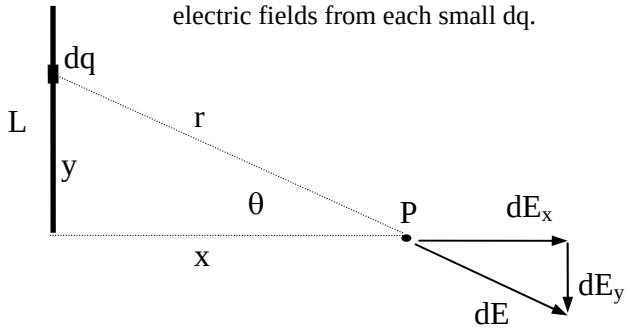
Electric Field Due to a Line Charge

Purpose: To gain additional experience in calculating electric fields, both analytically and by using an electronic spreadsheet to find the electric field near a one dimensional charged rod.

Equipment: Computer with Excel software.

Introduction: Consider the uniformly charged rod shown below. We can find the electric field at the point P by breaking the rod up in a collection of infinitesimal charges and summing the electric fields from each small dq.



Procedure:

1. Assuming the rod has a total charge Q, find the resultant field at the point P analytically (set up the integral and do the math!). Verify with your instructor that your solution is correct.
2. Solve the problem by using an electronic spreadsheet. Since the spreadsheet works with numbers, choose L = 2 m, Q = 4 μC, and x = 3 m. Create some separate cells that contain this information so that is easy to change these numbers if the need arises. Also set up a cell for N, the number of differential charge elements in your rod. Put these cells (with adjacent labels and units) on the left edge of you spreadsheet near the top where they are easy to refer to (see the attached sample spreadsheet).
3. Create columns for y, r, sin θ, cos θ, dE_x, and dE_y with appropriate column headings. In the first row of each of these columns put in the initial value or formula that calculates the value needed. Copy these formulas down through 100 rows. For the initial calculation break the rod into 100 pieces (N = 100).
4. Create two cells for the sum of the values in the dEx and dEy columns. These are of course the resultant x and y components of the electric field at P. Show the magnitude and direction of the field in two additional cells. Arrange all of these cells in a convenient viewing area near the top of your spreadsheet. Print out the first 15 or 20 rows of your spreadsheet for your lab report. Also print out the formulae used in these same rows of your spreadsheet. To do this, from the **Formulas** command tab, in the **Formula Auditing** section, click **Show Formulas**. The formulas are displayed. To hide formulas, click **Show Formulas** again. Also show the column and row headings (A1,B1, etc.) by choosing that option in **Page Layout** and check the **Headings/Print** box in the **Sheet Options** section.
5. Using the numbers given in part 2 above, verify that your answer compares favorably with your analytic solution found in part 1. Use the spreadsheet to find E for decreasing numbers of dqs. For example, try N = 50, N = 20, etc. Draw conclusions about when the approximation that your spreadsheet provides starts to deviate significantly from the exact answer. Make a table in your lab report showing E and N for at least five different values of N.

Sample Spreadsheet