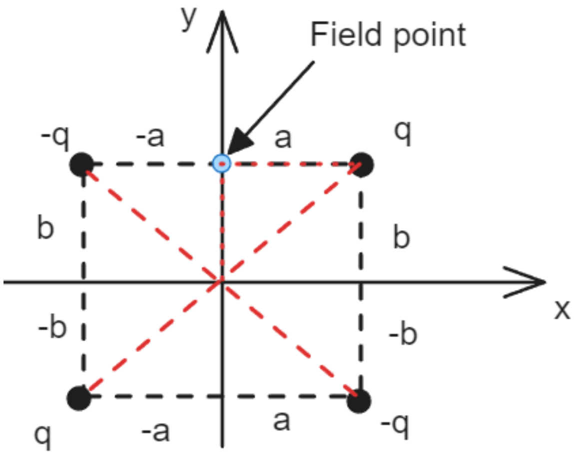
3. **Method of images I** *(hand in question)
Solve the problem stated in Griffiths Edition 4 3.11. The same problem in Griffiths Edition 5 is 3.13.

We replace the grounded plates with a negative point charge mirrowing over first the plate on y-axis making a negative charge at equal distance from the y-axis.

We do the same for the x-axis grounded plate. To compensate for the extra negative charge we introduce a positive charge diagnal of the starting charge.



This way we get **2 negative** (-a,b & a,-b) charges and **2 positive** (a,b & -a,-b)

As we work in 2D symatri z = 0

The potential is in the area is now given by

Electric potential due to a point charge
$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r} \qquad (23.14)$$
Value of point charge
Distance from point charge to where potential is measured
Electric constant

$$\vec{r}_{sep} = (\vec{r}_{field} - \vec{r}\,'_{source})$$
$$|r_{sep}| = \sqrt{(x-a)^2 + (y-b)^2}$$

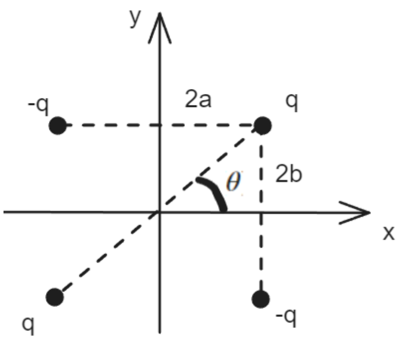
$$V\left(\vec{r}\right) = \frac{1}{4\pi\epsilon_0}\left(\frac{q}{\sqrt{(x-a)^2+(y-b)^2}} + \frac{q}{\sqrt{(x+a)^2+(y+b)^2}} - \frac{q}{\sqrt{(x+a)^2+(y-b)^2}} - \frac{q}{\sqrt{(x-a)^2+(y+b)^2}}\right)$$

where $(x, y) \neq (a, b)$

The force is now found with coulombs law know we have 3 point chagres acting on our source charge.

Coulomb's law:
Magnitude of electric force between two point charges
$$F = \frac{1}{4\pi\epsilon_0}\frac{|q_1 q_2|}{r^2} \qquad (21.2)$$
Values of the two charges
Distance between the two charges
Electric constant

By useing superposition we sum up the force acting in earch composant.



$$F = \frac{1}{4\pi\,\epsilon_0}\left(\frac{q^2\cdot\cos(\theta)}{\sqrt{(2a)^2+(2b)^2}}\,\hat{x} - \frac{q^2}{(2a)^2}\,\hat{x} + \frac{q^2\cdot\sin(\theta)}{\sqrt{(2a)^2+(2b)^2}}\,\hat{y} - \frac{q^2}{(2b)^2}\,\hat{y}\right)$$

$$F = \frac{q^2}{4\pi\,\epsilon_0}\left[\left(\frac{\cos(\theta)}{\sqrt{(2a)^2+(2b)^2}} - \frac{1}{(2a)^2}\right)\hat{x} + \left(\frac{\sin(\theta)}{\sqrt{(2a)^2+(2b)^2}} - \frac{1}{(2b)^2}\right)\hat{y}\right]$$

We find the work to bring the charge from infinity to the current possition useing the work energi therom

$$W = Q\left(V\left(\vec{r}_{a,b}\right) - V\left(\vec{r}_{\infty}\right)\right)$$

$$\text{at } \infty\ V \rightarrow 0$$

$$V\left(\vec{r}_{\infty}\right) = 0$$

$$W_{\text{tot}} = \frac{1}{8\pi\,\epsilon_0}\sum_{i\neq j}\frac{q_i q_j}{r_{\text{script,ij}}}$$

$$W_{\text{tot}} = \frac{q^2}{8\pi\,\epsilon_0}\left(\frac{1}{\sqrt{(2a)^2+(2b)^2}} - \frac{1}{2a} - \frac{1}{2b} - \frac{1}{2a} - \frac{1}{2b} + \frac{1}{\sqrt{(2a)^2+(2b)^2}}\right)$$

$$W_{\text{tot}} = \frac{q^2}{8\pi\,\epsilon_0}\left(\frac{2}{\sqrt{(2a)^2+(2b)^2}} - \frac{1}{a} - \frac{1}{b}\right)$$

Here i have used the interaction between the mirrored chargeds as well i am not use if this is correct.

The image method only works if we can place a mirror charge such that we are not forced to put an other charge in the area of our source charge.