This print-out should have 16 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

PLEASE REMEMBER THAT YOU MUST CARRY OUT YOUR CALCULATIONS TO AT LEAST THREE SIGNIFICANT FIGURES. YOUR ANSWER MUST BE WITHIN ONE PERCENT OF THE CORRECT RESULT TO BE MARKED AS CORRECT BY THE SERVER.

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001 (part 1 of 2) 5 points

A cylindrical shell of radius 9.5 cm and length 242 cm has its charge density uniformly distributed on its surface. The electric field intensity at a point 20.1 cm radially outward from its axis (measured from the midpoint of the shell) is 54000 N/C.

Given: $k_e = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$.

What is the net charge on the shell? Answer in units of C.

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002 (part 2 of 2) 4 points

What is the electric field at a point 4.06 cm from the axis? Answer in units of N/C.

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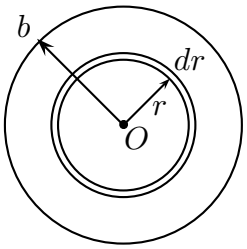
003 (part 1 of 3) 3 points

Consider a solid insulating sphere of radius b with nonuniform charge density $\rho = a\,r$, where a is a constant.



Find the charge Q_r contained within the radius r, when $r < b$ as in the figure. *Note:* The volume element dV for a spherical shell of radius r and thickness dr is equal to $4\,\pi\,r^2\,dr$.)

1. $Q_r = \pi\,a\,r^2$

2. $Q_r = \dfrac{a\,r^2}{\pi}$

3. $Q_r = \dfrac{a\,\pi}{r^2}$

4. $Q_r = \dfrac{r^4}{\pi\,a}$

5. $Q_r = 0$

6. $Q_r = \dfrac{r^3}{\pi\,a}$

7. $Q_r = \pi\,a\,r^3$

8. $Q_r = \pi\,a\,r^4$

9. $Q_r = \dfrac{a\,r^3}{\pi}$

10. $Q_r = \dfrac{a\,r^4}{\pi}$

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004 (part 2 of 3) 4 points

If $a = 3 \times 10^{-6}$ C/m^4 and $b = 1$ m, find E at $r = 0.8$ m. Answer in units of N/C.

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005 (part 3 of 3) 2 points

Find the charge Q_b contained within the radius r, when $r > b$.

1. $Q_b = \dfrac{a\,b^2}{\pi}$

2. $Q_b = \pi\,a\,b^4$

3. $Q_b = \dfrac{\pi\,a}{b^4}$

4. $Q_b = 0$

5. $Q_b = \pi\,a\,b^3$

6. $Q_b = \dfrac{\pi\,b^2}{a}$

7. $Q_b = \dfrac{a\,b^3}{\pi}$

8. $Q_b = \dfrac{\pi\,b^3}{a}$

9. $Q_b = \pi\,a\,b^2$

10. $Q_b = \dfrac{a\,b^4}{\pi}$

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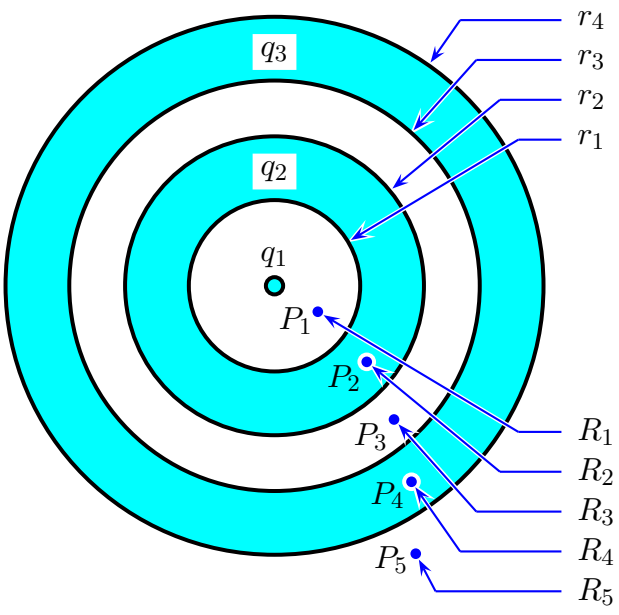
006 (part 1 of 9) 3 points

A point charge q_1 is concentric with two spherical conducting thick shells, as shown in the figure below. The smaller spherical conducting shell has a net charge of q_2 and the larger spherical conducting shell has a net charge of q_3.



