Electric field homework Name:__________________________
Date:___________________________

Overview of homework: The goal of this homework is to extend what you learned in lab this week about calculating the electric field due to a bar of charge; you will use the same basic ideas to slightly different questions.

1. **Electric field for a bar of charge.** In the lab we calculated E_x at the origin due to a bar of charge with a length 2 cm with charge density 1/18 μC/cm and located between 1 cm < x < 3 cm on the *x*-axis (y=0) (let's call this case A). Now we want to do something slightly different: move everything to the left by 1 cm and find the field at point *Q* located at (-1 cm, 0 cm) due to the same bar of charge with a length 2 cm with charge density 1/18 μC/cm and located between 0 cm < x < 2 cm on the *x*-axis (y=0) (let's call this case B).
   a. Do you expect E_x in case B to be less than, equal to, or greater than E_x in case A? Explain.

   b. Is the general formula you will use to find E_x different for case B compared to case A ($\int k\rho/r^2\, dx$)?

   c. Is *r(x)* different for case B (for case A *r=x)*? Hint: $r=\sqrt{[(x_1-x_2)^2+(y_1-y_2)^2]}$ gives the distance between points 1 and 2.

   d. Are the limits of your integral different for case B (for case A you integrated from 1 cm to 3 cm)?

   e. Calculate E_x for case B

   f. Does your answer agree with your expectations that you stated in part *a?*

2. Now let's do yet another slightly different case C: find the field at point *Q* located at (-1 cm, 0 cm) due to the same bar of charge with a length 2 cm with charge density 1/18 μC/cm and located between 1 cm < x < 3 cm on the *x*-axis (y=0)
    a. Do you expect E_x in case C to be less than, equal to, or greater than E_x in case A? Explain.
    b. Is the general formula you will use to find E_x different for case C?
    c. Is *r(x)* different for case C?
    d. Are the limits of your integral different for case C?
    e. Calculate E_x for case C
    f. Does your answer agree with your expectations that you stated in part *a?*

3. Now let's do yet another even more different case D: find the field at point P located at (0 cm, 0 cm) due to a bar of charge with a length 2 cm with **non constant** charge density 1/18 x μC/cm^2 and located between 1 cm < x < 3 cm on the x-axis (y=0)
    a. Do you expect E_x in case D to be less than, equal to, or greater than E_x in case A? Explain.

    b. Is the general formula you will use to find E_x different for case D as compared to case A? Before we imagined adding up E_x due to small chunks of the bar, taking the limit as the size of the bar went to zero, which resulted in an integration. Is this method still reasonable if the charge density is cot constant? Explain.

    c. Calculate E_x for case D.

    d. Does your answer agree with your expectations that you stated in part *a?*

4. A student in your class says "*Finding the electric field at point P due to a bar of charge is just like finding the field due to a point. I use $E=kq/r^2$, where q is the total charge and r is the distance between the center of the bar and point P. This works because the fields due to the charge on the bar on either side of the center balance each other.*"
    a. Do you agree or disagree with this statement. Explain your reasoning.

    b. Look back at your work from recitation (part 3*bi* on page 5 and *3civ* on page 8); what is the electric field from each of these calculations? Are they equal?

    c. Does your answer to *b* above support or refute your answer to *a* above? If they disagree, how would you revise either your answer to *a* or to *b?*