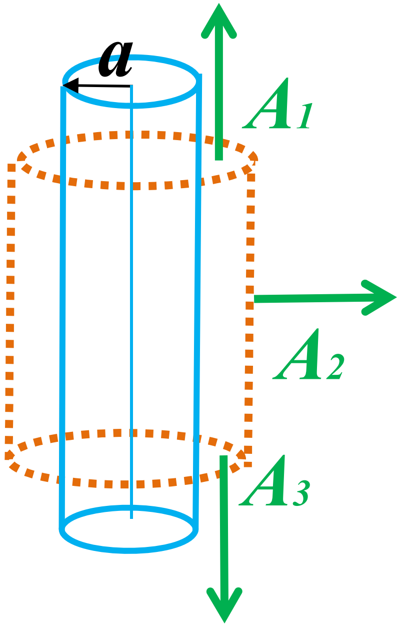
For the total E-field with $R \le x < 2R$,

$$\vec{E}(x) = \frac{-\rho(x-R)}{2\varepsilon_0} \hat{x}$$

For the total E-field with $2R \le x < 3R$,

$$E(x) = \frac{-\rho R^2}{2\varepsilon_0 (x-R)} \hat{x} + \frac{\rho(x^2 - 4R^2)}{2x\varepsilon_0} \hat{x}$$

(a) **Problem 2**



$$\Phi_E = \oiint \vec{E}\cdot d\vec{A} = \int_{A_1} \vec{E}\cdot d\vec{A} + \int_{A_2} \vec{E}\cdot d\vec{A} + \int_{A_3} \vec{E}\cdot d\vec{A}$$

$$= 0 + EA_2 + 0 = E(2\pi r L)$$

$$= \frac{Q_{in}}{\varepsilon_0} = \frac{Q(\frac{L}{l})}{\varepsilon_0}$$

1

$$\vec{E} = \frac{Q}{\varepsilon_0(2\pi r l)}\hat{r}$$ 1

1

$$\Delta V = -\int_a^{6a} \vec{E}\cdot d\vec{l} = -\int_a^{6a} \frac{Q}{\varepsilon_0(2\pi r l)}\hat{r}\cdot d\hat{r}$$

$$= -\frac{Q}{\varepsilon_0(2\pi l)}\int_a^{6a}\frac{1}{r}\,dr = -\frac{Q}{\varepsilon_0(2\pi l)}\ln(6)$$ 1

$$C = \frac{Q}{|\Delta V|} = \frac{2\pi\varepsilon_0 l}{\ln(6)}$$ 1

(b) Method I

(I) in $a < r < 3a$

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

$$V(r) - V(a) = -\int_a^r \vec{E}\cdot d\vec{l} = -\frac{Q}{\varepsilon_0(2\pi l)}\ln\left(\frac{r}{a}\right)$$

$$V(3a) - V(a) = -\frac{Q}{\varepsilon_0(2\pi l)}\ln(3) \quad 1$$

(II) in $3a < r < 4a$

$$\vec{E} = 0$$

$$V(4a) - V(3a) = V(r) - V(3a) = 0 \quad 1$$

(III) in $4a < r < 6a$

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

$$V(r) - V(4a) = -\int_{4a}^r \vec{E}\cdot d\vec{l} = -\frac{Q}{\varepsilon_0(2\pi l)}\ln\left(\frac{r}{4a}\right)$$

$$V(6a) - V(4a) = -\frac{Q}{\varepsilon_0(2\pi l)}\ln\left(\frac{3}{2}\right) \quad 1$$

