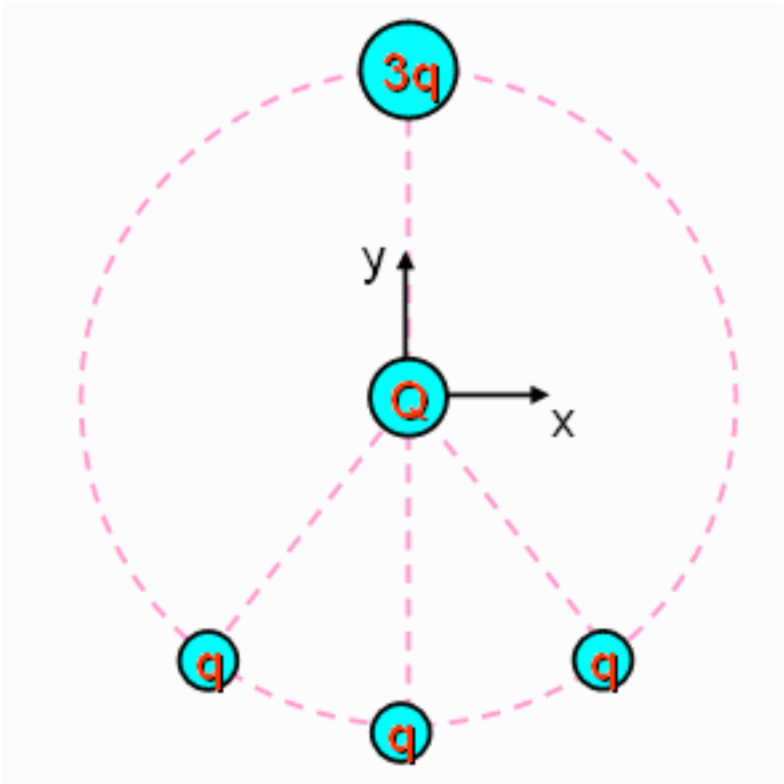
Clickers

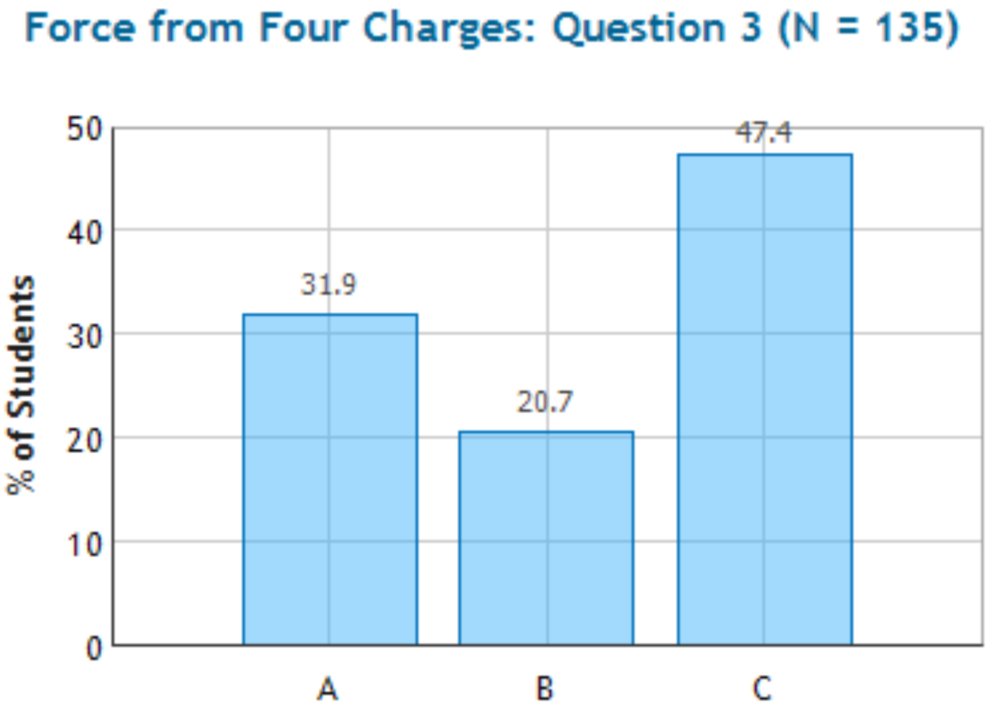
- Setup
- History
- 2-1
- 2-2

From smartPhysics



For the collection of charges shown in the above problem, which of the following statements best describes $\mathbf{F}_Y$, the y component of the net force on the charge at the origin

