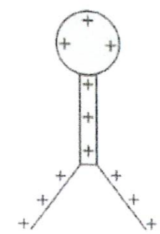
1.

A positively charged electroscope has separated leaves.



a. Suppose you bring a positively charged rod close to the top of the electroscope, but not touching. How will the leaves respond? Use both charge diagrams and words to explain.

plastic rod repels pos. charge on electroscope.
Leaves get more pos. charge & have stronger repulsion.

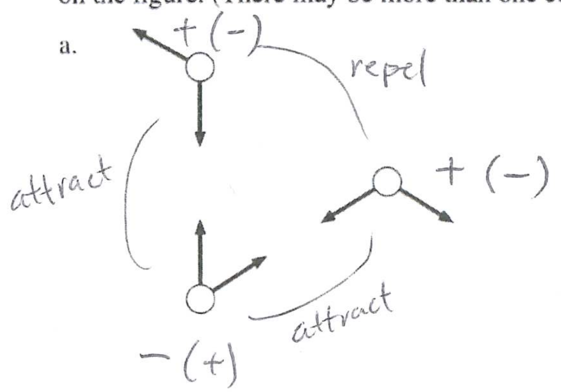
b. How will the leaves respond if you bring a negatively charged rod close to the top of the electroscope, but not touching? Use both charge diagrams and words to explain.

neg. rod attracts pos. charge.
∴ leaves get less charged & move closer together.

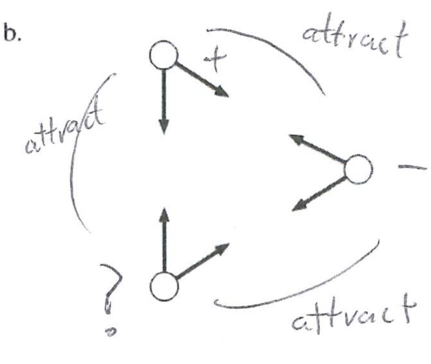
2.

Can you assign charges (positive or negative) so that these forces are correct? If so, show the charges on the figure. (There may be more than one correct response.) If not, why not?

a.



b.



not possible.

c.

$\vec{F}_{12} = -\vec{F}_{21}$

not possible

$\vec{F}_{12}$ & $\vec{F}_{21}$ can't have diff. mag.

d.

+ (−) − (+)

attract

$\therefore 4(3-x)^2 = x^2$

$4(9-6x+x^2) = x^2 \quad \therefore 36 - 24x + 4x^2 = x^2$

$\therefore 3x^2 - 24x + 36 = 0$

$\therefore x^2 - 8x + 12 = 0$

3.

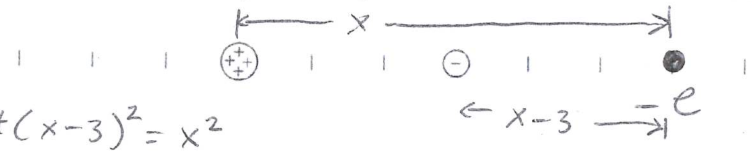
$(x-6)(x-2) = 0 \quad \therefore x = 2, \; x = 6$

Draw a + on the figure below at the position or positions where a proton would experience no net force.

$\frac{ke\,4q}{x^2} = \frac{keq}{(3-x)^2}$

$\therefore x = 2$ is only physical sol'n

Draw a − on the figure below at the position or positions where an electron would experience no net force.



$\frac{ke\,4q}{x^2} = \frac{keq}{(x-3)^2}$

$4(x-3)^2 = x^2$

$4(x^2-6x+9) = x^2$

$\therefore 3x^2 - 24x + 36$

$x^2 - 8x + 12 = 0$

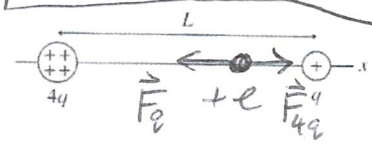
$(x-2)(x-6) = 0$

$\therefore x = 2, \; x = 6$

$x = 6$ is only physical sol'n

4.

