Homework #2

Due 2/18/2005, 4 PM in mailboxes outside Science Center 109

Read: Chapter 24

Instructions: Please box your solutions. The homework problems are graded out of 3 points, and then the total re-scaled to 30. For each problem, in order to get full credit, you must also include a sentence explaining the most important idea you used in order to solve it. Do not summarize the whole solution, simply the one most important idea.

HW Problems

   Three point charges are arranged as shown in Figure P23.19.
   (a) Find the vector electric field that the 6.00-nC and -3.00-nC charges together create at the origin.
   (b) Find the vector force on the 5.00-nC charge.

   ![Figure P23.19](image)

   A continuous line of charge lies along the x axis, extending from $x = +x_0$ to positive infinity. The line carries charge with a uniform linear charge density $\lambda_0$. What are the magnitude and direction of the electric field at the origin?
3. Serway 23.34.
(a) Consider a uniformly charged thin-walled right circular cylindrical shell having total charge \( Q \), radius \( R \), and height \( h \). Determine the electric field at a point a distance \( d \) from the right side of the cylinder as shown in Figure P23.34. (Suggestion: Use the result of Example 23.8 and treat the cylinder as a collection of ring charges.)
(b) What If? Consider now a solid cylinder with the same dimensions and carrying the same charge, uniformly distributed through its volume. Use the result of Example 23.9 to find the field it creates at the same point.

![Figure P23.34](image)

Figure P23.40 shows the electric field lines for two point charges separated by a small distance.
(a) Determine the ratio \( q_1/q_2 \).
(b) What are the signs of \( q_1 \) and \( q_2 \)?

![Figure P23.40](image)
5. Serway 24.4.
Consider a closed triangular box resting within a horizontal electric field of magnitude $E = 7.80 \times 10^4$ N/C as shown in Figure P24.4. Calculate the electric flux through (a) the vertical rectangular surface, (b) the slanted surface, and (c) the entire surface of the box.

![Figure P24.4](image)

An infinitely long line charge having a uniform charge per unit length $\lambda$ lies a distance $d$ from point $O$ as shown in Figure P24.19. Determine the total electric flux through the surface of a sphere of radius $R$ centered at $O$ resulting from this line charge. Consider both cases, where $R < d$ and $R > d$.

![Figure P24.19](image)

7. Serway 24.34.
An insulating solid sphere of radius $a$ has a uniform volume charge density and carries a total positive charge $Q$. A spherical gaussian surface of radius $r$, which shares a common center with the insulating sphere, is inflated starting from $r = 0$.
(a) Find an expression for the electric flux passing through the surface of the gaussian sphere as a function of $r$ for $r < a$.
(b) Find an expression for the electric flux for $r > a$.
(c) Plot the flux versus $r$. 

8. Serway 24.43.
A square plate of copper with 50.0-cm sides has no net charge and is placed in a region of uniform electric field of 80.0 kN/C directed perpendicularly to the plate. Find (a) the charge density of each face of the plate and (b) the total charge on each face.

A conducting spherical shell of inner radius \( a \) and outer radius \( b \) carries a net charge \( Q \). A point charge \( q \) is placed at the center of this shell. Determine the surface charge density on (a) the inner surface of the shell and (b) the outer surface of the shell.