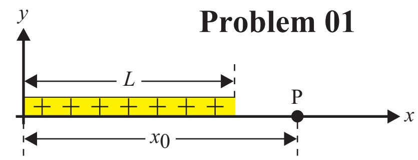
Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.1 Electric Field Calculations Using Coulomb's Law Homework # 105

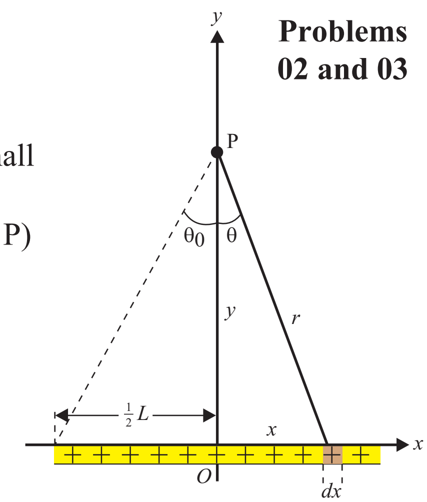
II

Problem 01



01. The uniform finite line charge shown in the diagram to the right has a charge of Q and a length of L.
    a.) Determine the linear charge density, λ, for this line charge.
    b.) What is the relationship between a small segment of this line charge, dx, the small amount of charge in this segment, dq, and the linear charge density, λ.
    c.) Determine the electric field at point P in terms of Q, L, x_0, and Coulomb's constant, k.
    d.) Determine the electric field at point P in terms of Q, L, x_0, and Coulomb's constant, k, if $x_o >>> L$.
    e.) Determine the electric field at point P with the following data: $Q = +25.0\ \mu C$, $L = 10.0$ cm, and $x_0 = 11.4$ cm.
    f.) Determine the electric field at point P with the following data: $Q = +25.0\ \mu C$, $L = 10.0$ cm, and $x_0 = 4.65$ m.

Problems 02 and 03



02. The uniform finite line charge shown in the diagram to the right has a charge of Q and a length of L. The y-axis is a perpendicular bisector of this line charge.
    a.) Determine the linear charge density, λ, for this line charge.
    b.) What is the relationship between a small segment of this line charge, dx, the small amount of charge in this segment, dq, and the linear charge density, λ.
    c.) Sketch the vector $d\vec{E}$ (that represents the electric field from segment dx at point P) and show its x and y components.
    d.) Determine the **NET** x-component of the electric field at point P.
    e.) Determine $\dfrac{dE_y}{dx}$ at the point P in terms of dx, r, λ, θ, and Coulomb's constant, k.
    f.) Determine x in terms of y and θ.
    g.) Determine $\dfrac{dx}{d\theta}$ at the point P in terms of r and y.
    h.) Determine E_{NET} at point P in terms of L, y, λ, and Coulomb's constant, k.
    i.) Determine E_{NET} at point P in terms of Q, y, and Coulomb's constant, k, if $y >>> L$.
    j.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $L = 10.0$ cm, and $y = 6.00$ cm.
    k.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $L = 10.0$ cm, and $y = 4.65$ m.

03. Assume the uniform line charge shown in the diagram above and to the right is very long (infinite line charge) compared to y. Determine the electric field at point P in terms of y, λ, and Coulomb's constant, k, if $L >>> y$.

ANSWERS: **01.** a.) $\lambda = \frac{Q}{L}$ b.) $dq = \lambda \cdot dx$ c.) $E = k\frac{Q}{x_0(x_0 - L)}$ d.) $E = k\frac{Q}{x_0^2}$ e.) 1.48×10^8 N/C

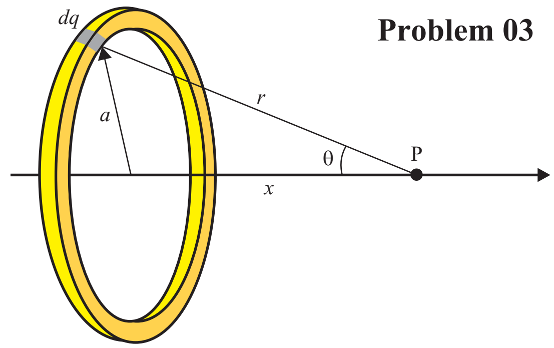
01. e.) 1.04×10^4 N/C **02.** a.) $\lambda = \frac{Q}{L}$ b.) $dq = \lambda \cdot dx$ d.) 0 e.) $\frac{dE_y}{dx} = k\frac{\lambda dx}{r^2}\cos\theta \left(dE_y = k\frac{\lambda dx}{r^2}\cos\theta\right)$

02. f.) $x = y \cdot \tan\theta$ g.) $\frac{dx}{d\theta} = \frac{r^2}{y}\left(dx = \frac{r^2}{y}d\theta\right)$ h.) $E_{NET} = \frac{k\lambda L}{y\sqrt{\left(\frac{1}{2}L\right)^2 + y^2}}$ i.) $E_{NET} = k\frac{Q}{y^2}$ j.) 4.80×10^7 N/C

