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 notice that for your homework to be considered towards your grade, it needs to be submitted one hour before the corresponding recitation starts. Work submitted after this time, but before the DUE DATE on top of this page, will be accepted but not graded.

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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**Charged Cylindrical Shell**
24:02, calculus, numeric, > 1 min, normal.

**001**
A cylindrical shell of radius 7 cm and length 240 cm has its charge density uniformly distributed on its surface. The electric field intensity at a point 19 cm radially outward from its axis (measured from the midpoint of the shell) is 36000 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**
What is the electric field at a point 4 cm from the axis? Answer in units of N/C.

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**Nonuniformly Charged Sphere**
24:03, calculus, numeric, > 1 min, normal.

**003**
Consider a solid insulating sphere of radius \( b \) with nonuniform charge density \( \rho = a r \), where \( a \) is a constant.

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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. \( Q_r = 0 \)
2. \( Q_r = \pi a r^3 \)
3. \( Q_r = \pi a r^2 \)
4. \( Q_r = \frac{ar^4}{\pi} \)
5. \( Q_r = \frac{ar^3}{\pi} \)
6. \( Q_r = \frac{ar^2}{\pi} \)
7. \( Q_r = \frac{r^4}{\pi a} \)
8. \( Q_r = \frac{r^3}{\pi a} \)
9. \( Q_r = \frac{a \pi}{r^2} \)
10. \( Q_r = \pi a r^4 \)

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**004**
If \( a = 1 \times 10^{-6} \text{ C/m}^4 \) and \( b = 1 \text{ m} \), find \( E \) at \( r = 0.5 \text{ m} \). Answer in units of N/C.

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**005**
Find the charge \( Q_b \) contained within the radius \( r \), when \( r > b \). 

1. \( Q_b = \frac{\pi b^3}{a} \)
2. \( Q_b = \pi a b^3 \)
3. \( Q_b = \pi a b^2 \)
4. $Q_b = \frac{\pi a}{b^4}$
5. $Q_b = \pi a b^4$
6. $Q_b = \frac{\pi b^2}{a}$
7. $Q_b = \frac{a b^4}{\pi}$
8. $Q_b = \frac{a b^3}{\pi}$
9. $Q_b = \frac{a b^2}{\pi}$
10. $Q_b = 0$

Concentric Hollow Shells 02
24:08, calculus, multiple choice, > 1 min, fixed.

006
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. $Q = +q_1 + q_2$
3. $Q = +q_1 + q_2 + q_3$
4. $Q = -q_1$
5. $Q = -q_1 - q_2$
6. $Q = -q_1 - q_2 - q_3$
7. $Q = -q_1 + q_2$
8. $Q = +q_1 - q_2$
9. $Q = +q_1 + q_2 + q_3$
10. $Q = 0$

007

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

1. $Q = +q_1$
2. $Q = +q_1 + q_2$
3. $Q = +q_1 + q_2 + q_3$
4. $Q = -q_1$
5. $Q = -q_1 - q_2$
6. $Q = -q_1 - q_2 - q_3$
7. $Q = -q_1 + q_2$
8. $Q = +q_1 - q_2$
9. $Q = +q_1 + q_2 - q_3$
10. $Q = 0$

008
What is the charge $Q$ on the inner surface of the larger spherical conducting shell, where $R = r_3$?

1. $Q = +q_1$
2. $Q = +q_1 + q_2$
3. $Q = +q_1 + q_2 + q_3$
4. $Q = -q_1$
5. $Q = -q_1 - q_2$
6. $Q = -q_1 - q_2 - q_3$
7. $Q = -q_1 + q_2$
8. $Q = +q_1 - q_2$
9. $Q = -q_1 - q_2 + q_3$
10. $Q = 0$

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

1. $E = k_e \frac{+q_1}{R_1^2}$
2. $E = k_e \frac{+q_1 + q_2}{R_1^2}$
3. $E = k_e \frac{+q_1 - q_2}{R_1^2}$
4. $E = k_e \frac{-q_1 + q_2}{R_1^2}$
5. $E = k_e \frac{+q_1 + q_2 + q_3}{R_1^2}$
6. $E = k_e \frac{+q_1 - q_2 - q_3}{R_1^2}$
7. $E = k_e \frac{-q_1 + q_2 + q_3}{R_1^2}$
8. $E = k_e \frac{+q_1 - q_2 + q_3}{R_1^2}$
9. $E = k_e \frac{+q_1 + q_2 - q_3}{R_1^2}$
10. $E = 0$

