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← 202010-A-10228-PHYS-122-University Physics 2-06(Lecture), Fall 2020

INSTRUCTOR

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Chapter 24 HW (Electric Potential) (Homework)

Current Score

QUESTION	1	2	3	4	5	6	7	8	9	10
POINTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

POINTS	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TOTAL SCORE

10/10

100.0%

Due Date Past Due

THU, OCT 1, 2020
11:59 PM GMT+4



Request Extension

Assignment Submission & Scoring

Assignment Submission

For this assignment, you submit answers by question parts. The number of submissions remaining for each question part only changes if you submit or change the answer.

Assignment Scoring

Your last submission is used for your score.

The due date for this assignment has passed.

Your work can be viewed below, but no changes can be made.

Important! Before you view the answer key, decide whether or not you plan to request an extension. Your Instructor may not grant you an extension if you have viewed the answer key. Automatic extensions are not granted if you have viewed the answer key.



Request Extension



View Key

1. [1/1 Points]

DETAILS

PREVIOUS ANSWERS

SERPSE10 24.1.OP.001.

MY NOTES

ASK YOUR TEACHER

PRACTICE ANOTHER

A particle with a charge of $q = 15.0 \mu\text{C}$ travels from the origin to the point $(x, y) = (20.0 \text{ cm}, 50.0 \text{ cm})$ in the presence of a uniform electric field $\vec{E} = 250\hat{i} \text{ V/m}$. Determine the following.

- (a) the change in the electric potential energy (in J) of the particle–field system

-7.5e-4 ✓ J

- (b) the electric potential difference (in V) through which the particle moves

-50 ✓ V

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2. [1/1 Points]

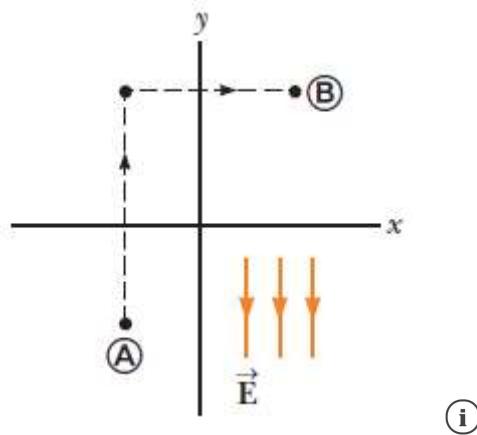
[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.1.OP.004.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

A uniform electric field of magnitude **255 V/m** is directed in the negative **y** direction as shown in the figure below. The coordinates of point **(A)** are **(-0.300, -0.550) m**, and those of point **(B)** are **(0.300, 0.800) m**. Calculate the electric potential difference $V_B - V_A$ using the dashed-line path.

344.5 ✓ V

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3. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.2.P.003.MI.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

Oppositely charged parallel plates are separated by **5.20** mm. A potential difference of 600 V exists between the plates.

(a) What is the magnitude of the electric field between the plates?

1.15e5 ✓ N/C

(b) What is the magnitude of the force on an electron between the plates?

1.85e-14 ✓ N

(c) How much work must be done on the electron to move it to the negative plate if it is initially positioned **2.92** mm from the positive plate?

4.22e-17 ✓ J

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4. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.3.OP.007.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

A particle has a charge of $q = 2e$, where e is the charge on an electron.

- (a) Determine the electric potential (in V) due to the charge at a distance $r = 0.330$ cm from the charge.

✓ V

- (b) Determine the electric potential difference (in V) between a point that is $2r$ away and this point, that is $V(2r) - V(r)$.

✓ V

- (c) Determine the electric potential difference (in V) between a point that is $\frac{r}{2}$ away and this point, that is $V\left(\frac{r}{2}\right) - V(r)$.

✓ V

- (d) How would the answers change if the electrons are replaced by protons?

- The sign of answer (a) would change.
- The sign of answer (b) would change.
- The sign of answer (c) would change.
- The sign of all answers would change.
- All answers would remain the same.