02. k.) 1.04×10^4 N/C **03.** $E_{NET} = \dfrac{2k\lambda}{y}$

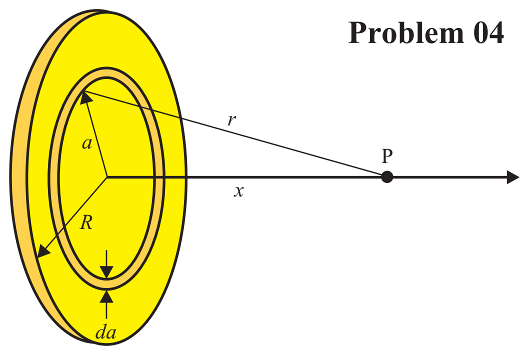
II

Problem 03



04. A thin ringed object with a uniform charge of Q (+) and a radius of a is shown in the diagram to the right. Notice x, a, θ, and r are all constants. Point P is on the axis of the ring.
   a.) Sketch the vector $d\vec{E}$ and show its x and y components at point P.
   b.) Determine the **NET** y-component of the electric field at point P.
   c.) Describe dE_x in its simplest form in terms of x, a, dq, and k.
   d.) Determine E_{NET} at point P in terms of Q, x, a, and k.
   e.) Determine E_{NET} at point P in terms of Q, x, a, and k, if $x >>> a$.
   f.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $a = 10.0$ cm, and $x = 6.00$ cm.
   g.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $a = 10.0$ cm, and $x = 4.65$ m.

Problem 04



05. A solid disk with a uniform charge of Q (+) and a radius of R is shown in the diagram to the right. Notice x and R are both constants. Point P is on the axis of the disk.
   a.) Determine the area charge density, σ, for this disk of charge.
   b.) Sketch the vector $d\vec{E}$ and show its x and y components at point P.
   c.) Determine the **NET** y-component of the electric field at point P.
   d.) Describe dE_x in its simplest form in terms of x, a, dq, and k.
   e.) Determine E_{NET} at point P in terms of Q, x, a, and k.
   f.) Determine E_{NET} at point P in terms of Q, x, a, and k, if $x >>> R$.
   g.) Determine E_{NET} at point P in terms of Q, x, a, and k, if $R >>> x$ (as if the disk were an infinite plane of charge).
   h.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $R = 10.0$ cm, and $x = 6.00$ cm.
   i.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $R = 10.0$ cm, and $x = 4.65$ m.
   j.) Determine E_{NET} at point P with the following data: $Q = +25.0\ \mu C$, $R = 4.65$ m, and $x = 6.00$ cm.

ANSWERS: **04.** b.) 0   c.) $dE_x = k\dfrac{dq}{(x^2+a^2)^{3/2}}x$ d.) $E_{NET} = \dfrac{kQx}{(x^2+a^2)^{3/2}}$ e.) $E_{NET} = k\frac{Q}{x^2}$ f.) 8.51×10^6 N/C

04. f.) 1.04×10^4 N/C   **05.** a.) $\sigma = \frac{Q}{A} = \frac{Q}{\pi R^2}$ c.) 0   d.) $dE_x = \pi k\sigma \dfrac{2a\,da}{(x^2+a^2)^{3/2}}x$ e.) $E_{NET} = 2\pi k\sigma\left(1 - \dfrac{x}{\sqrt{x^2+R^2}}\right)$

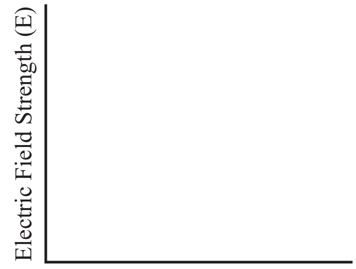
05. f.) $E_{NET} = k\frac{Q}{x^2}$ g.) $E_{NET} = 2\pi k\sigma = \frac{\sigma}{2\varepsilon_0}$ h.) 2.18×10^7 N/C   i.) 1.04×10^4 N/C   j.) 2.08×10^4 N/C

Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.2 Electric Field Calculations Using Gauss's Law Homework # 107

II

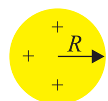
Problems 01 and 02

01. A point charge with a charge of Q (+) is shown in the diagram to the right.
    a.) Sketch the electric field lines on the diagram to the right.
    b.) What should be the shape of a Gaussian surface such that the strength of the electric field will be a constant everywhere on this surface and the direction of the electric field will be perpendicular to the surface at all points on the surface?
    c.) Use Gauss's law to derive a mathematical expression to predict the electric field strength as a function of its distance, r, from the point source.
    d.) On the graph to the right and below, graph the expression derived in c.) above.

