

## 03. Analysis Tools

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### 1. Point Charges

#### Point Charges

Find the electric field at the indicated point. The charges are separated by a distance  $4a$ .

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The electric field at this point will be the vector sum of the electric field from the left charge (special  $e_1$ ) and the electric field from the right charge (special  $e_2$ ).

Let's examine the left charge first. Since the problem is expressed symbolically, the charge is simply " $2q$ ", and the distance,  $r$ , between the charge and the indicated point of interest should be expressed in terms of " $a$ ". Since each square in the diagram has width and height  $a$ , this distance can be expressed as:

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All that's to determine is the unit vector. The unit vector is simply a mathematical description of how to get from the source charge to the point of interest. In English, to get from the source charge to the point of interest you should move  $3a$  in the  $x$ -direction and  $a$  in the  $y$ -direction<sup>[1]</sup>. This can be written as:

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This is the vector that points from the source charge to point of interest. However, this is not a *unit* vector that points from the source charge to the point of interest. However, this is not a *unit* vector since its magnitude isn't 1. (A unit vector should convey a *direction* in space without altering the *magnitude* of the rest of the equation. It can accomplish this only if its magnitude is equal to 1.)

However, it's simple to convert a regular vector into a unit vector, just divide the vector by its magnitude. This leads to:

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Putting this all together yields:

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Repeating for the right charge gives:

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Adding these two contributions together yields

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Thus, the electric field at the location indicated points to the right and slightly downward.

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<sup>[1]</sup>For the sake of consistency, we will use a common coordinate system with the  $+x$ -direction pointing to the right and the  $+y$ -direction pointing to the top of the page. For three dimensional systems, the  $+z$ -direction will point directly out of the page. The coordinate axes will be indicated in the vast majority of diagrams.