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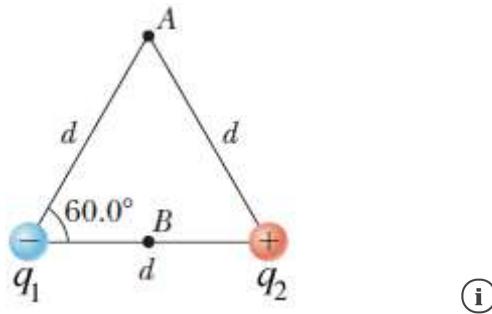
5. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.3.OP.009.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

Two charges, $q_1 = -18.5 \text{ nC}$ and $q_2 = 26.5 \text{ nC}$, are separated by a distance $d = 1.50 \text{ cm}$ as shown in the figure.



(i)

Determine the following.

- (a) the electric potential (in kV) at point A

4.79 kV

- (b) the electric potential (in kV) at point B, which is halfway between the charges

9.59 kV

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6. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.4.OP.020.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

The potential in a region between $x = 0$ and $x = 6.00$ m is $V = a + bx$, where $a = 16.6$ V and $b = -6.90$ V/m.

(a) Determine the potential at $x = 0$.

✓ V

Determine the potential at $x = 3.00$ m.

✓ V

Determine the potential at $x = 6.00$ m.

✓ V

(b) Determine the magnitude and direction of the electric field at $x = 0$.

magnitude ✓ V/m

direction ✓

Determine the magnitude and direction of the electric field at $x = 3.00$ m.

magnitude ✓ V/m

direction ✓

Determine the magnitude and direction of the electric field at $x = 6.00$ m.

magnitude ✓ V/m

direction ✓

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7. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.6.OP.025.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

A spherical conductor with a **0.173** m radius is initially uncharged. How many electrons should be removed from the sphere in order for it to have an electrical potential of **4.10** kV at the surface?

4.9e11 ✓ electrons

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8. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.6.OP.027.MI.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

A long, straight metal rod has a radius of **6.00** cm and a charge per unit length of **22.8** nC/m. Find the electric field at the following distances from the axis of the rod, where distances are measured perpendicular to the rod's axis.

(a) **1.50** cmmagnitude **0** ✓ N/Cdirection **magnitude is zero** ✓(b) **18.0** cmmagnitude **2.3e3** ✓ N/Cdirection **outward** ✓(c) **180** cmmagnitude **227.8** ✓ N/Cdirection **outward** ✓

Need Help?**Read It****Master It**

9. [1/1 Points]

DETAILS**PREVIOUS ANSWERS****SERPSE10 24.6.OP.032.****MY NOTES****ASK YOUR TEACHER****PRACTICE ANOTHER**

A square conducting plate **48.0** cm on a side and with no net charge is placed in a region, where there is a uniform electric field of **84.0** kN/C directed to the right and perpendicular to the plate.

- (a) Find the charge density (in nC/m^2) on the surface of the right face of the plate.

7.4e2 ✓ nC/m^2

- (b) Find the charge density (in nC/m^2) on the surface of the left face of the plate.

-7.4e2 ✓ nC/m^2

- (c) Find the magnitude (in nC) of the charge on either face of the plate.

1.7e2 ✓ nC

Need Help?**Read It**

10. [1/1 Points]

[DETAILS](#)[PREVIOUS ANSWERS](#)

SERPSE10 24.6.P.034.MI.SA.

[MY NOTES](#)[ASK YOUR TEACHER](#)[PRACTICE ANOTHER](#)

This question has several parts that must be completed sequentially. If you skip a part of the question, you will not receive any points for the skipped part, and you will not be able to come back to the skipped part.

Tutorial Exercise

A solid conducting sphere of radius 2.00 cm has a charge of $8.53 \mu\text{C}$. A conducting spherical shell of inner radius 4.00 cm and outer radius 5.00 cm is concentric with the solid sphere and has a charge of $-1.71 \mu\text{C}$. Find the electric field at the following radii from the center of this charge configuration.