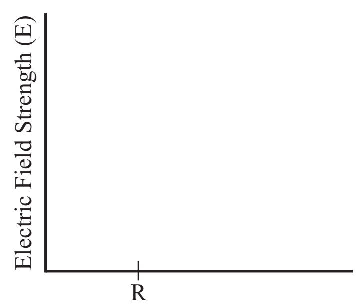


02. If the point charge in the diagram above and to the right has a charge of +25.0 μC, find the field strength at a distance of 6.00 cm from the point source.

Problems 03 and 04



03. A hollow spherical shell (negligible thickness) with a uniformly distributed charge is shown in the diagram to the right. The shell has a net charge of Q (+) and a radius of R.
    a.) Sketch the electric field lines on the diagram to the right.
    b.) What is the surface charge density, σ, of the spherical shell?
    c.) What should be the shape of a Gaussian surface such that the strength of the electric field will be a constant everywhere on this surface and the direction of the electric field will be perpendicular to the surface at all points on the surface?
    d.) Use Gauss's law predict the electric field anywhere inside the shell.
    e.) Use Gauss's law to derive a mathematical expression to predict the electric field strength as a function of its distance outside the spherical shell.
    f.) On the graph to the right and below, graph the expression derived in d.) and e.) above.
    g.) What is the difference in electric field strength between a point just inside the spherical shell and one just outside (the amount of discontinuity).



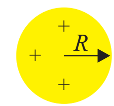
04. Assume the shell in the diagram above and to the right has a charge of +25.0 μC and a radius of 10.0 cm.
    a.) What is the surface charge density, σ, of the spherical shell?
    b.) Find the field strength at a distance of 6.00 cm from the center of the shell.
    c.) Find the field strength at a distance of 16.00 cm from the center of the shell.
    d.) Find the field strength at a distance of 6.00 m from the center of the shell.

ANSWERS: **01.** b.) sphere c.) $E_{\text{NET}} = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r^2}$ **02.** 6.25×10^7 N/C
03. b.) $\sigma = \frac{Q}{A} = \frac{Q}{4\pi R^2}$ c.) sphere d.) 0 e.) $E_{\text{NET}} = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r^2} = \frac{\sigma}{\varepsilon_o}$ g.) $\frac{\sigma}{\varepsilon_o}$
04. a.) 199 μC/m^2 b.) 0 c.) 8.79×10^6 N/C d.) 6250 N/C

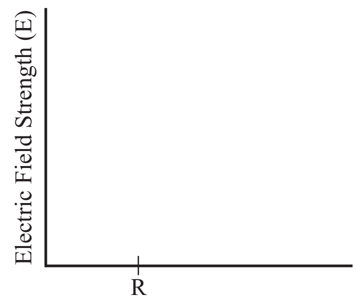
Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.2 Electric Field Calculations Using Gauss's Law Homework # 108

II

Problems 05 & 06

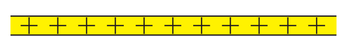


05. A solid spherical insulating material with a uniformly distributed charge is shown in the diagram to the right. The sphere has a net charge of Q (+) and a radius of R.
   a.) Sketch the electric field lines on the diagram to the right.
   b.) What is the charge density, ρ, of the sphere?
   c.) What should be the shape of a Gaussian surface such that the strength of the electric field will be a constant everywhere on this surface and the direction of the electric field will be perpendicular to the surface at all points on the surface?
   d.) Use Gauss's law predict the electric field anywhere inside the sphere.
   e.) Use Gauss's law to derive a mathematical expression to predict the electric field strength as a function of its distance outside the sphere.
   f.) On the graph to the right and below, graph the expression derived in d.) and e.) above.
   g.) What is the difference in electric field strength between a point just inside the sphere and one just outside the sphere (the amount of discontinuity).

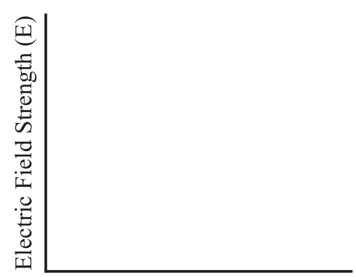


06. Assume the solid sphere in the diagram above and to the right has a charge of +25.0 μC and a radius of 10.0 cm.
   a.) What is the charge density, ρ, of the sphere?
   b.) Find the field strength at a distance of 6.00 cm from the center of the sphere.
   c.) Find the field strength at a distance of 16.00 cm from the center of the sphere.
   d.) Find the field strength at a distance of 6.00 m from the center of the sphere.

Problems 07 and 08



07. An infinite line charge with a uniformly distributed charge shown in the diagram to the right has a linear charge density of λ.
   a.) Sketch the electric field lines on the diagram to the right.
   b.) What should be the shape of a Gaussian surface such that the strength of the electric field will be a constant everywhere on this surface and the direction of the electric field will be perpendicular to the surface at all points on the surface?
   c.) Use Gauss's law to derive a mathematical expression to predict the electric field strength as a function of its distance from the line charge.
   d.) On the graph to the right and below, graph the expression derived in c.) above.



