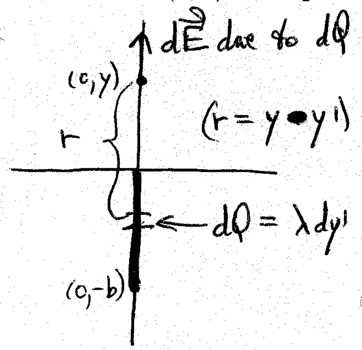
Pink

5. (15 pts) A positive charge ($Q > 0$) is uniformly distributed from $(0, -b)$ to the origin $(0, 0)$. Compute E_y at $(0, y)$ for $y > 0$.



$$|d\vec{E}| = \frac{k\,dQ}{r^2} = \frac{k\lambda\,dy'}{r^2}$$

Use $dr = d(y-y') = 0 - dy' = -dy'$.

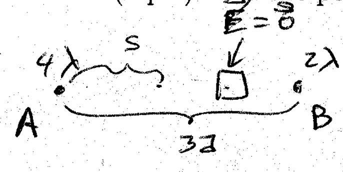
Then $|d\vec{E}| = \frac{k\lambda(-dr)}{r^2}$ ← sign OK since $dr < 0$ on going from $y' = -b$ to $y' = 0$

$$dE_y = |d\vec{E}| = \frac{k\lambda(-dr)}{r^2}$$

$$E_y = -k\lambda\int_{y+b}^{y}\frac{dr}{r^2} = k\lambda\int_{y}^{y+b}\frac{dr}{r^2} = k\lambda\left(-\frac{1}{r}\right)\Big|_y^{y+b} = k\lambda\left(\frac{1}{y} - \frac{1}{y+b}\right)$$

6. Two uniform line charges are normal to the page. A, with charge density 4λ, passes through the origin. To its right, B, with charge density 2λ, passes through $(3a, 0)$.

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



At $(s,0)$, $|\vec{E}_A| = |\vec{E}_B|$, so

$$\frac{2k(4\lambda)}{s} = \frac{2k(2\lambda)}{3a-s}, \text{ so } 2(3a-s) = s,$$

or $6a = 3s$, so $s = 2a$

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

For A alone, 16 lines, so angles of $\frac{360}{16} = 22.5°$

For B alone, 8 lines, so angles of $\frac{360}{8} = 45°$

For combination, 24 lines, so angles of $\frac{360}{24} = 15°$

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