Positive charges $4q$ and q are distance L apart. Let them be on the x-axis with $4q$ at the origin.



a. Suppose a proton were placed on the x-axis to the *right* of q. Is it *possible* that the net electric force on the proton is zero? Explain.

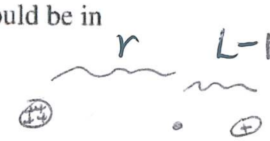
No. if proton is to right of 4q & q, it is repelled by both.

b. *On the figure*, draw a proton at an arbitrary point on the x-axis to the *left* of q, between $4q$ and q. Draw two force vectors and label them $\vec{F}_{4q}$ and $\vec{F}_q$ to show the two forces on this proton. Is it *possible* that, for the proper choice of r, the net electric force on the proton is zero? Explain.

Yes. $\vec{F}_q$ is to left, $\vec{F}_{4q}$ is to right. It is possible that $\vec{F}_{net} = \vec{F}_{4q} + \vec{F}_q = 0$.

c. Write expressions for the magnitudes of forces $\vec{F}_{4q}$ and $\vec{F}_q$. Your expressions should be in terms of K, q, e, L, and r.

$F_{4q} = \frac{K\,4qe}{r^2} \qquad F_q = \frac{kqe}{(L-r)^2}$



d. Find the specific position—as a fraction of L—at which the net force is zero.

$\frac{K\,4qe}{r^2} = \frac{kqe}{(L-r)^2}$

$r^2 = 4(L-r)^2$

$r^2 = 4(L^2 - 2Lr + r^2)$

$0 = 3r^2 - 8Lr + 4L^2$

$r = \frac{8L \pm \sqrt{64L^2 - 4(3)(4L^2)}}{6} = \frac{4L}{3} \pm \frac{1}{6}L\sqrt{64-48}$

$\therefore r = \frac{4}{3}L \pm \frac{2}{3}L$

~~$r = 2L$~~ or $r = \frac{2}{3}L$

5.

a. The electric field of a point charge is shown at *one* point in space.

Can you tell if the point charge is + or −? If not, why not?

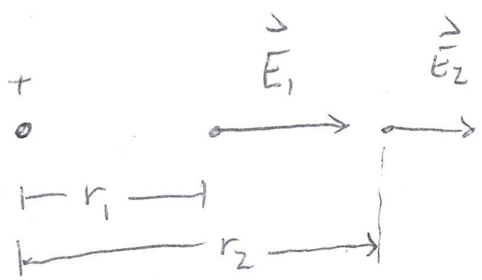
no. ~~cham~~ can have pos. to left of pt.
or neg to right of pt.

b. Here the electric field of a point charge is shown at two positions in space.

Now can you tell if the point charge is + or −? Explain.

b/c $\vec{E}$ get weaker further to right, pt. charge must be to the left. ∴ charge is pos.

c. Can you determine the location of the charge? If so, draw it on the figure. If not, why not?



$$\frac{E_1}{E_2} = \frac{\frac{1}{4\pi\varepsilon_0}\frac{q}{r_1^2}}{\frac{1}{4\pi\varepsilon_0}\frac{q}{r_2^2}} = \left(\frac{r_2}{r_1}\right)^2 \qquad \therefore \frac{r_2}{r_1} = \sqrt{\frac{E_1}{E_2}} = \sqrt{\frac{9}{4}}$$

Know also, from fig. $r_2 - r_1 = 1$ unit. $\therefore \frac{r_2}{r_1} = \frac{3}{2}$ $\quad r_2 = \frac{3}{2} r_1$

$\therefore r_2 = 1 + r_1$

$$r_2 = 1 + r_1$$

$$r_2 = \frac{3}{2} r_1$$

$$\therefore 1 + r_1 = \frac{3}{2} r_1$$

$$\therefore 1 = \frac{1}{2} r_1 \quad \therefore \boxed{r_1 = 2 \text{ units}}$$

$$\boxed{\therefore r_2 = 1 + r_1 = 3 \text{ units}}$$