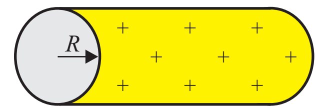
08. Assume the infinite line charge in the diagram above and to the right has a line charge density, λ, of +250 μC/m.
   a.) Find the field strength at a distance of 6.00 cm from the line charge.
   b.) Find the field strength at a distance of 16.00 cm from the line charge.
   c.) Find the field strength at a distance of 6.00 m from the line charge.

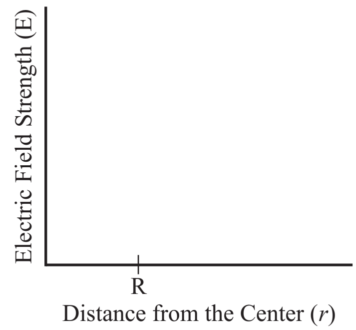
ANSWERS: **05.** b.) $\rho = \frac{Q}{V} = \frac{Q}{\frac{4}{3}\pi R^3}$ c.) sphere d.) $E_{NET} = \frac{\rho}{3\varepsilon_o} r = \frac{1}{4\pi\varepsilon_o}\frac{Q}{R^3} r = k\frac{Q}{R^3} r$ e.) $E_{NET} = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r^2} = k\frac{Q}{r^2}$
05. g.) no discontinuity (continuous) **06.** a.) 5.97 mC/m^3 b.) 1.37 x 10^7 N/C c.) 8.79 x 10^6 N/C d.) 6250 N/C
07. b.) cylinder c.) $E_{NET} = \frac{1}{2\pi\varepsilon_o}\frac{\lambda}{r} = \frac{2k\lambda}{r}$ **08.** a.) 7.50 x 10^7 N/C b.) 2.81 x 10^7 N/C c.) 7.50 x 10^5 N/C

Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.2 Electric Field Calculations Using Gauss's Law   Homework # 109

II

Problems 09 and 10

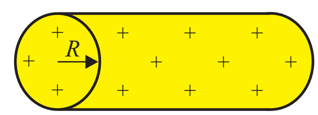


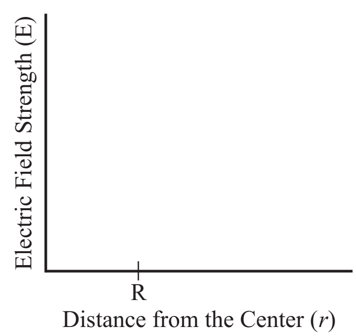


09. A hollow cylindrical shell (negligible thickness) with a uniformly distributed charge is shown in the diagram to the right. The shell has a net charge of Q (+), a radius of R, and a length of L.
    a.) Sketch the electric field lines on the diagram to the right.
    b.) What is the surface charge density, σ, of the cylindrical shell?
    c.) What should be the shape of a Gaussian surface such that the strength of the electric field will be a constant everywhere on this surface and the direction of the electric field will be perpendicular to the surface at all points on the surface?
    d.) Use Gauss's law predict the electric field anywhere inside the shell.
    e.) Use Gauss's law to derive a mathematical expression to predict the electric field strength as a function of its distance outside the cylindrical shell.
    f.) On the graph to the right, graph the expression derived in d.) and e.) above.
    g.) What is the difference in electric field strength between a point just inside the cylindrical shell and one just outside (the amount of discontinuity).

10. Assume the shell in the diagram above and to the right has a charge of +25.0 μC, a radius of 10.0 cm, and a length of 20.0 cm.
    a.) What is the surface charge density, σ, of the spherical shell?
    b.) Find the field strength at a distance of 6.00 cm from the center of the shell.
    c.) Find the field strength at a distance of 16.00 cm from the center of the shell.
    d.) Find the field strength at a distance of 6.00 m from the center of the shell.

Problem 11





11. An infinitely long solid cylindrical insulating material with a uniformly distributed charge is shown in the diagram to the right. The cylinder has a net charge of Q (+) and a radius of R.
    a.) What is the charge density, ρ, of the cylinder?
    b.) What should be the shape of a Gaussian surface such that the strength of the electric field will be a constant everywhere on this surface and the direction of the electric field will be perpendicular to the surface at all points on the surface?
    c.) Use Gauss's law predict the electric field anywhere inside the cylinder.
    d.) Use Gauss's law to derive a mathematical expression to predict the electric field strength as a function of its distance outside the cylinder.
    e.) On the graph to the right, graph the expression derived in c.) and d.) above.
    f.) What is the difference in electric field strength between a point just inside the cylinder and one just outside the sphere (the amount of discontinuity).

