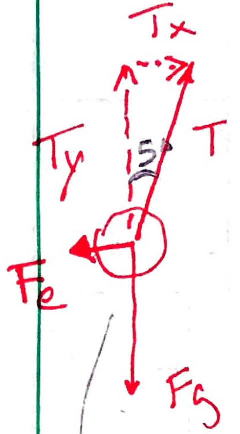
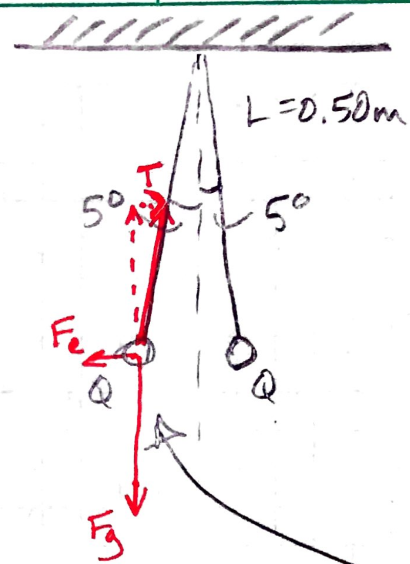
5.55



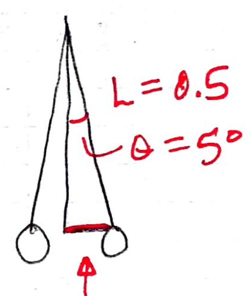


Find Q & sign of charge. Can't determine sign of charge: Q could be positive on both balls, or negative – either way they're going to repel.

Force of repulsion is needed to solve for Q, so we need a free-body diagram. I'll focus on one ball to simplify the diagram:

$$\Sigma F_y = 0$$
$$T_y - F_g = 0$$
$$T\cos\theta = mg$$
$$T = \frac{mg}{\cos\theta} \quad (= 0.0492)$$

$$\Sigma F_x = 0$$
$$F_e - T_x = 0$$
$$F_e = T_x = T\sin 5$$
$$F_e = \left(\frac{mg}{\cos\theta}\right)\sin\theta \quad (= 0.00429)$$



$$\text{opp} = L\sin\theta$$
$$= 0.5\sin 5$$
$$= 0.043\text{m}$$
$$\times 2$$
$$= 0.087$$

What is $F_{electric}$? $F_e = \frac{kq_1q_2}{r^2}$

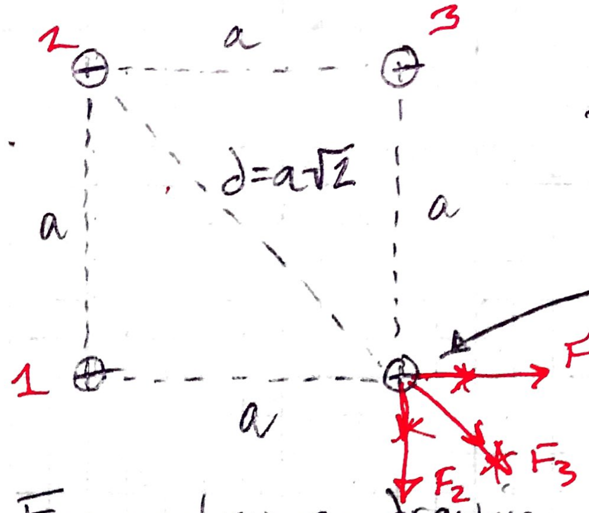
Combining

$$\frac{kq_1q_2}{r^2} = mg\tan\theta$$

$$\frac{(8.99e9)Q^2}{(0.087)^2} = (0.005\text{kg})(9.8)\tan 5°$$

$$Q = \boxed{6.01e-8\,C}$$ positive or negative

5.63



Find force on this charge

Need Force analysis, so drawing ~~free body~~ diagrams.

$$\Sigma F = F_1 + F_2 + F_3$$

I'm going to use i-j notation for components

$$F_1 = \frac{kq_1q_2}{r^2} = \frac{kq^2}{a^2} = \frac{kq^2}{a^2}\,\hat{i} \rightarrow$$

$$F_3 = \frac{kq^2}{a^2} - \hat{j} \text{ (by symmetry)} \downarrow$$

$$F_2 = \frac{kqq}{r^2} = \frac{kq^2}{(a\sqrt{2})^2} = \frac{kq^2}{2a^2} \searrow$$

