Don't waste time on questions you aren't sure of. Be clear and concise. A cluttered response will not get full credit.

1. (10 pts) A non-conducting rod lies on the z-axis from \((-2a, 0, 0)\) to \((a, 0, 0)\), where \(a\) is a constant. It has charge per unit length \(\lambda = 6ax^2\), where \(a\) is a constant. What units must \(x\) and \(\lambda\) have? In terms of \(a\) and \(\lambda\), find the total charge \(Q\) on the rod, and the average charge per unit length \(\overline{\lambda}\).

\[
Q = \int_{-2a}^{a} \lambda \, dx = \int_{-2a}^{a} 6ax^2 \, dx = 6a \left[ \frac{x^3}{3} \right]_{-2a}^{a} = 18a^3
\]

\[
\overline{\lambda} = \frac{Q}{L} = \frac{18a^3}{3a} = 6a^2
\]

2. (10 pts) For the benefit of Bart Simpson's teacher, concisely explain the amber effect and why it is attractive. In your figure use a negative source charge.

3. Consider two infinite conducting parallel plates, the top with total charge per unit area \(3\sigma_0\) and the bottom with total charge per unit area \(5\sigma_0\) \((\sigma_0 > 0)\).

   a. (5 pts) Find the total field (magnitude and direction) between the plates.

   
   \[
   \vec{E} = 2\pi k \left( 3\sigma_0 \right) \hat{z} + 2\pi k \left( 5\sigma_0 \right) \hat{z} = 4\pi k \sigma_0 \hat{z}
   \]

   b. (5 pts) Find the charge density on the top surface of the bottom sheet.

   
   \[
   \vec{E}_{\text{out}} \cdot \hat{n} = 4\pi k \sigma_3 \quad ; \quad \vec{E}_{\text{out}} = 4\pi k \sigma_0 \hat{z} \quad \hat{n} = 1
   \]

   \[
   \Rightarrow \sigma_3 = 4\pi k \sigma_0 = \frac{(4\pi k \sigma_0 \hat{z}) \cdot \hat{z}}{4\pi k} = \sigma_0
   \]