12. Consider an infinite plane of charge with a surface charge density of σ.
    a.) What is the **NET** electric field near the plane.
    b.) What is the amount of discontinuity of the electric fields on the two sides of the plane?

ANSWERS: **09.** b.) $\sigma = \frac{Q}{A} = \frac{Q}{2\pi RL}$ c.) cylinder d.) 0 e.) $E_{\text{NET}} = \frac{1}{2\pi\varepsilon_o}\frac{\lambda}{r} = \frac{2k\lambda}{r}$ g.) $\frac{\sigma}{\varepsilon_o}$ **10.** a.) 199 $\mu C/m^2$
10. b.) 0 c.) 1.40 x 10^7 N/C d.) 3.75 x 10^5 N/C **11.** a.) $\rho = \frac{Q}{V} = \frac{Q}{\pi R^2 L}$ b.) cylinder
11. c.) $E_{\text{NET}} = \frac{\rho}{2\varepsilon_o} r = \frac{\lambda}{2\pi\varepsilon_o R^2} r$ d.) $E_{\text{NET}} = \frac{1}{2\pi\varepsilon_o}\frac{\lambda}{r}$ f.) no discontinuity (continuous) **12.** a.) $E_{\text{NET}} = \frac{\sigma}{2\varepsilon_o}$ b.) $\frac{\sigma}{\varepsilon_o}$

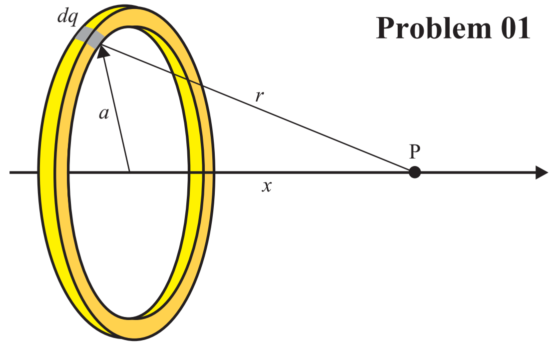
Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.3 Potential Calculations of Continuous Charge Distributions — Homework # 110

II

01. A thin ringed object with a uniform charge of Q (+) and a radius of a is shown in the diagram to the right. Notice x, a, and r are all constants. Point P is on the axis of the ring.
    a.) What is the potential at point P?
    b.) How much work would be required to move a positive charge of q from point P to a very large distance away (infinity)?

For parts c.) and d.) assume Q = +25.0 μC, a = 10.0 cm, and x = 6.00 cm.
    c.) Determine the potential at point P.
    d.) How much work would be required to move a proton from point P to a very large distance away (infinity)?

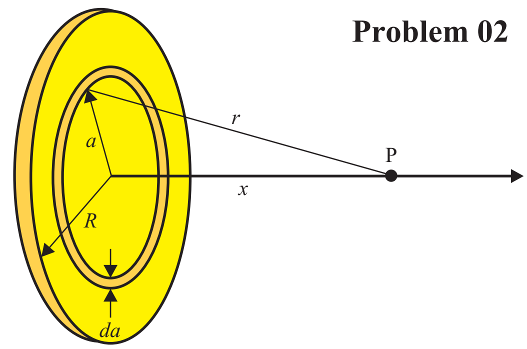
Problem 01



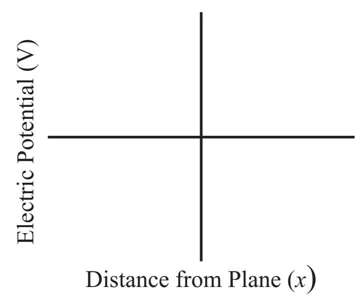
02. A solid disk with a uniform charge of Q (+) and a radius of R is shown in the diagram to the right. Notice x and R are both constants. Point P is on the axis of the disk.
    a.) What is the potential at point P?
    b.) How much work would be required to move a positive charge of q from point P to a very large distance away (infinity)?

For parts c.) and d.) assume Q = +25.0 μC, R = 10.0 cm, and x = 6.00 cm.
    c.) Determine the potential at point P.
    d.) How much work would be required to move a proton from point P to a very large distance away (infinity)?

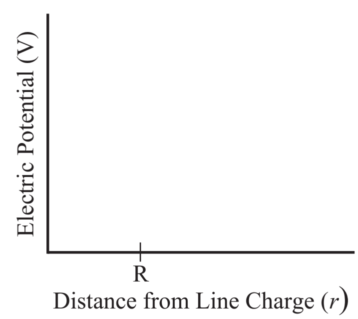
Problem 02



03. Consider an infinite vertical plane of charge oriented along the y-axis with a surface charge density of σ.
    a.) Write a mathematical expression that describes the potential as a function of distance from the plane along the x-axis (both positive and negative x-axis). Assume the potential at the vertical plane of charge (x = 0) is 100 V.
    b.) Sketch a graph of the expression determined in a.) above. Is the graph continuous?