$\mathbf{F}_Y > 0$
$\mathbf{F}_Y = 0$
$\mathbf{F}_Y < 0$



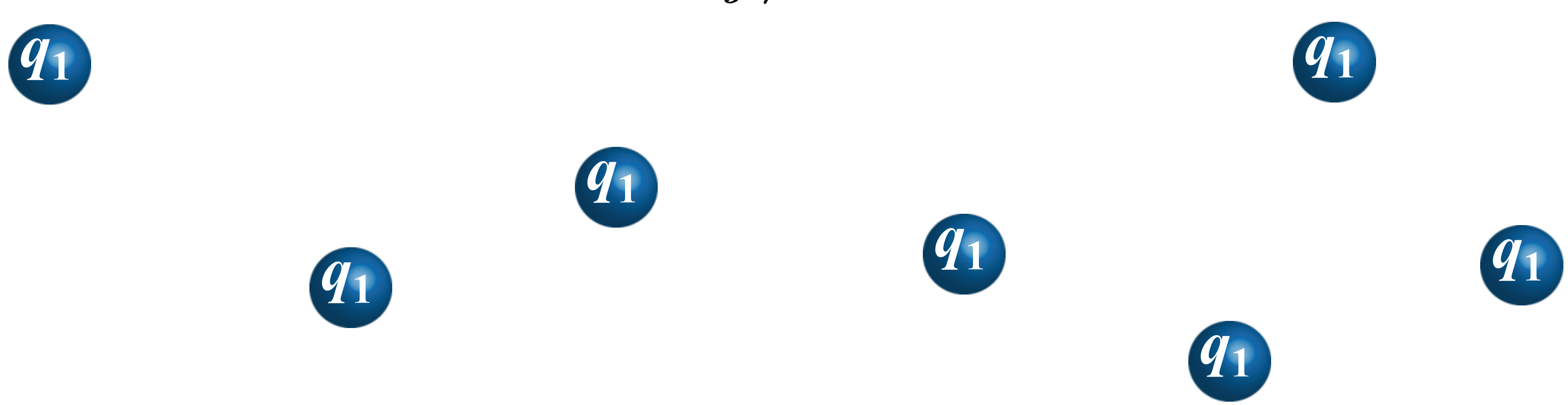
Introduction to the Electric Field…

- Coulomb Law:

$$\vec{F}_{1,2} = \frac{k\ q_1 q_2}{r_{1,2}^2}\hat{r}_{1,2}$$

- Superposition for an collection of *discrete* charges:

$$\vec{F}_{\mathrm{Net},i} = \sum_{j \neq i} \frac{k\ q_i q_j}{r_{j,i}^2}\hat{r}_{j,i}$$



Introduction to the Electric Field…

- Superposition for an collection of *discrete* charges:

$$\vec{F}_{\mathrm{Net},0} = \sum_{j\neq 0} \frac{k\ q_0 q_j}{r_{j,0}^2}\hat{r}_{j,0} = q_0 \sum_{j\neq 0} \frac{k\ q_j}{r_{j,0}^2}\hat{r}_{j,i}$$

- Define the **Electric Field** (q_0 is a test charge):

$$\vec{E} \equiv \frac{\vec{F}_{\mathrm{Net},0}}{q_0}$$

Electric field from a point charge

- **Electric Field** from a point charge (at the origin):

