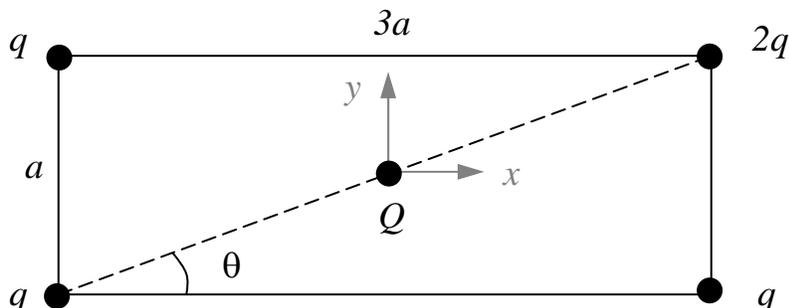


**Discussion Question 2B**  
**P212, Week 2**  
*Electric Field Due to Point Charges*

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**  $\mathbf{E}$  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.

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

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

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

(d) What is the **total** electric field  $\mathbf{E}$  at the center of the rectangle, given the particular values  $q = 3 \mu\text{C}$  and  $a = 2 \text{ cm}$ ?

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