$\Rightarrow$

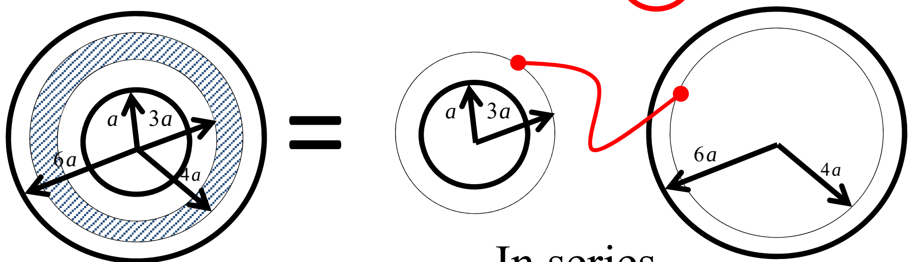
1

$$\Delta V = V(6a) - V(a) = -\frac{Q}{\varepsilon_0(2\pi l)}\ln\left(\frac{3}{2}\right) - 0 - \frac{Q}{\varepsilon_0(2\pi l)}\ln(3)$$

$$C = \frac{Q}{|\Delta V|} = \frac{2\pi\varepsilon_0 l}{2\ln(3) - \ln 2} \quad 1$$

(b) Method II

2



In series

$$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} \quad 1$$

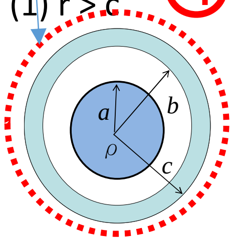
$$C_1 = \frac{2\pi\varepsilon_0 l}{\ln(3)} \quad \text{and} \quad C_2 = \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{3}{2}\right)} \quad 1$$

$$\Rightarrow \quad C = \frac{Q}{|\Delta V|} = \frac{2\pi\varepsilon_0 l}{2\ln(3) - \ln 2} \quad 1$$

Problem 3

Guass's surface

(1) r > c 1



$$Q=\int_0^a \rho_0\left[1-\frac{r^2}{a^2}\right]4\pi r^2 dr=\frac{8}{15}\pi\rho_0 a^3$$

$$\oint \vec{E}\cdot d\vec{A}=\frac{Q_{encl}}{\epsilon_0}$$

$$E\ 4\pi r^2=\frac{Q}{\epsilon_0}=\frac{1}{\epsilon_0}\frac{8}{15}\pi\rho_0 a^3$$

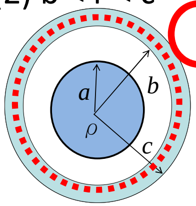
$$\vec{E}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15r^2}\hat{r}=\frac{1}{\epsilon_0}\frac{2\rho_0 a^3}{15r^2}\hat{r}$$ 1

$$\text{V(r)-V}(\infty)=-\int_\infty^r \vec{E}\cdot d\vec{r}$$

$$\text{V(r)}=-\int_\infty^r \frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15r^2}dr=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15r}$$ 1

$$\text{V(c)}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15c}$$

(2) b < r < c 1



$\vec{E}=0\ within\ metal$ 1

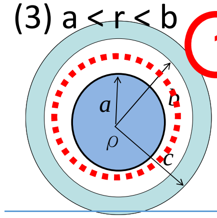
$$Q_b=-Q=-\frac{8}{15}\pi\rho_0 a^3$$ 1

$$Q_c=Q=\frac{8}{15}\pi\rho_0 a^3$$

$$\text{V(r)-V(c)}=0$$

$$\text{V(r)=V(c)}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15c}$$ 1

(3) a < r < b 1

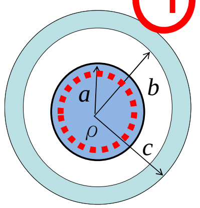


$$\vec{E}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15r^2}\hat{r}=\frac{1}{\epsilon_0}\frac{2\rho_0 a^3}{15r^2}\hat{r}$$ 1

$$\text{V(r)-V}(\infty)=-\int_\infty^r \vec{E}\cdot d\vec{r}=-\{\int_\infty^c \vec{E}\cdot d\vec{r}+\underbrace{\int_c^b \vec{E}\cdot d\vec{r}}_{0}+\int_b^r \vec{E}\cdot d\vec{r}\}$$

$$\text{V(r)}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15c}-0+\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15r}-\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15b}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15}\left(\frac{1}{r}-\frac{1}{b}+\frac{1}{c}\right)$$ 2