$$\vec{E} \equiv \frac{\vec{F}_{1,0}}{q_0} = \frac{k\, q_1}{r^2}\hat{r}$$

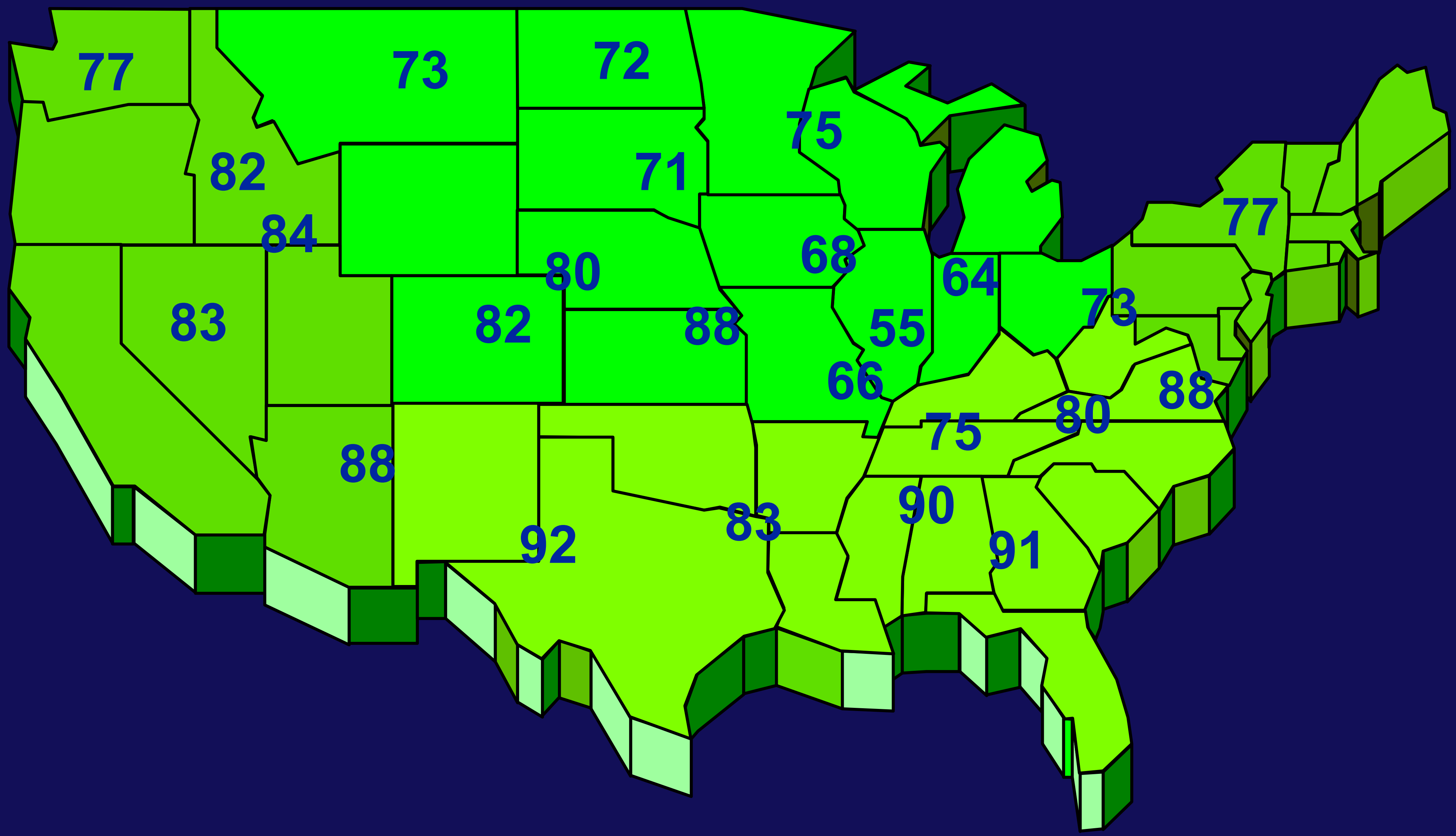
- **Electric Field** from a collection of charges:

$$\vec{E}(\vec{r}_0) = \sum_{j \neq 0} \frac{k\ \ q_j}{r_{j,0}^2}\hat{r}_{j,0}$$

What is a field?

