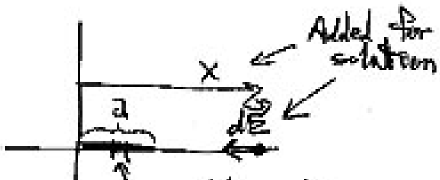
Key Pink

5. (15 pts) A negative charge ($Q < 0$) is uniformly distributed from the origin to $(a, 0)$. Compute E_x at $(x, 0)$ for $x > a$.



For solution, I added $dq = \lambda dx'$, with $\lambda = \frac{Q}{a} < 0$

$d\vec{E}$ points along $-\hat{x}$.

$$|d\vec{E}| = \frac{k|dq|}{r^2} = \frac{k|\lambda|dx'}{(x-x')^2}$$

$$dE_x = -|d\vec{E}| = -k\frac{(|Q|/a)dx'}{(x'-x)^2}$$

$$E_x = -k\frac{|Q|}{a}\int_0^a \frac{dx'}{(x'-x)^2} = -\frac{k|Q|}{a}\left(-\frac{1}{x'-x}\right)\Big|_0^a$$

$$= \frac{k|Q|}{a}\left[\frac{1}{a-x} - \frac{1}{-x}\right] = \frac{k|Q|}{a}\left[\frac{1}{x} - \frac{1}{x-a}\right] \quad (E_x < 0)$$

6. Two uniform line charges are normal to the page. A, with charge density -3λ, passes through the origin. B, with charge density -6λ, passes through $(3a, 0)$.

a. (8 pts) Find the position $(s, 0)$ where the electric field is zero.

$(s,0)$ lies between A and B. $|\vec{E}_{-6\lambda}| = |\vec{E}_{-3\lambda}|$ at $(s,0)$

so $\frac{2k|-6\lambda|}{3a-s} = \frac{2k|-3\lambda|}{s}$, or $2s = (3a-s)$, so $2s + s = 3a$, so $\boxed{s = a}$

b. (7 pts) If λ is represented by two field lines, find the angle between the field lines near A; near B; as viewed from far away from both A and B.

A: $\frac{360}{2\times 3} = 60^\circ$; B: $\frac{360}{2\times 6} = 30^\circ$

overall, $\frac{360}{2\times 9} = 20^\circ$

c. (10 pts) Sketch the field lines for this geometry. Take one field line from A to go directly to the ~~left~~ right, and take one field line from B to go directly to the ~~right~~ left.