(a) $r = 1.00 \text{ cm}$

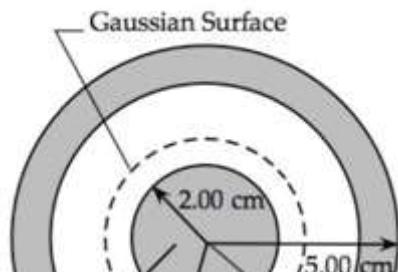
(b) $r = 3.00 \text{ cm}$

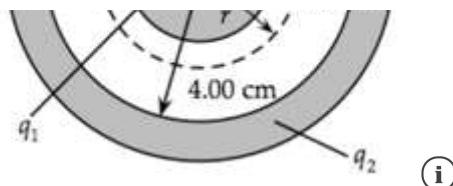
(c) $r = 4.50 \text{ cm}$

(d) $r = 7.00 \text{ cm}$

Step 1

We observe that there is spherical symmetry in this charge distribution. This means that the electric fields produced by this distribution will also display spherical symmetry. At any point at which the magnitude of the electric field is non-zero, the magnitude will depend only on the distance r from the center of the distribution, and the electric field vector will be in the radial direction. To take advantage of this symmetry, we choose a spherical gaussian surface of radius r centered on the center of the charge distribution as shown in the diagram.





For such a gaussian surface, the magnitude of the electric field is the same at all points on the surface. The electric flux through the Gaussian surface of area A with radius r in an electric field of constant magnitude E is given by

$$\Phi_E = EA = 4\pi r^2 E.$$

Gauss's law states that the total electric flux through any closed surface is $Q_{\text{inside}}/\epsilon_0$, where the constant $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$ is the permittivity of free space and Q_{inside} is the net charge enclosed by the Gaussian surface. Therefore, we have

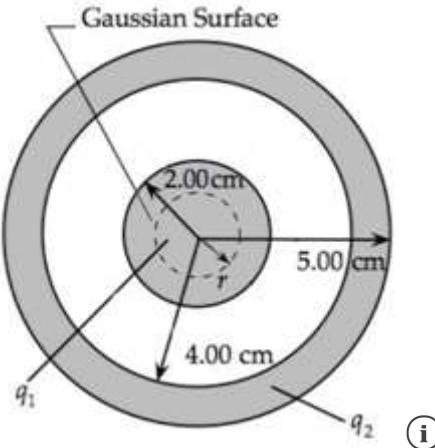
$$\Phi_E = 4\pi r^2 E = \frac{Q_{\text{inside}}}{\epsilon_0},$$

and the magnitude of the electric field at all points on the Gaussian surface is

$$E = \frac{Q_{\text{inside}}}{4\pi\epsilon_0 r^2} = \frac{k_e Q_{\text{inside}}}{r^2},$$

where the Coulomb constant $k_e = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$.

- (a) When $r = 1.00 \text{ cm}$, all points on the Gaussian surface are located within the conducting material of the solid sphere of radius 2.00 cm .

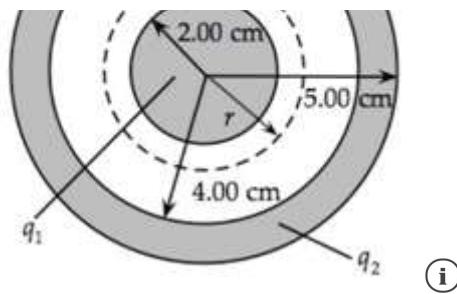


Because a nonzero electric field cannot exist within a conductor in electrostatic equilibrium, we conclude that $\vec{E} = \boxed{0}$ ✓ N/C at all points where $r = 1.00 \text{ cm}$.

Step 2

- (b) For $r = 3.00 \text{ cm}$, all points on the Gaussian surface are located in the space between the solid sphere and the inner surface of the spherical shell.