- Scalar, vector (or tensor…) valued function of space (and time).
  - Electric Field (vector) $\vec{E}(\vec{r}, t)$
  - Magnetic Field (vector) $\vec{B}(\vec{r}, t)$
  - Electric Potential (scalar) $\Phi(\vec{r}, t)$

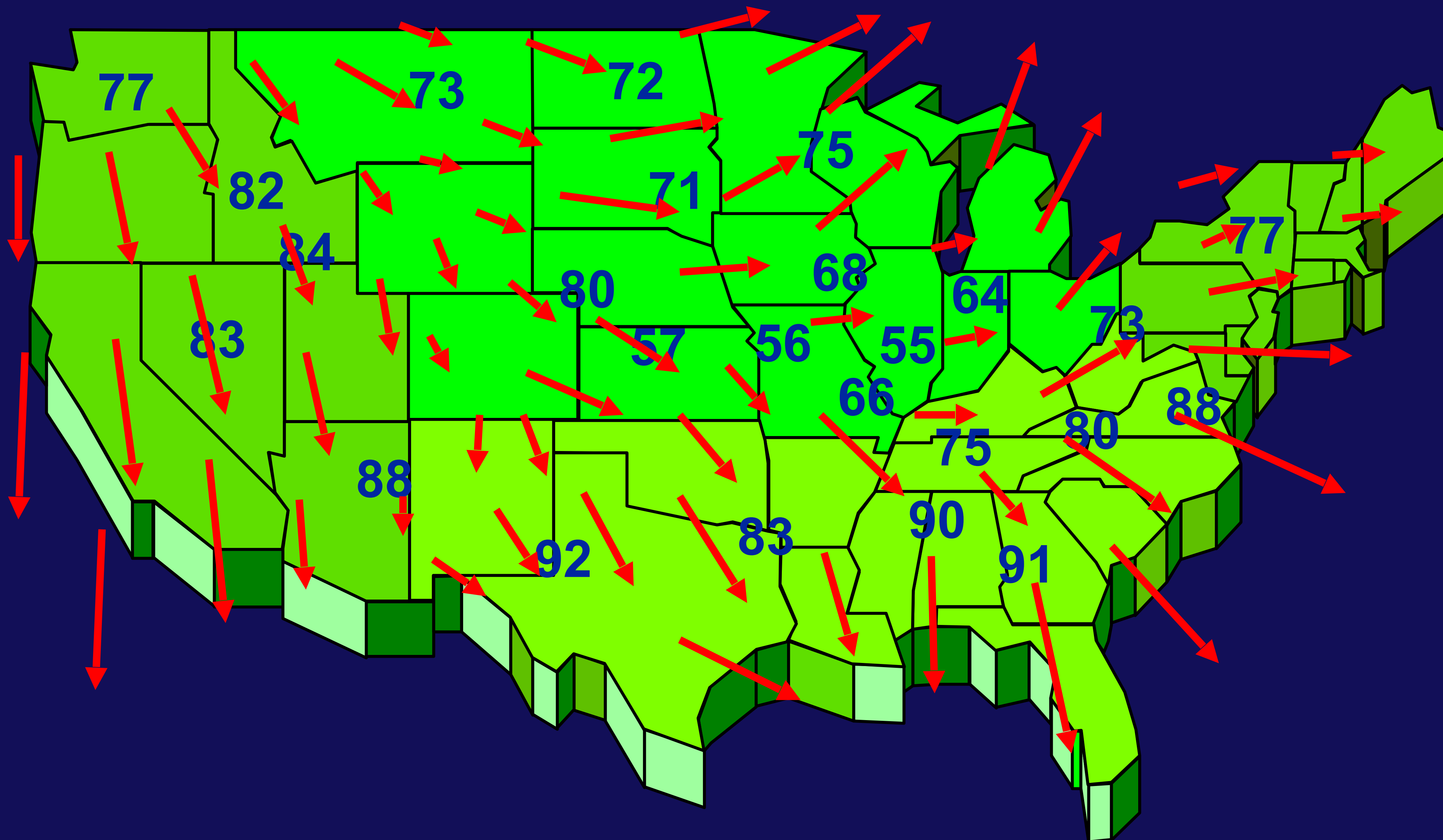
Fields of all kinds...



These isolated Temperatures make up a Scalar Field
(you learn only the temperature at a place you choose)

Fields of all kinds...

It may be more interesting to know which way the wind is blowing …



That would require a VECTOR field.

(you learn how fast the wind is blowing, AND in what direction)

Asside: What is a contact force?

