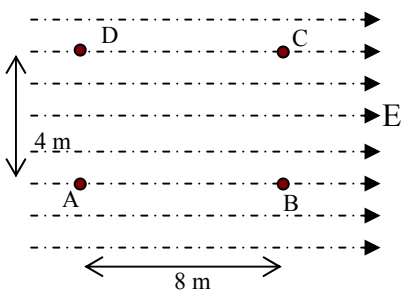
AP Physics C Review 15 Electric Potential & Capacitance

1. An electric field of 600 N/C exists. Calculate the change in potential energy if:
   a. A charge of +5 μC moves from A to B.
   b. A charge of –5 μC moves from A to B.
   c. A charge of +5 μC moves from A to C.
   d. A charge of +5 μC moves from A to D.



2. If q_1 = 6 C and is located at the point (0,3) and q_2 = 4 C and is located at point (0,8).
   a. Find the potential at point (6, 6) due to both charges.
   b. Find the amount of work to move a +1 C charge from (0,5) to (6,6).

3. **A positive charge distribution exists within a nonconducting spherical region of radius a. The volume charge density ρ is not uniform but varies with the distance r from the center of the spherical charge distribution, according to the relationship**

   $\rho = \beta r$, for $0 \le r \le a$, where β is a positive constant, and
   $\rho = 0$, for $r > a$.

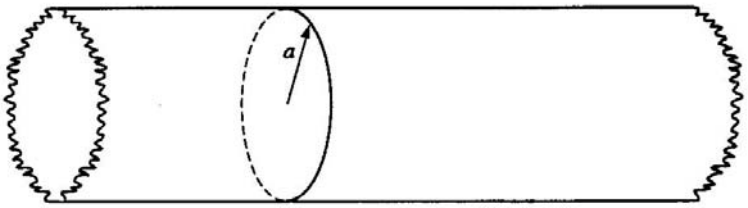
   (a) Show that the total charge Q in the spherical region of radius a is $\beta\pi a^4$.

   (b) In terms of β, r, a, and fundamental constants, determine the magnitude of the electric field at a point a distance r from the center of the spherical charge distribution for each of the following cases.

   i. $r > a$
   ii. $r = a$
   iii. $0 < r < a$

   (c) In terms of β, a, and fundamental constants, determine the electric potential at a point a distance r from the center of the spherical charge distribution for each of the following cases.

   i. $r = a$
   ii. $r = 0$



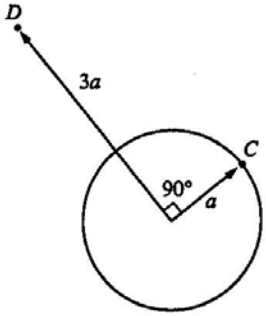
4. A very long nonconducting rod of radius a has positive charge distributed throughout its volume. The charge distribution is cyclindrically symmetric, and the total charge per unit length of the rod is λ.

(a) Use Gauss's law to derive an expression for the magnitude of the electric field E outside the rod.

(b) The diagrams below represent cross sections of the rod. On these diagrams, sketch the following.

i. Several equipotential lines in the region $r > a$

ii. Several electric field lines in the region $r > a$



(c) In the diagram above, point C is a distance a from the center of the rod (i.e., on the rod's surface), and point D is a distance $3a$ from the center on a radius that is 90° from point C. Determine the following.

i. The potential difference $V_C - V_D$ between points C and D

ii. The work required by an external agent to move a charge $+Q$ from rest at point D to rest at point C

Inside the rod ($r < a$), the charge density ρ is a function of radial distance r from the axis of the rod and is given by $\rho = \rho_0(r/a)^{1/2}$, where ρ_0 is a constant.

(d) Determine the magnitude of the electric field E as a function of r for $r < a$. Express your answer in terms of ρ_0, a, and fundamental constants.