Integration Worksheet

No matter if you want to find the electric field or electric potential of a charge distribution, your strategy is the same: you know how to calculate these quantities for an arrangement of several point charges, so you mentally "chop up" the charge distributions into little *point-like* pieces of charge, and sum up all contributions from all pieces.

Procedure:

1) Draw a graph of the situation.

2) Draw in a small piece of charge dq.

3) In a completely general way, label the position of your small piece of charge by "x" or "y" or "z" (for rods), or "r" for a ring or disk of charge.

4) Find dq in terms of the charge density (linear charge density, area charge density, volume charge density), and the length or area occupied by dq, e.g. $dq = \lambda dx$. *Hint: do not call the length "dL" if you are interested in a rod of length L, this is bound to confuse you!*

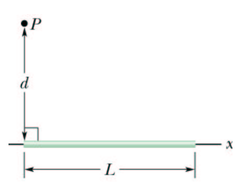
5) Identify the point P at which you want to calculate the potential, draw it in your figure.

6) In general terms, write down the *distance* r from your piece of charge to point P. Use the position of your small piece of charge as identified in step 3 above to do so.

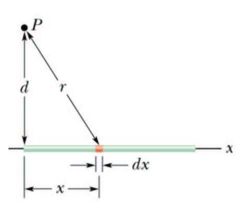
7) Write out the electric field or electric potential due to the small charge dq at point P.

8) Write down the integral to find the contribution from all small pieces of charge.

9) Solve the integral using calculus.



(a)

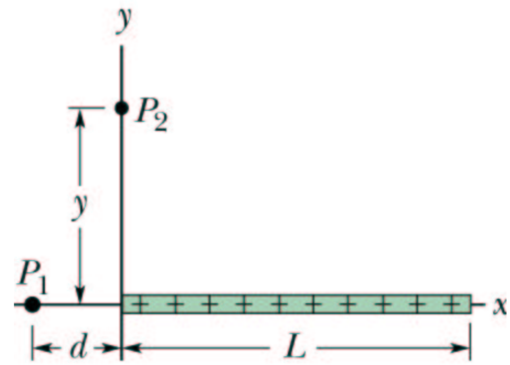


(b)

Examples:

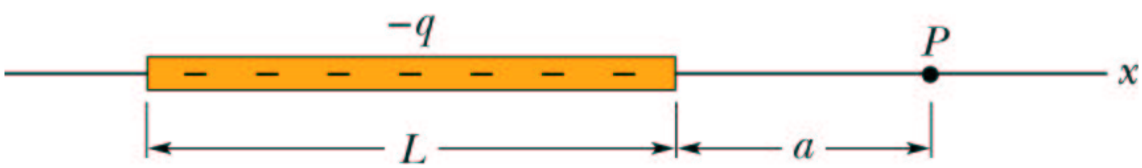
Do at least the set-up (steps 1 -8) for calculating the electric potential in the following situations:

1) charged rod of length L, point P_1 at $-d$, uniform charge distribution λ

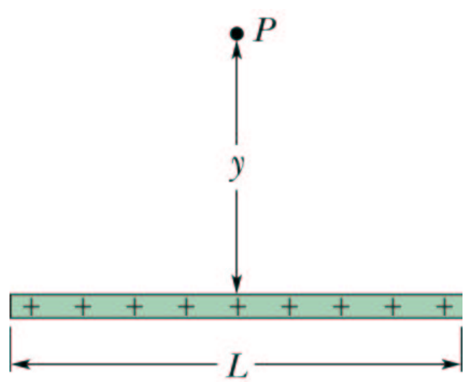


2) charged rod of length L, point P_2 at y, uniform charge distribution λ (see previous figure)

3) charged rod of length L, point P at a distance a from the end of the rod, uniform charge distribution λ



4) charged rod of length L, point P at y midway above the rod, uniform charge distribution λ



How do your results for 1 and 2 change if $\lambda = cx$, instead of $\lambda = constant$?