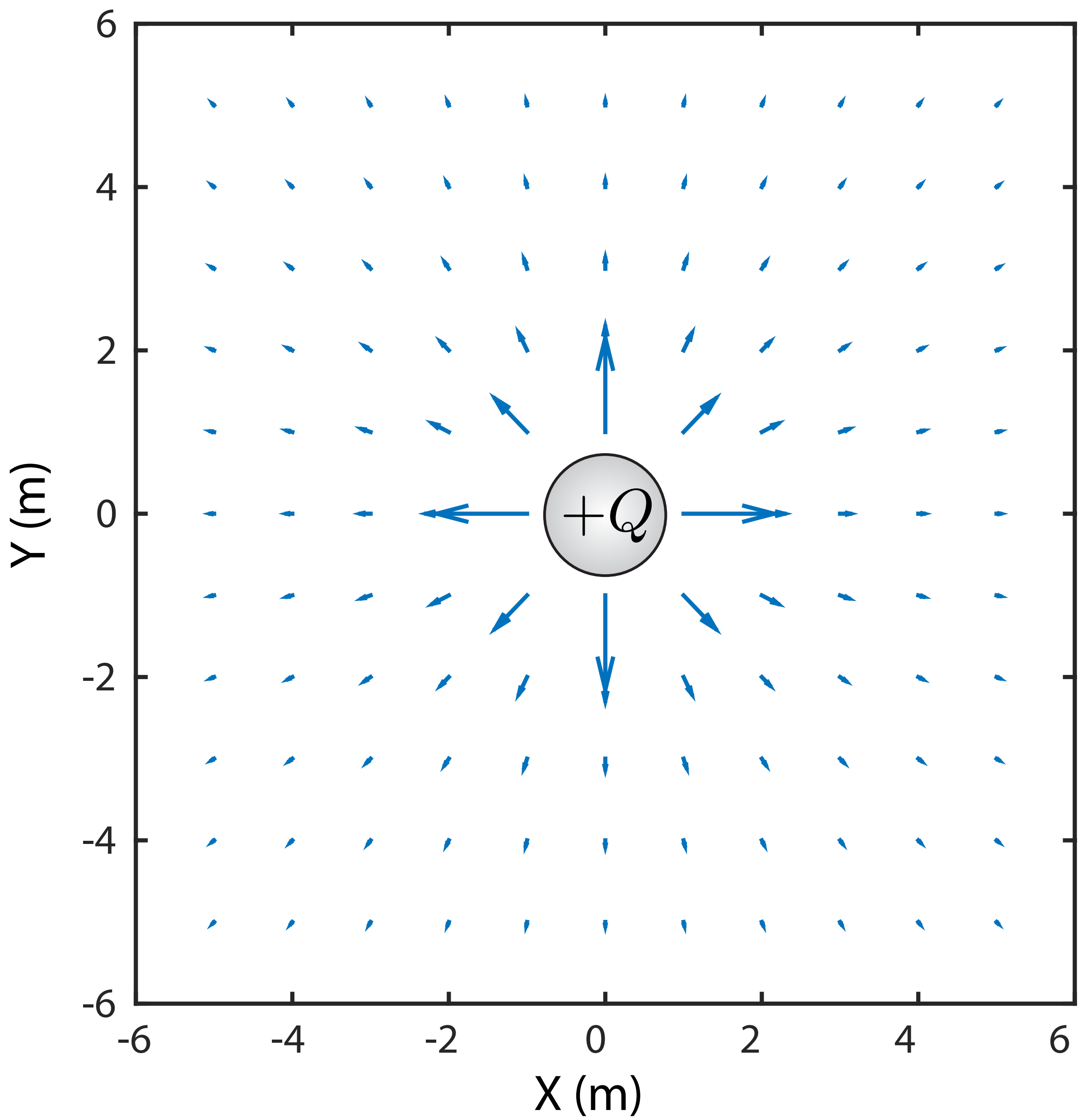
(Have you ever touched anything?)