Hint: Under static conditions, the charge on a conductor resides on the surface of the conductor.

What is the charge Q on the inner surface of the smaller spherical conducting shell, where $R = r_1$?

1. $Q = +q_1$

2. $Q = +q_1 + q_2 + q_3$

3. $Q = +q_1 + q_2$

4. $Q = +q_1 - q_2$

5. $Q = -q_1$

6. $Q = -q_1 - q_2$

7. $Q = -q_1 + q_2$

8. $Q = -q_1 + q_2 + q_3$

9. $Q = 0$

10. $Q = -q_1 - q_2 - q_3$

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007 (part 2 of 9) 3 points

What is the charge Q on the outer surface of the smaller spherical conducting shell, where $R = r_2$?

1. $Q = -q_1 - q_2$

2. $Q = -q_1$

3. $Q = 0$

4. $Q = +q_1 + q_2 - q_3$

5. $Q = +q_1 - q_2$

6. $Q = +q_1 + q_2$

7. $Q = +q_1$

8. $Q = -q_1 - q_2 - q_3$

9. $Q = -q_1 + q_2$

10. $Q = +q_1 + q_2 + q_3$

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008 (part 3 of 9) 3 points

What is the charge Q on the inner surface of the larger spherical conducting shell, where $R = r_3$?

1. $Q = +q_1 + q_2$

2. $Q = -q_1$

3. $Q = -q_1 + q_2$

4. $Q = -q_1 - q_2$

5. $Q = -q_1 - q_2 - q_3$

6. $Q = +q_1 + q_2 + q_3$

7. $Q = -q_1 - q_2 + q_3$

8. $Q = 0$

9. $Q = +q_1$

10. $Q = +q_1 - q_2$

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009 (part 4 of 9) 3 points

What is the charge Q on the outer surface of the larger spherical conducting shell, where $R = r_4$?

1. $Q = +q_1 + q_2 + q_3$

2. $Q = -q_1 + q_2$

3. $Q = +q_1 - q_2$

4. $Q = 0$

5. $Q = -q_1 - q_2$

6. $Q = +q_1 + q_2 - q_3$

7. $Q = -q_1$

8. $Q = -q_1 - q_2 - q_3$

9. $Q = +q_1 + q_2$

10. $Q = +q_1$

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010 (part 5 of 9) 3 points

What is the electric field at P_1, where $r = R_1$?

1. $E = k_e \dfrac{-q_1 + q_2 + q_3}{R_1^2}$

2. $E = k_e \dfrac{-q_1 + q_2}{R_1^2}$

3. $E = k_e \dfrac{+q_1 - q_2}{R_1^2}$

4. $E = 0$

5. $E = k_e \dfrac{+q_1}{R_1^2}$

6. $E = k_e \dfrac{+q_1 + q_2 - q_3}{R_1^2}$

7. $E = k_e \dfrac{+q_1 - q_2 - q_3}{R_1^2}$

8. $E = k_e \dfrac{+q_1 - q_2 + q_3}{R_1^2}$

9. $E = k_e \dfrac{+q_1 + q_2 + q_3}{R_1^2}$

10. $E = k_e \dfrac{+q_1 + q_2}{R_1^2}$

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011 (part 6 of 9) 2 points

What is the electric field at P_2, where $r = R_2$?

1. $E = k_e \dfrac{+q_1}{R_2^2}$

2. $E = k_e \dfrac{-q_1 + q_2 + q_3}{R_2^2}$

3. $E = k_e \dfrac{+q_1 + q_2 + q_3}{R_2^2}$

4. $E = k_e \dfrac{+q_1 - q_2 + q_3}{R_2^2}$

5. $E = 0$

6. $E = k_e \dfrac{+q_1 + q_2}{R_2^2}$

7. $E = k_e \dfrac{+q_1 - q_2}{R_2^2}$

8. $E = k_e \dfrac{+q_1 + q_2 - q_3}{R_2^2}$

9. $E = k_e \dfrac{+q_1 - q_2 - q_3}{R_2^2}$

10. $E = k_e \dfrac{-q_1 + q_2}{R_2^2}$

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012 (part 7 of 9) 2 points

What is the electric field at P_3, where $r = R_3$.