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

1. $Q = +q_1$
2. $Q = +q_1 + q_2$
3. $Q = +q_1 + q_2 + q_3$
4. $Q = -q_1$
5. $Q = -q_1 - q_2$
6. $Q = -q_1 - q_2 - q_3$
7. $Q = -q_1 + q_2$
8. $Q = +q_1 - q_2$
9. $Q = +q_1 + q_2 - q_3$
10. $Q = 0$

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

1. $E = k_e \frac{+q_1}{R_2^2}$
2. $E = k_e \frac{+q_1 + q_2}{R_2^2}$
3. $E = k_e \frac{+q_1 - q_2}{R_2^2}$
4. $E = k_e \frac{-q_1 + q_2}{R_2^2}$
5. $E = k_e \frac{+q_1 + q_2 + q_3}{R_2^2}$
6. $E = k_e \frac{+q_1 - q_2 - q_3}{R_2^2}$
7. $E = k_e \frac{-q_1 + q_2 + q_3}{R_2^2}$
8. $E = k_e \frac{+q_1 - q_2 + q_3}{R_2^2}$
9. $E = k_e \frac{+q_1 + q_2 - q_3}{R_2^2}$
10. $E = 0$
What is the electric field at $P_3$, where $r = R_3$.

1. $E = k_e \frac{+q_1}{R_3^2}$
2. $E = k_e \frac{+q_1 + q_2}{R_3^2}$
3. $E = k_e \frac{+q_1 - q_2}{R_3^2}$
4. $E = k_e \frac{-q_1 + q_2}{R_3^2}$
5. $E = k_e \frac{+q_1 + q_2 + q_3}{R_3^2}$
6. $E = k_e \frac{+q_1 - q_2 - q_3}{R_3^2}$
7. $E = k_e \frac{-q_1 + q_2 + q_3}{R_3^2}$
8. $E = k_e \frac{+q_1 - q_2 + q_3}{R_3^2}$
9. $E = k_e \frac{+q_1 + q_2 - q_3}{R_3^2}$
10. $E = 0$

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

1. $E = k_e \frac{+q_1}{R_4^2}$
2. $E = k_e \frac{+q_1 + q_2}{R_4^2}$
3. $E = k_e \frac{+q_1 - q_2}{R_4^2}$
4. $E = k_e \frac{-q_1 + q_2}{R_4^2}$
5. $E = k_e \frac{+q_1 + q_2 + q_3}{R_4^2}$
6. $E = k_e \frac{+q_1 - q_2 - q_3}{R_4^2}$
7. $E = k_e \frac{-q_1 + q_2 + q_3}{R_4^2}$
8. $E = k_e \frac{+q_1 - q_2 + q_3}{R_4^2}$
9. $E = k_e \frac{+q_1 + q_2 - q_3}{R_4^2}$
10. $E = 0$

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

1. $E = k_e \frac{+q_1}{R_5^2}$
2. $E = k_e \frac{+q_1 + q_2}{R_5^2}$
3. $E = k_e \frac{+q_1 - q_2}{R_5^2}$
4. $E = k_e \frac{-q_1 + q_2}{R_5^2}$
5. $E = k_e \frac{+q_1 + q_2 + q_3}{R_5^2}$
6. $E = k_e \frac{+q_1 - q_2 - q_3}{R_5^2}$
7. $E = k_e \frac{-q_1 + q_2 + q_3}{R_5^2}$
8. $E = k_e \frac{+q_1 - q_2 + q_3}{R_5^2}$
9. $E = k_e \frac{+q_1 + q_2 - q_3}{R_5^2}$
10. $E = 0$

Conducting Spherical Shell 02

A conducting spherical shell having an inner radius of 4 cm and outer radius of 5 cm carries a net charge of 10 $\mu$C. A conducting sphere is placed at the center of this shell having a radius of 0.8 cm carring a net charge of 2 $\mu$C.

Determine the surface charge density on the inner surface of the shell. Answer in units of C/m$^2$.
outer surface of the shell. Answer in units of 
C/m².