Visualizing the E field

$$\vec{E}(\vec{r}) = \frac{k\ q_1}{r^2}\hat{r}$$

- **Direction:**
  - Radial
  - Direction of the force on a positive charge
- **Amplitude:**
  - Decreases with distance

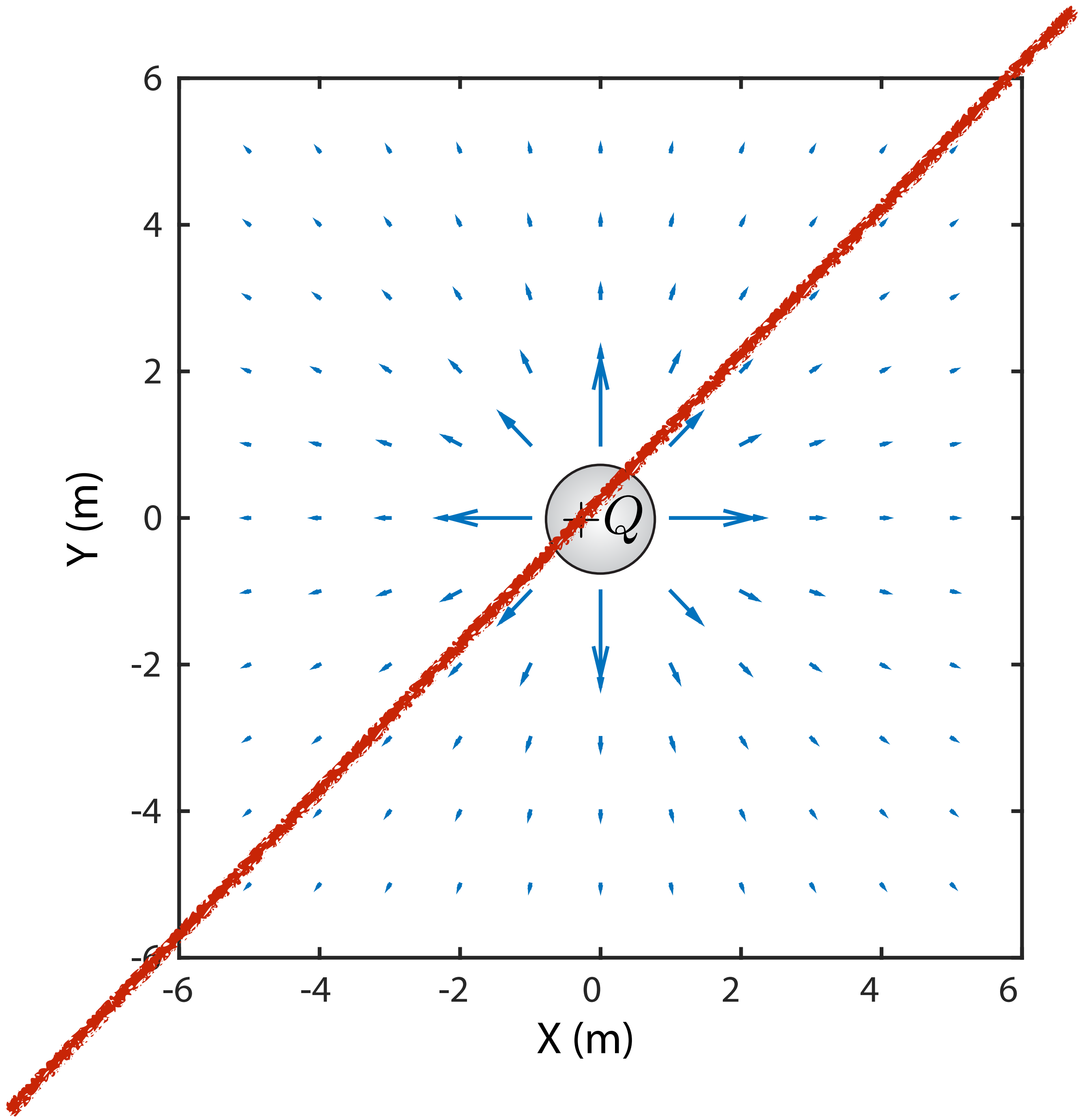
Visualizing the E field



$$\vec{E}(\vec{r}) = \frac{k\ q_1}{r^2}\hat{r}$$

- "quiver" or Velocity Plot
- You almost never see the E field drawn this way!
- General tool for visualizing a vector field.