04. A hollow spherical shell (negligible thickness) with a uniformly distributed charge has a net charge of Q (+) and a radius of R.
    a.) Write a mathematical expression that describes the potential as a function of distance from the center of the shell, r (both inside and outside the shell).
    b.) Sketch a graph of the expression determined in a.) above. Is the graph continuous?



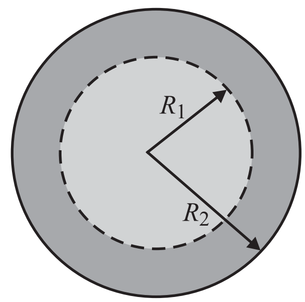
05. Consider an infinite line charge with a uniformly distributed charge that has a linear charge density of λ. Write a mathematical expression that describes the potential as a function of distance from the line charge, r. Assume V = 100 V at r = 10.0 cm.

ANSWERS: **01.** a.) $V = k\frac{Q}{\sqrt{x^2+a^2}}$ b.) $W_{P\infty} = k\frac{Q\cdot q}{\sqrt{x^2+a^2}}$ c.) 1.93 x 10^6 V d.) 3.09 x10^{-13} J
02. a.) $V = 2\pi k\sigma\left(\sqrt{x^2+R^2} - x\right)$ b.) $W_{P\infty} = 2\pi k\sigma\left(\sqrt{x^2+R^2} - x\right)q$ c.) 2.55 x 10^6 V d.) 4.08 x 10^{-13} J
03. a.) $V(x) = 100 - \frac{\sigma}{2\varepsilon_o}x$ b.) yes **04.** a.) $V(r) = k\frac{Q}{R}\ (r \le R)$, $V(r) = k\frac{Q}{r}\ (r > R)$ b.) yes
05. $V(r) = 100 - 2k\lambda\ln\left(\frac{r}{0.10}\right)$

Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.4 Electric Field and Potential of Multiple Charged Objects — Homework # 111

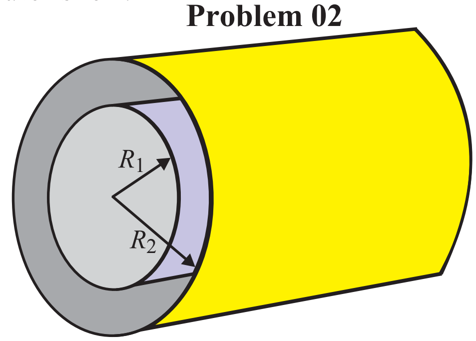
II

Problem 01



01. The diagram to the right shows the cross section of two concentric, conducting spherical shells (each with negligible thickness). The smaller, inner shell has a radius, R_1, of 6.00 cm and a charge, Q_1, of +18.0 μC. The larger, outer shell has a radius, R_2, of 9.00 cm and a charge, Q_2, of -11.0 μC.
    a.) Write an equation describing the **NET** electric field inside the inner shell (where $r \le R_1$).
    b.) Write an equation describing the **NET** electric field as a function of distance from the center, r, for $R_1 < r \le R_2$.
    c.) Write an equation describing the **NET** electric field as a function of distance from the center, r, where $r > R_2$.
    d.) What is the **NET** electric field 4.00 cm outside the outer shell?
    e.) What is the **NET** electrostatic potential of the outer shell?
    f.) Determine the constant of integration when calculating the **NET** electrostatic potential between the two shells.
    g.) What is the **NET** electrostatic potential of the inner shell?
    h.) What is the potential difference between the inner shell and the outer shell?
    i.) What is the **NET** electrostatic potential at the center of the two shells?
    j.) How much work would be required to move an electron from the inner shell to the outer shell?
    k.) How much work would be required to move an proton from infinity to the outer shell?

Problem 02



02. The diagram to the right shows two concentric, conducting cylindrical shells (each with negligible thickness). The radii (R_1 = 6.00 cm and R_2 = 9.00 cm) and charges (Q_1 = +18.0 μC and Q_2 = -11.0 μC) of these cylindrical shells are identical to those of the spherical shells in problem 01 above. Both shells have an equal length of 60.0 cm. Assume the **NET** electrostatic potential is zero at a radial distance of 100.0 m from the center of the two shells.
    a.) Write an equation describing the **NET** electric field inside the inner shell (where $r \le R_1$).
    b.) Write an equation describing the **NET** electric field as a function of distance from the center, r, for $R_1 < r \le R_2$.
    c.) Write an equation describing the **NET** electric field as a function of distance from the center, r, where $r > R_2$.
    d.) What is the **NET** electric field 4.00 cm outside the outer shell?
    e.) Determine the constant of integration when calculating the **NET** electrostatic potential outside the two shells.
    f.) What is the **NET** electrostatic potential of the outer shell?
    g.) Determine the constant of integration when calculating the **NET** electrostatic potential between the two shells.
    h.) What is the **NET** electrostatic potential of the inner shell?
    i.) What is the potential difference between the inner shell and the outer shell?
    j.) What is the **NET** electrostatic potential at the center of the two shells?
    k.) How much work would be required to move an electron from the inner shell to the outer shell?
    l.) How much work would be required to move a proton from a position 100.0 m from the center to the outer shell?