(4) r < a 1



$$E\ 4\pi r^2=\frac{1}{\epsilon_0}\int_0^r \rho_0\left[1-\frac{r^2}{a^2}\right]4\pi r^2 dr$$

$$\vec{E}=\frac{\rho_0}{\epsilon_0}\left[\frac{r}{3}-\frac{r^3}{5a^2}\right]\hat{r}$$ 1

$$\text{V(r)-V}(\infty)=-\int_\infty^r \vec{E}\cdot d\vec{r}=-\{\int_\infty^c \vec{E}\cdot d\vec{r}+\int_c^b \vec{E}\cdot d\vec{r}+\int_b^a \vec{E}\cdot d\vec{r}+\int_a^r \vec{E}\cdot d\vec{r}\}$$

$$\text{V(r)}=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15}\left(\frac{1}{a}-\frac{1}{b}+\frac{1}{c}\right)-\int_a^r\frac{\rho_0}{\epsilon_0}\left[\frac{r}{3}-\frac{r^3}{5a^2}\right]dr$$ 2

$$=\frac{1}{4\pi\epsilon_0}\frac{8\pi\rho_0 a^3}{15}\left(\frac{1}{a}-\frac{1}{b}+\frac{1}{c}\right)+\frac{\rho_0}{\epsilon_0}\left[-\frac{r^2}{6}+\frac{r^4}{20a^2}+\frac{7a^2}{60}\right]=\frac{\rho_0}{\epsilon_0}\left[\frac{r^4}{20a^2}-\frac{r^2}{6}+\frac{a^2}{4}-\frac{2a^3}{15b}+\frac{2a^3}{15c}\right]$$

Problem 4

$$d\vec{E} = \frac{kdq}{\left|\vec{r}-\vec{r}'\right|^3}\left(\vec{r}-\vec{r}'\right) \qquad dV = \frac{kdq}{\left|\vec{r}-\vec{r}'\right|}$$

11 pts

1. For the E-field results from the charge on AB line segment,

$$\vec{r} = (0,0,z), \quad \vec{r}' = (x',0,0) \qquad dq = \lambda_1 dx' = \lambda_0\left(1-\frac{x'}{a}\right)dx'$$ 1 pts

$$\left|\vec{r}-\vec{r}'\right| = \left|(-x',0,z)\right| = \sqrt{x'^2+z^2}$$ 1 pts

0, odd function

1 pts

$$V_P^{(1)} = \int_{-a}^{a}\frac{kdq}{\left|\vec{r}-\vec{r}'\right|} = k\int_{-a}^{a}\frac{\lambda_0\left(1-\frac{x'}{a}\right)dx'}{\left(x'^2+z^2\right)^{1/2}} = k\int_{-a}^{a}\frac{\lambda_0 dx'}{\left(x'^2+z^2\right)^{1/2}} - \frac{k}{a}\cancel{\int_{-a}^{a}\frac{\lambda_0 x' dx'}{\left(x'^2+z^2\right)^{1/2}}}$$

$$= 2k\lambda_0\int_0^a\frac{dx'}{\left(x'^2+z^2\right)^{1/2}} \boxed{= 2k\lambda_0 \ln\frac{a+\sqrt{z^2+a^2}}{z}}$$

1 pts 1 pts

$$\int\frac{dx}{\sqrt{x^2\pm b^2}} = \ln\left(x+\sqrt{x^2\pm b^2}\right)$$

$$\vec{E}^{(1)} = \int d\vec{E} = \int_{-a}^{a} \frac{kdq}{\left|\vec{r}-\vec{r}'\right|^3}\left(\vec{r}-\vec{r}'\right) = k\int_{-a}^{a} \frac{\lambda_0\left(1-\frac{x'}{a}\right)dx'}{\left(x'^2+z^2\right)^{3/2}}(-x',0,z)$$ **1 pts**

