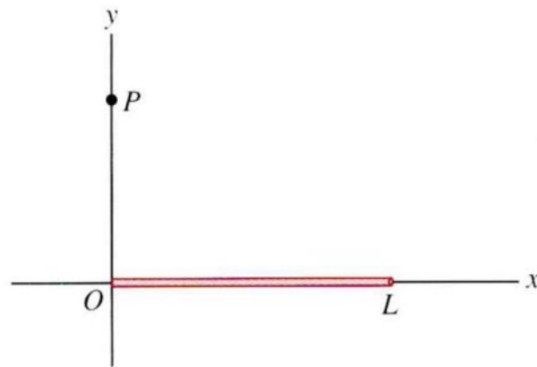


**Collaborators:**

**HRK P28.10 Solo** A total amount of positive charge  $Q$  is spread onto a nonconducting, flat, circular annulus of inner radius  $a$  and outer radius  $b$ . The charge is distributed so that the charge density (charge per unit area) is given by  $\sigma = k/r^3$  where  $r$  is the distance from the center of the annulus to any point on it. Show that (with  $V = 0$  at infinity) the potential at the center of the annulus is given by;

$$V = \frac{Q}{8\pi\epsilon_0} \left( \frac{a+b}{ab} \right)$$

**HRK 28.13** On a thin rod of length  $l$  lying along the  $x$  axis with one end at the origin  $x = 0$ , as in Fig. 28-46, there is distributed a charge per unit length given by  $\lambda = kr$ , where  $k$  is a constant  $r$  is the distance from the origin. (a) Taking the electrostatic potential at infinity to be zero, find  $V$  at the point  $P$  on the  $y$  axis. (b) Determine the vertical component  $E_y$  of the electric field at  $P$  from the result of part (a) and also by direct calculation. (c) Why cannot  $E_x$ , the horizontal component of the electric field at  $P$ , be found using the result of part (a)? (d) At what distance from the rod along the  $y$  axis is the potential equal to the value at the left end of the rod?



**FIGURE 28-46.** Problem 13.

■

**3. Need Thursday Lecture** In lecture, we calculated the amount of electrostatic energy contained in the *interior* electric field of a uniform sphere of radius  $R$  and charge density  $\rho$ . The result was

$$U = \frac{2\pi\rho^2}{45\epsilon_0} R^5$$

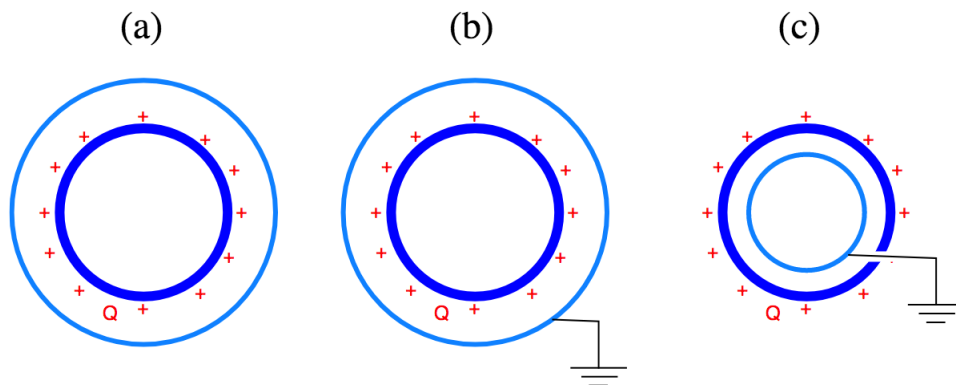
For this problem, complete the calculation by calculating the energy stored in the *exterior* electric field, and verify that the *total* stored energy matched the work done to assemble the sphere.

■

4. Consider an infinitely long line of charge with linear charge density  $\lambda$ . The line of charge is parallel to and a distance  $d$  above the plane, including any surface charges. Then using the concepts discussed in lecture, determine the electric field  $E(x)$  at the surface of the plane as a function of the horizontal distance  $x$  from the perpendicular between the plane and line.

■

5. Consider a hollow conducting sphere that carries a net positive charge  $Q$ . Next, a second initially uncharged concentric conducting sphere is brought into proximity with the first (without touching it). In scenario (a), the second sphere is placed outside the first and left *ungrounded*. In scenario (b), the second sphere is outside the first and grounded. In scenario c the second sphere is *inside* the first and also grounded.



For all three scenarios, describe the final arrangement of charge on the second sphere and the electric field (if any) outside the second sphere.

■

**6. Need Thursday Lecture** A cylindrical capacitor is made from two long thin concentric metal cylinders of length  $L$  and radii  $a$  and  $b$  ( $L \gg a$  and  $a > b$ )

- (a) Using the definition of capacitance  $C = Q/V$ , calculate the capacitance per unit length  $C/L$  of this configuration.
- (b) Repeat the capacitance calculation, this time using the stored energy  $U = \frac{1}{2} \frac{Q^2}{C}$ .

■