ANSWERS: **01.** a.) E = 0 b.) $E = \frac{1}{4\pi\varepsilon_o}\frac{Q_1}{r^2} = \frac{1.62 \times 10^5}{r^2}$ c.) $E = \frac{1}{4\pi\varepsilon_o}\frac{(Q_1 + Q_2)}{r^2} = \frac{6.30 \times 10^4}{r^2}$ d.) 3.73 x 10^6 N/C
01. e.) 7.00 x 10^5 V f.) -1.10 x 10^6 V g.) 1.60 x 10^6 V h.) 9.00 x 10^5 V i.) 1.60 x 10^6 V j.) 1.44 x 10^{-13} J
01. k.) 1.12 x 10^{-13} J **02.** a.) $E = 0$ b.) $E = \frac{1}{2\pi\varepsilon_o}\frac{\lambda_1}{r} = 2k\frac{Q_1/L}{r} = \frac{5.40 \times 10^5}{r}$ c.) $E = \frac{1}{2\pi\varepsilon_o}\frac{\lambda_1+\lambda_2}{r} = 2k\frac{(Q_1 + Q_2)/L}{r} = \frac{2.10 \times 10^5}{r}$
02. d.) 1.62 x 10^6 N/C e.) 9.67 x 10^5 V f.) 1.47 x 10^6 V g.) 1.72 x 10^5 V h.) 1.69 x 10^6 V i.) 2.19 x 10^5 V
02. j.) 1.69 x 10^6 V k.) 3.50 x 10^{-14} J l.) 2.36 x 10^{-13} J

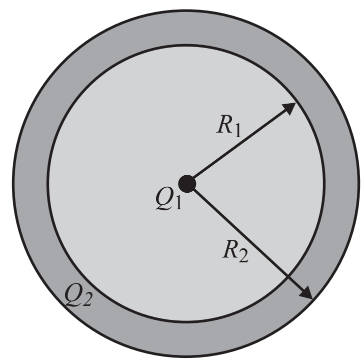
Chapter 13
Engineering Electrostatics: Continuous Charge Distributions
13.4 Electric Field and Potential of Multiple Charged Objects Homework # 112

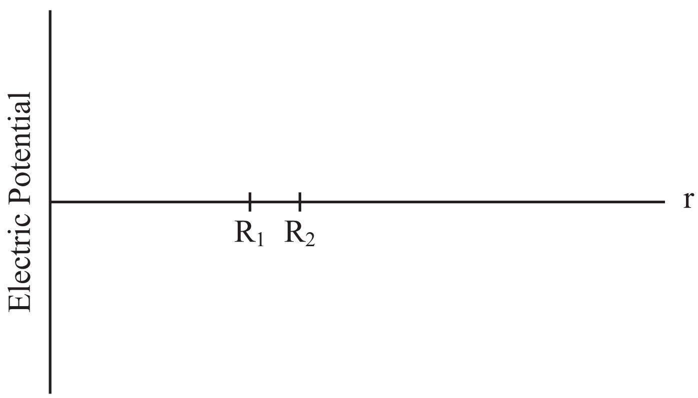
II

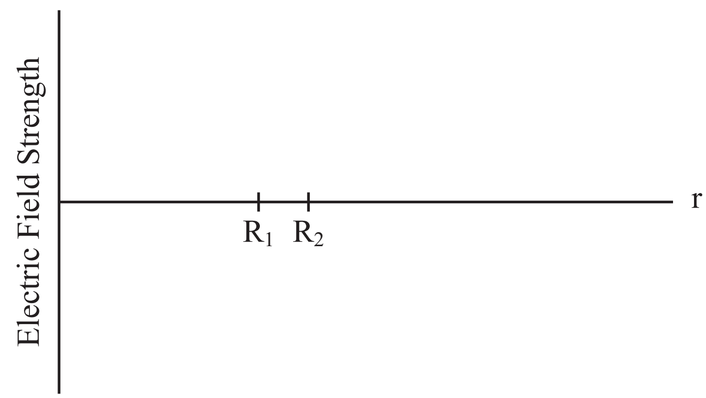
03. The diagram to the right shows the cross section of a conducting spherical shell with a thickness of 2.00 cm. The inner surface of the shell has a radius, R_1, of 8.00 cm, while the outer surface has a radius, R_2, of 10.00 cm. The charge on the shell is $Q_2 = +14.00\ \mu C$. The shell encloses a point charge located at its center with a charge of $Q_1 = -5.00\ \mu C$.