0, odd function

$$E_x^{(1)} = k\int_{-a}^{a} \frac{-\lambda_0 x' dx'}{\left(x'^2+z^2\right)^{3/2}} + \frac{k\lambda_0}{a}\int_{-a}^{a} \frac{x'^2 dx'}{\left(x'^2+z^2\right)^{3/2}} = \frac{2k\lambda_0}{a}\int_{0}^{a} \frac{x'^2 dx'}{\left(x'^2+z^2\right)^{3/2}}$$ **1 pts**

$$\boxed{= \frac{2k\lambda_0}{a}\left[\frac{-a}{\sqrt{a^2+z^2}} + \ln\left(\frac{a+\sqrt{a^2+z^2}}{z}\right)\right]}$$ **1 pts**

$$\int \frac{x^2 dx}{\left(x^2 \pm a^2\right)^{3/2}} = \frac{-x}{\sqrt{x^2 \pm a^2}} + \ln\left(x+\sqrt{x^2 \pm a^2}\right)$$

$$\boxed{E_y^{(1)} = 0}$$ **1 pts**

$$\int \frac{dx}{\left(x^2 \pm a^2\right)^{3/2}} = \frac{\pm x}{a^2\sqrt{x^2 \pm a^2}}$$

1 pts

$$E_z^{(1)} = k\int_{-a}^{a} \frac{\lambda_0 z dx'}{\left(x'^2+z^2\right)^{3/2}} - \frac{k\lambda_0 z}{a}\int_{-a}^{a} \frac{x' dx'}{\left(x'^2+z^2\right)^{3/2}} = 2k\lambda_0 z\int_{0}^{a} \frac{dx'}{\left(x'^2+z^2\right)^{3/2}}$$

$$\boxed{= 2k\lambda_0 \frac{a}{z\sqrt{a^2+z^2}}}$$ **1 pts**

0, odd function

9 pts

2. For the E-field results from the charge on AB semi-circle,

$$\vec{r} = (0,0,z),\quad \vec{r}' = (x', y', 0) = (a\cos\theta, a\sin\theta, 0) \qquad dq = \lambda_2 d\ell = \lambda_0 \sin\theta \left(a d\theta\right)$$

1 pts 1 pts

$$\left|\vec{r} - \vec{r}'\right| = \left|(-x', -y', z)\right| = \sqrt{a^2 + z^2}$$

$$V_P^{(2)} = \int_0^\pi \frac{kdq}{\left|\vec{r} - \vec{r}'\right|} = k\int_0^\pi \frac{\lambda_0 a \sin\theta d\theta}{\left(a^2 + z^2\right)^{1/2}} = \frac{2k\lambda_0 a}{\left(a^2 + z^2\right)^{1/2}}$$

2 pts

$$\vec{E}^{(2)} = \int_0^\pi \frac{kdq}{\left|\vec{r} - \vec{r}'\right|^3}\left(\vec{r} - \vec{r}'\right) = k\int_0^\pi \frac{\lambda_0 a \sin\theta d\theta}{\left(a^2 + z^2\right)^{3/2}}(-a\cos\theta, -a\sin\theta, z)$$

$$E_x^{(2)} = \frac{-k\lambda_0 a^2}{\left(a^2 + z^2\right)^{3/2}}\int_0^\pi \cos\theta \sin\theta \, d\theta = 0$$

1 pts

$$E_z^{(2)} = \frac{k\lambda_0 az}{\left(a^2 + z^2\right)^{3/2}}\int_0^\pi \sin\theta \, d\theta = \frac{2k\lambda_0 az}{\left(a^2 + z^2\right)^{3/2}}$$

1 pts 1 pts

$$E_y^{(2)} = \frac{-k\lambda_0 a^2}{\left(a^2 + z^2\right)^{3/2}}\int_0^\pi \sin^2\theta \, d\theta = \frac{-\pi k\lambda_0 a^2}{2\left(a^2 + z^2\right)^{3/2}}$$

1 pts 1 pts