Visualizing the E field



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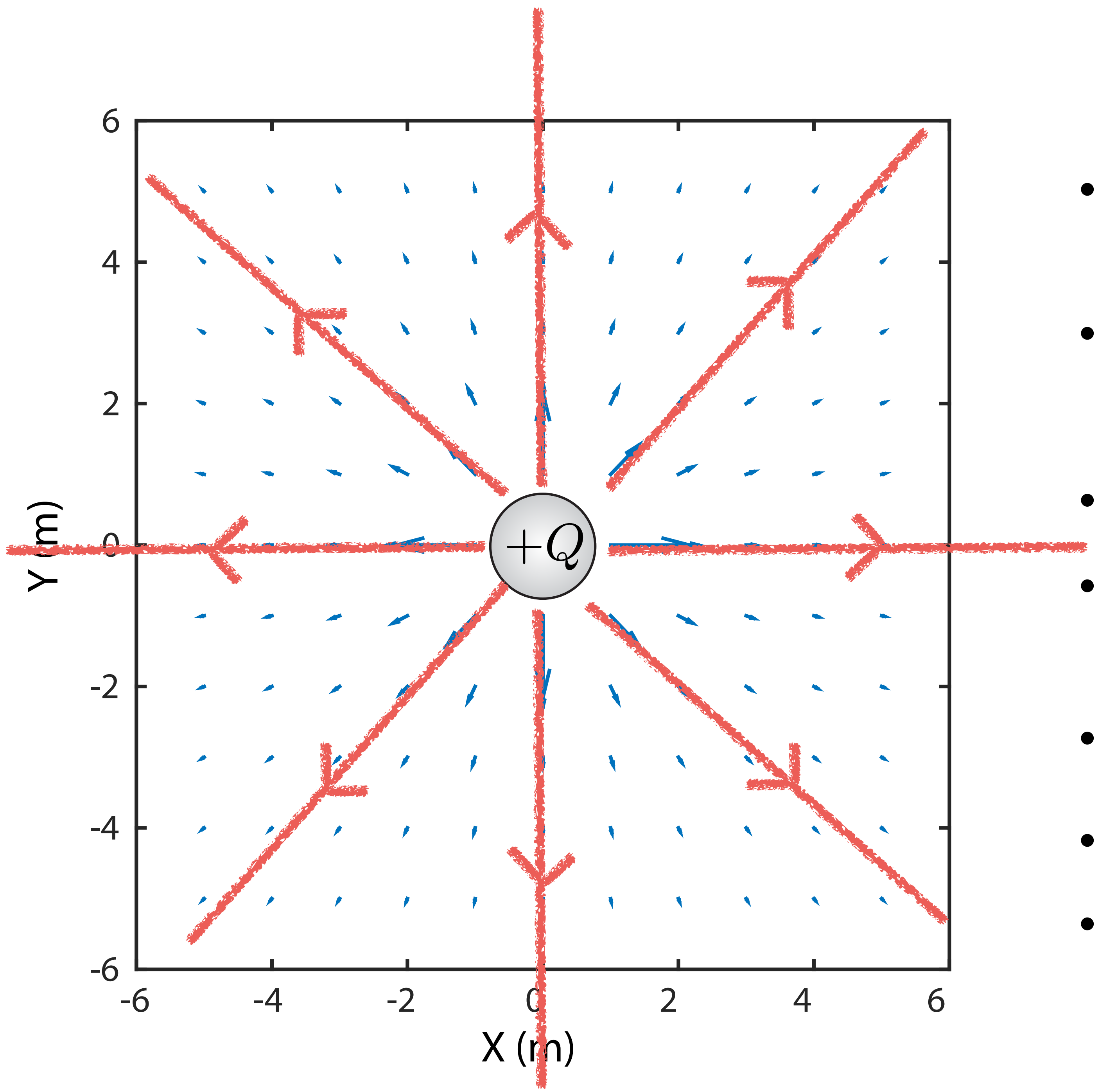
E field lines



- Lines start/end at +/- charges (or ∞)
- Number of lines starting/ending is ∝ |charge|
- Arrow is the direction of the Field
- Lines emanating/terminating are uniformly spaced
- Density of lines is ∝ |E|
- Lines are tangent to E field
- Lines are radial and equally spaced →∞

Demos

Dipole E-field

Line charge

2 positive charges