a.) What is the **NET** electrostatic potential just outside the shell?
b.) What is the **NET** electrostatic potential just inside the shell?
c.) What is the **NET** electrostatic potential at the center of the shell (at Q_1)?
d.) Determine the constant of integration when calculating the **NET** electrostatic potential inside the inner the wall of the shell.
e.) What is the **NET** electrostatic potential 3.00 cm from the central charge?
f.) Where, other than infinity, will the **NET** electrostatic potential be zero?
g.) On the graph below, sketch the electric potential as a function of distance, r, from Q_1.
h.) On the graph below and to the right, sketch the electric field strength as a function of distance, r, from Q_1.

Problem 03





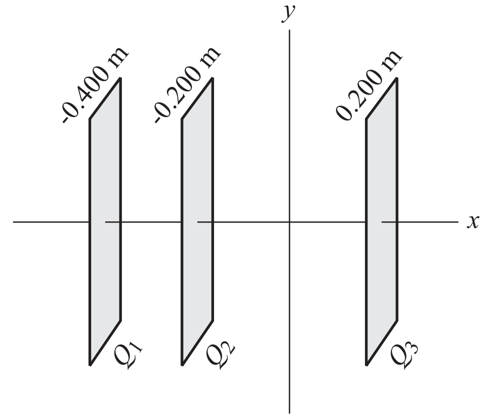


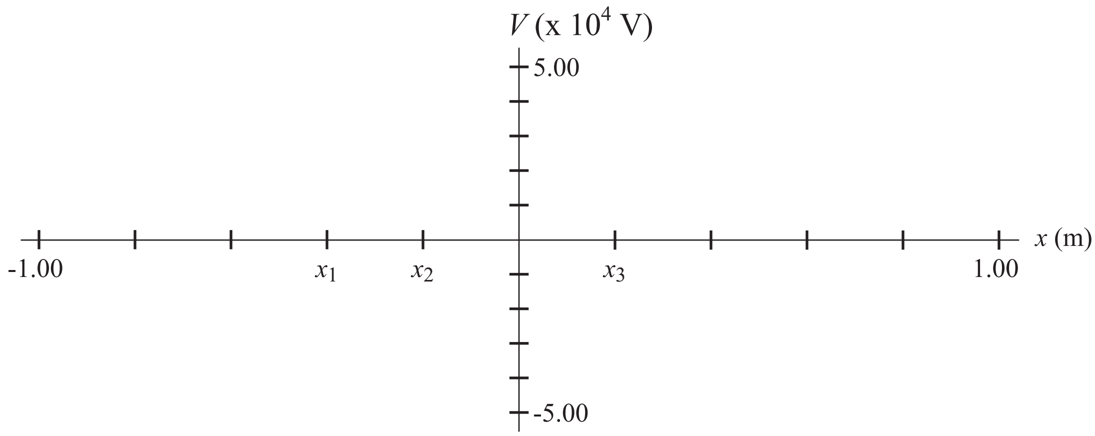
ANSWERS: **03.** a.) 8.10×10^5 V b.) 8.10×10^5 V c.) ∞ d.) 1.3725×10^6 V e.) -1.275×10^5 V
03. f.) 3.28 cm from Q_1

III

04. Each of the three vertical, parallel, conducting plates shown in the diagram to the right has an area of 2.00 m^2. The first plate contains a charge of Q_1 = +8.00 μC and is located at x_1 = -0.400 m. The second plate contains a charge of Q_2 = -8.00 μC and is located at x_2 = -0.200 m. The third plate contains a charge of Q_3 = +4.00 μC and is located at x_3 = 0.200 m. Assume the **NET** electric potential is zero at the origin.
a.) Determine the **NET** electric field to the left of plate 1.
b.) Determine the **NET** electric field between plates 1 and 2.
c.) Determine the **NET** electric field between plates 2 and 3.
d.) Determine the **NET** electric field to the right of plate 3.
e.) Determine the **NET** electric potential of each plate (V_1, V_2, and V_3).
f.) Where, other than the origin, is the **NET** electric potential zero?
g.) On the graph below, sketch the potential as a function of position along the x-axis.
h.) What is the potential difference between plates 1 and 2?
i.) How much work would be required to move an electron from plate 3 to plate 1?

Problem 04





ANSWERS: **04.** a.) -1.13 x 10^5 N/C b.) 3.39 x 10^5 N/C c.) -1.13 x 10^5 N/C d.) 1.13 x 10^5 N/C
04. e.) V_1 = 4.52 x 10^4 V, V_2 = -2.26 x 10^4 V, V_3 = 2.26 x 10^4 V f.) x = -0.800 m, -0.267 m, 0.400 m
04. h.) 6.78 x 10^4 V i.) 3.62 x 10^{-15} J