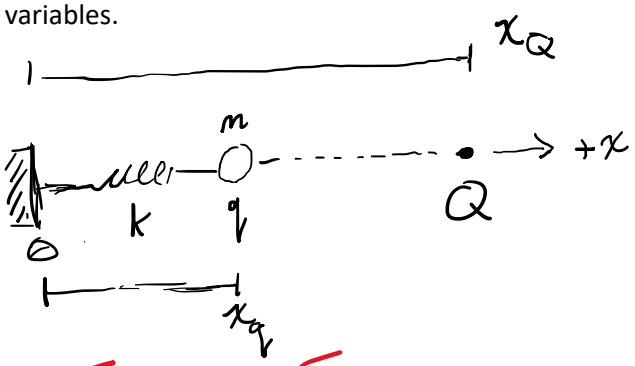
Electric Charges and Coulomb's Law

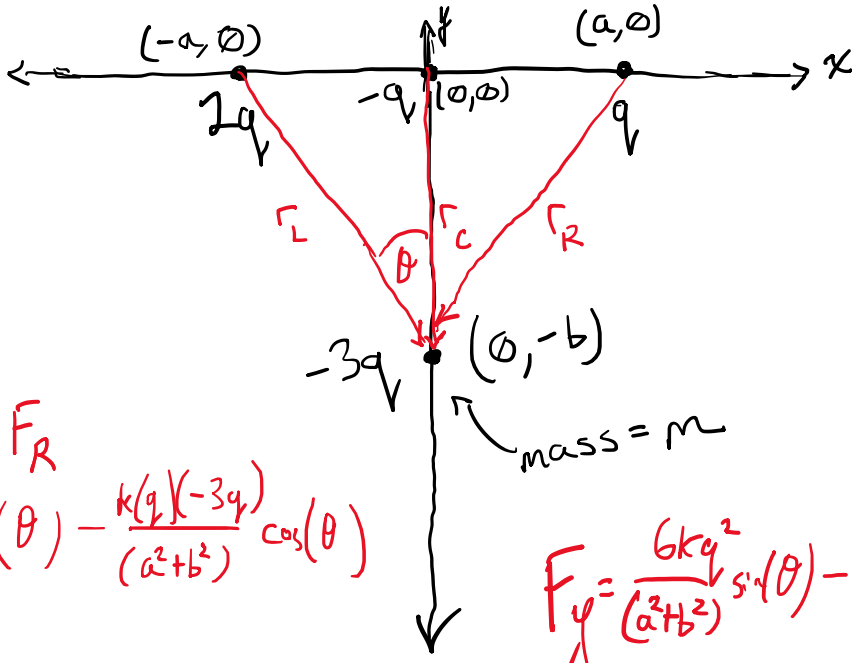
1. Charge Q is fixed in space at the position x_Q, and charge q is attached to a spring with a spring constant k, and an equilibrium length x_o. Solve for the net force on charge q in terms of the given variables.



$$\sum F = F_{spring} + F_{coulomb}$$

$$= -k(x_q - x_o) - \frac{1}{4\pi\varepsilon_o}\frac{Qq}{(x_Q - x_q)^2}$$

2. Four charges are positioned according to the diagram below. What is the initial acceleration of mass m?



$$\vec{F} = \frac{kq_1q_2}{r^2}\hat{r}$$

$$\sum F = F_L + F_C + F_R$$

$$F_x = \frac{k(2q)(-3q)}{(a^2+b^2)}\cos(\theta) - \frac{k(q)(-3q)}{(a^2+b^2)}\cos(\theta)$$

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$$= \frac{-3kq^2}{a^2+b^2}\left(\frac{b}{\sqrt{a^2+b^2}}\right)\hat{x}$$

$$F_y = \frac{6kq^2}{(a^2+b^2)}\sin(\theta) - \frac{3kq^2}{b^2} + \frac{3kq^2}{a^2+b^2}\sin(\theta)$$

$$= \left(\frac{9kq^2}{a^2+b^2}\left(\frac{a}{\sqrt{a^2+b^2}}\right) - \frac{3kq^2}{b^2}\right)\hat{y}$$

$$\vec{F} = \vec{F}_x + \vec{F}_y$$