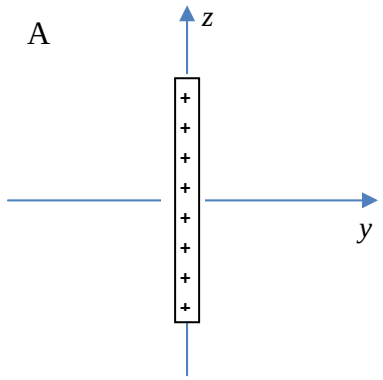
Lesson #21: Multipole Expansion **Name:** _____

Study section 3.4 and answer the following questions (be sure to show/ explain your work).

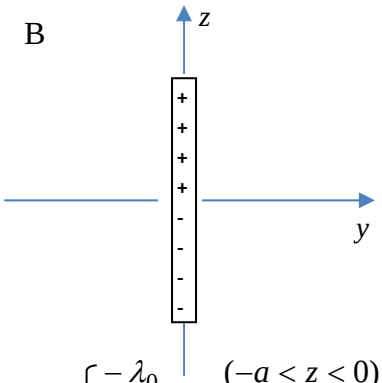
Consider the two line charge distributions shown below. The line charge density is given for each case, where λ_0 is a positive constant.

A



$\lambda(z) = +\lambda_0 \qquad (-a < z < +a)$

B



$$\lambda(z) = \begin{cases} -\lambda_0 & (-a < z < 0) \\ +\lambda_0 & (0 < z < +a) \end{cases}$$

1. What do you expect is the leading term (i.e., monopole, dipole, etc.) in the multipole expansion for each of these distributions?

   For A, the leading term is *(circle one)*: **monopole** **dipole** **quadrupole** **octopole**

   For B, the leading term is *(circle one)*: **monopole** **dipole** **quadrupole** **octopole**

2. Explain the choices you made for question 1. How did you decide the answers?

3. For line charge densities, the dipole moment is defined analogously to Eq. 3.98. That is, $\vec{p} = \hat{z}\int z'\,\lambda(z')\,dz'$ where z′ is the usual source charge coordinate. Calculate the dipole moment for each of the distributions shown above.

4. For each of the distributions, write down the approximate electric potential at large distances from the charge ($r >> a$).