tutorial #1 [Coulomb's law & electric field] .quiz

1) Francis Hauksbee tries to balance a charge $q = -4\ \mu$C at point A as shown in fig. 1, using two charges Q_1 and Q_2 on a horizontal line. The weight of the charge is $W = 1.0\times10^{-3}$N which is drawn in the picture.

a) What should be the electrostatic force on the charge q to cancel the weight? Draw this force vector in the figure.
b) What is the sign of the charges Q_1 and Q_2, if the charge q is in equilibrium.
c) Draw the force vectors of Q_1 and Q_2 on q. Why should we choose $Q_1 = Q_2$?
d) Now that we know $Q_1 = Q_2 =: Q$ (call them both Q), find the total electrostatic force on the charge q in terms of Q. Remember you still do not know Q so the answer is something like $F_{\rm E}$ = some number $\times\, Q$. I will write the trigonometric relations on the board.
e) Now using part 'a', i.e. the equilibrium condition, find the value of Q.

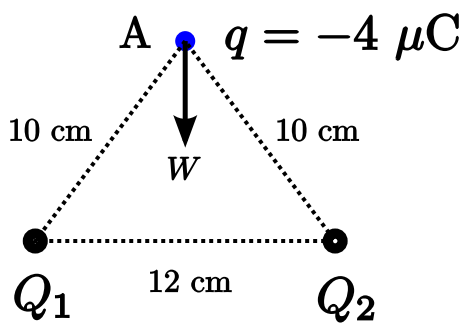

Figure 1: Charges and the weight force.

a) $\vec{F}_E = W\hat{y}$

b) they should repel q so $Q_1, Q_2 < 0$.

c) We want $(\vec{F}_1 + \vec{F}_2)\cdot\hat{x} = F_{1x} + F_{2x} = 0$

$\Rightarrow |F_{1x}| = |F_{2x}| \Rightarrow |\vec{F}_1| = |\vec{F}_2| \Rightarrow Q_1 = Q_2$.

d) $F_E = 2k\dfrac{qQ}{(10\,\text{cm})^2}\cos\theta$

$= 5.8\times10^6\, Q$ N

e) $F_E = W \rightarrow 5.8\times10^6\, Q = 1.0\times10^{-3}$ N

$\rightarrow Q = 1.7\times10^{-10}$ C.