x-component = $F_2 \cos 45 = \frac{kq^2}{\sqrt{2}\,2a^2}$
& y-component

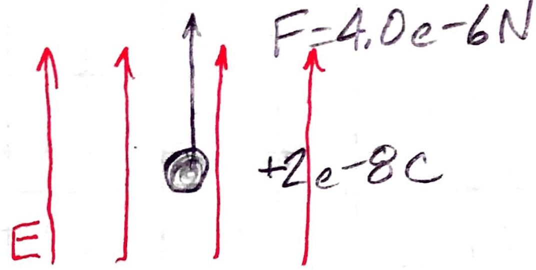
$$F_{net} = \left(\frac{kq^2}{a^2} + \frac{kq^2}{(\sqrt{2})2a^2}\right)\hat{i} + -\left(\frac{kq^2}{a^2} + \frac{kq^2}{2a^2\sqrt{2}}\right)\hat{j}$$

Simplify?

$$\boxed{\frac{kq^2}{a^2}\left[\left(1 + \frac{1}{2\sqrt{2}}\right)\hat{i} - \left(1 + \frac{1}{2\sqrt{2}}\right)\hat{j}\right]}$$

Kind of ugly!

5.65



a) Find E field at this point.

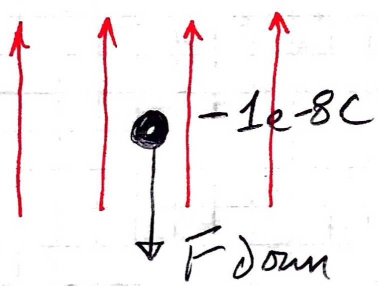
$E = \frac{F_{experienced}}{q}$, so $E = \frac{4e-6\ N}{2e-8\ C}$

$= \boxed{2.0e2\ N/C \mid up}$

b) If charge of $q = -1.0e-8C$ is placed at that same location,

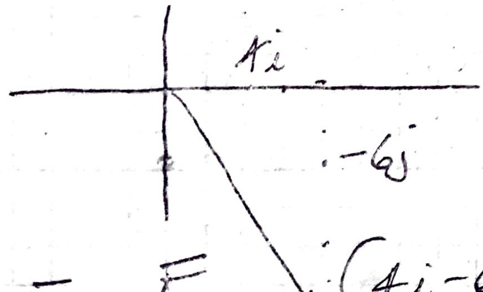
$F = qE = (-1.0e\text{-}8C)(2.0e\ 2\ N/C)$

$\boxed{2.0e-6\ N,\ \underline{down}}$



Because opposite charge.

5.69 Find E where $F = (4i - 6j)e{-6}\ N$ on a $-2e{-6}\ C$ charge:



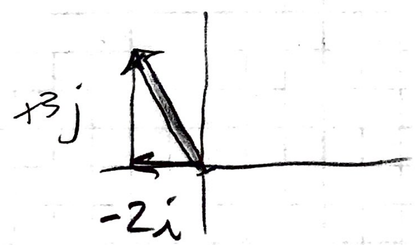
$$E = \frac{F}{q}, \text{ so } \frac{(4i - 6j)e{-6}}{2e{-6}}$$

$$E = (2i - 3j)\ N/C$$

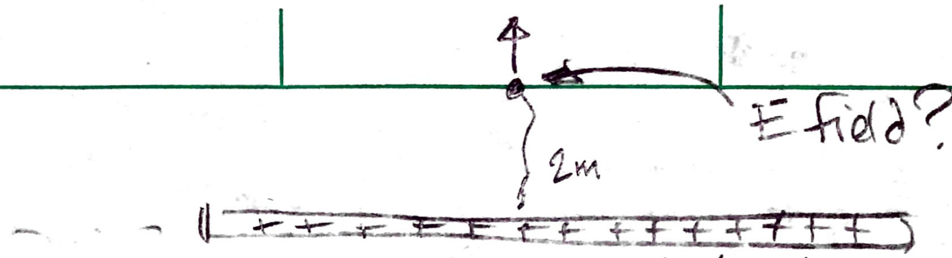
Not using negative at first

It's a negative charge experiencing that force, so the actual E field is in the opposite direction. Flip the signs on the result to get the opposite:

$$E = \boxed{(-2i + 3j)\ N/C}$$



5.81



long thin distribution

$\lambda = 4e{-6}\ C/m$

Derivation in ~~book~~/class indicates that, near a long thin distribution of charge,

$$E = \frac{2k\lambda}{r} = \frac{2(8.99e9)(4e{-6})}{2}$$

$$= \boxed{3.60e4\ N/C}$$ away from charge