1. $E = k_e \dfrac{+q_1 - q_2 - q_3}{R_3^2}$

2. $E = k_e \dfrac{+q_1 - q_2 + q_3}{R_3^2}$

3. $E = k_e \dfrac{+q_1}{R_3^2}$

4. $E = k_e \dfrac{+q_1 + q_2 - q_3}{R_3^2}$

5. $E = k_e \dfrac{+q_1 + q_2 + q_3}{R_3^2}$

6. $E = k_e \dfrac{+q_1 + q_2}{R_3^2}$

7. $E = k_e \dfrac{-q_1 + q_2}{R_3^2}$

8. $E = k_e \dfrac{+q_1 - q_2}{R_3^2}$

9. $E = 0$

10. $E = k_e \dfrac{-q_1 + q_2 + q_3}{R_3^2}$

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013 (part 8 of 9) 2 points

What is the electric field at P_4, where $r = R_4$.

1. $E = k_e \dfrac{+q_1}{R_4^2}$

2. $E = k_e \dfrac{-q_1 + q_2 + q_3}{R_4^2}$

3. $E = k_e \dfrac{+q_1 + q_2 - q_3}{R_4^2}$

4. $E = k_e \dfrac{+q_1 + q_2}{R_4^2}$

5. $E = k_e \dfrac{+q_1 - q_2}{R_4^2}$

6. $E = k_e \dfrac{+q_1 + q_2 + q_3}{R_4^2}$

7. $E = k_e \dfrac{-q_1 + q_2}{R_4^2}$

8. $E = 0$

9. $E = k_e \dfrac{+q_1 - q_2 - q_3}{R_4^2}$

10. $E = k_e \dfrac{+q_1 - q_2 + q_3}{R_4^2}$

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014 (part 9 of 9) 2 points

What is the electric field at P_5, where $r = R_5$.

1. $E = k_e \dfrac{+q_1 - q_2 - q_3}{R_5^2}$

2. $E = k_e \dfrac{+q_1 + q_2 + q_3}{R_5^2}$

3. $E = k_e \dfrac{+q_1 + q_2}{R_5^2}$

4. $E = k_e \dfrac{-q_1 + q_2}{R_5^2}$

5. $E = k_e \dfrac{+q_1 - q_2 + q_3}{R_5^2}$

6. $E = 0$

7. $E = k_e \dfrac{+q_1}{R_5^2}$

8. $E = k_e \dfrac{+q_1 - q_2}{R_5^2}$

9. $E = k_e \dfrac{-q_1 + q_2 + q_3}{R_5^2}$

10. $E = k_e \dfrac{+q_1 + q_2 - q_3}{R_5^2}$

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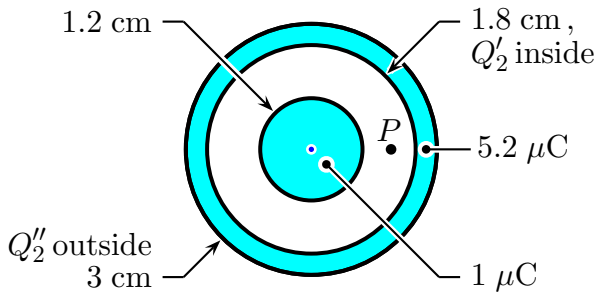
015 (part 1 of 2) 5 points

A conducting spherical shell having an inner radius of 1.8 cm and outer radius of 3 cm carries a net charge of 5.2 μC. A conducting sphere is placed at the center of this shell having a radius of 1.2 cm carring a net charge of 1 μC.



Determine the surface charge density on the inner surface of the shell. Answer in units of $\mathrm{C/m^2}$.

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016 (part 2 of 2) 4 points

Determine the surface charge density on the outer surface of the shell. Answer in units of $\mathrm{C/m^2}$.