The net charge enclosed by this Gaussian surface is that on the inner sphere, $Q_{\text{inside}} = q_1 = +8.53 \mu\text{C}$, so the magnitude of the electric field at this location is

$$E = \frac{k_e Q_{\text{inside}}}{r^2}$$

$$= \frac{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)([8.53] \checkmark \times 10^{-6} \text{ C})}{([3] \checkmark \times 10^{-2} \text{ m})^2}$$

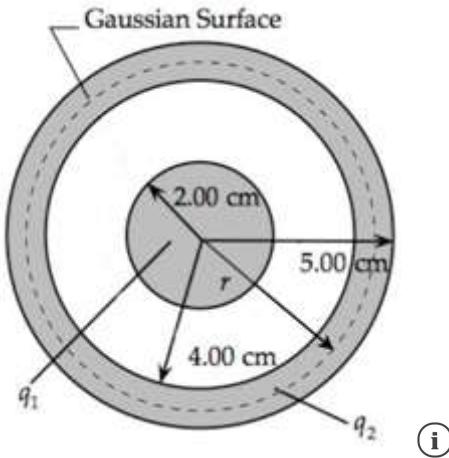
$$= [8.5] \checkmark \times 10^7 \text{ N/C.}$$

Since $Q_{\text{inside}} > 0$, at $r = 3.00 \text{ cm}$,

$$\vec{E} = [8.5] \checkmark \times 10^7 \text{ N/C radially outward} \checkmark .$$

Step 3

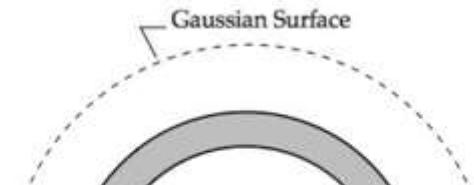
(c) When $r = 4.50 \text{ cm}$, all points on the Gaussian surface are located within the conducting material again, this time within the material of the spherical shell.

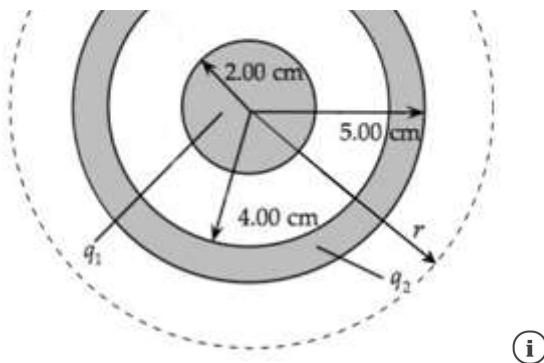


As in part (a), the field must be $\vec{E} = [0] \checkmark \text{ N/C}$ at all points for $r = 4.50 \text{ cm}$.

Step 4

(d) For $r = 7.00 \text{ cm}$, all points on the Gaussian surface lie outside the spherical shell and the net charge enclosed is the sum of the charges on the sphere and the shell. Remember that q_2 is negative!





$$Q_{\text{inside}} = q_1 + q_2 = +[6.82] \checkmark \mu\text{C}$$

The magnitude of the electric field at all points where $r = 7.00 \text{ cm}$ is then

$$E = \frac{k_e Q_{\text{inside}}}{r^2}$$

$$= \frac{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)([6.82] \checkmark \times 10^{-6} \text{ C})}{(7.0 \checkmark \times 10^{-2} \text{ m})^2}$$

$$= [12.5] \checkmark \times 10^6 \text{ N/C.}$$

Step 5

Again, $Q_{\text{inside}} > 0$. Therefore, for $r = 7.00 \text{ cm}$,

$$\vec{E} = [12.5] \checkmark \times 10^6 \text{ N/C} \text{ radially outward} \checkmark .$$

SUMMARY

We applied the concept of Gauss's law to four positions (at four radii) relative to the center of a charged conducting sphere of given radius surrounded concentrically by a charged spherical shell whose inner radius and outer radius are given. Because a nonzero electric field cannot exist within a conductor in electrostatic equilibrium, the electric field is zero within the solid sphere and within the spherical shell. Between the solid sphere and the inner surface of the conducting shell, the magnitude of the electric field is given by Gauss's law in terms of the charge on the sphere; the field points radially outward. Outside the spherical shell, the charge enclosed by the gaussian surface is the sum of the charges on the solid sphere and the spherical shell. We find the magnitude of the electric field from Gauss's law using this total charge; the direction of the electric field is radially outward because the net charge enclosed by the gaussian surface is positive.

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