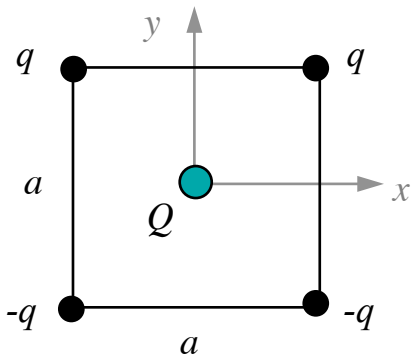
Name: _____ Sec. _____ **P212: Quiz 1 Week 2**

Two positive point charges $+q$ and two negative point charges $-q$ are fixed at the corners of a square of side a, as shown in the figure. The square is centered on the origin, and a positive test charge Q is placed at the origin.



1) Calculate the components $\mathbf{E}_x$ and $\mathbf{E}_y$ of the electric field at the origin due to the 4 charges at the corners of the square. **[8]**

$$E_x = 0$$

$$E_y = -\frac{-4kq}{r^2} \cdot \frac{1}{\sqrt{2}} \text{ and } r = \frac{a}{\sqrt{2}} \rightarrow E_y = -\frac{-8kq}{\sqrt{2}a^2}$$

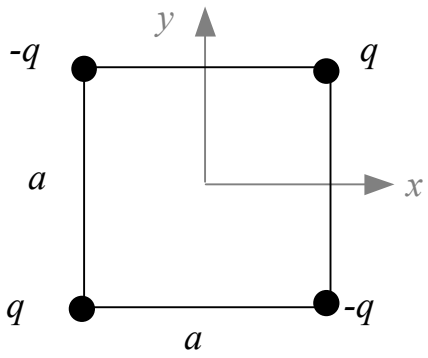
Rubric:
$E_x = 0$ (2)
Setup E_y (2)
Calculate r (2)
Angle (1)
Direction (1)

2) Let **F** be the force experienced by the test charge Q. By what factor would the magnitude of this force increase if *all* the charges in the problem (the 4 fixed q's and the test charge Q) were *doubled*? **[4]**

F increases by a factor of 4 since F depends on qQ

Rubric:
answer (4)

The figure below shows a similar arrangement of charges, but now with the positive and negative charges placed on different corners.

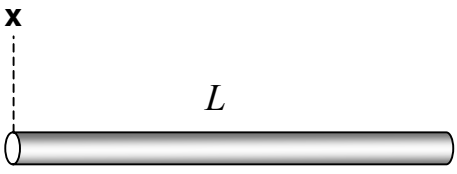


3) Given this new arrangement, are there any **equilibrium points** in the *xy*-plane where a test charge could be placed so that it would experience **no net force**? Circle **all** options below which apply: **[4]**

(a) Yes, there is an equilibrium point at the origin.
(b) Yes, all points along the *y* axis are equilibrium points.
(c) Yes, all points along the *x* axis are equilibrium points.
(d) Yes, all points along the diagonal lines connecting the corners are equilibrium points.
(e) No, there are no equilibrium points in the *xy* plane.

Rubric:
Select correct answer (2)
Don't select incorrect answers (2)

4) The figure below shows a solid rod of length *L* that carries a total charge +*Q*. The charge is uniformly distributed along the length of the rod. If the total charge on the rod were kept the same, but the rod's length was *increased* to 2*L*, would the magnitude of the electric field at the point **x** increase, decrease, or stay the same? Provide a brief but *clear* explanation of your reasoning. **[4]**



Decrease because the charge is further away

Rubric:
answer (2)
explanation (2)