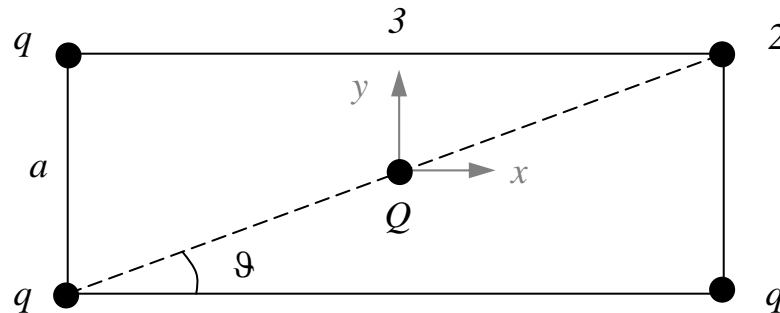# Discussion Question 2A
P212, Week 2
Electric Field Due to Point Charges

Four point charges *2q, q, q, and q* are placed at the corners of a rectangle of dimensions *a* and *3a* as shown in the figure. A fifth charge *Q* is placed at the center of the rectangle. Our task is to compute the **electric field** at the center of the rectangle, and then determine the force on *Q*.

(a) Each of the 4 charges at the corners contributes to the **electric field E** at the center of the rectangle. You'll have to add these contributions by components. First, start by finding the **magnitudes** of all the electric field contributions you will need to add together.

$| E_q | = kq/r^2$ $r = \sqrt{\dfrac{5}{2}}a$

$| E_{2q} | = 2kq/r^2$

> *Did you draw a **sketch**? Without it this problem is*
> ***much** harder than it needs to be …*

(b) *Without using your calculator*, calculate sin(θ), cos(θ), and tan(θ) where θ is the angle defined in the diagram. (Express your answer algebraically.)

$\sin\theta = 1/\sqrt{10}$ $\cos\theta = 3/\sqrt{10}$ $\tan\theta = 1/3$

(c) Now compute the **x- and y-components** of the relevant contributions to the electric field at the center of the rectangle.

$E_x = -\dfrac{6kq}{5\sqrt{10}\,a^2}$ $E_y = -\dfrac{2kq}{5\sqrt{10}\,a^2}$

(d) What is the **total** electric field **E** at the center of the rectangle, given the particular values *q =* 3 µC and *a =* 2 cm?

$| E | = 2.7 * 10^7$ N/C

(e) Finally, what is the **force** on the fifth charge *Q* due to this electric field, given *Q =* 4 µC? Remember that force is also a vector, and you should give both its x and y components.

$F_x = -102$ N $F_y = -34$ N