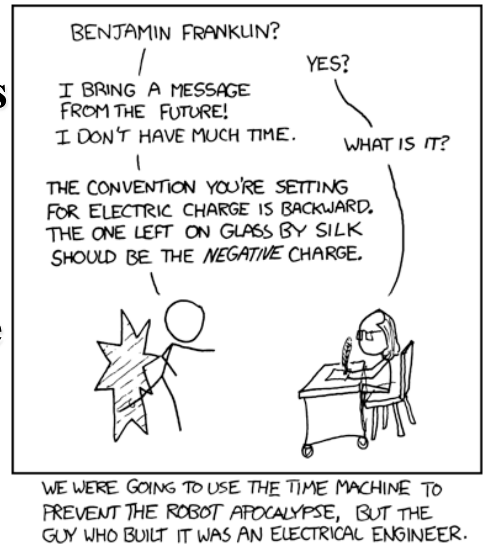
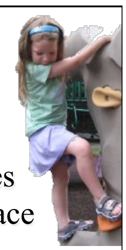
October 17, 2012 Physics 131 Prof. E. F. Redish

- **Theme Music:**
  Black-Eyed Peas
  Electric City
- **Cartoon:**
  Randall Monroe
  XKCD



Foothold ideas: Fields



- A *field* is a concept we use to describe anything that varies in space. It is a set of values assigned to each point in space (e.g., temperature or wind speed).
- A *force field* is an idea we use for non-touching forces. It puts a force vector at each point in space, summarizing the effect of all objects that would exert a force on a particular object placed at that point.
- A *gravitational*, *electric, or magnetic field* is a force field with something (a "coupling strength") divided out so the field no longer depends on what test object is used.

$$\vec{g} = \frac{\vec{F}_{\text{acting on } m}}{m} \qquad \vec{E} = \frac{\vec{F}_{\text{acting on } q}}{q}$$

Field is the value at a position in space " r " assuming that the force is measured by placing the object at r.

In Equations

$$\vec{F}_q = \vec{F}_{Q_1 \to q} + \vec{F}_{Q_2 \to q} + \vec{F}_{Q_3 \to q} + \vec{F}_{Q_4 \to q} + ...$$

$$\vec{F}_q = \frac{k_C q Q_1}{r_1^2}\hat{r}_1 + \frac{k_C q Q_2}{r_2^2}\hat{r}_2 + \frac{k_C q Q_3}{r_3^2}\hat{r}_3 + \frac{k_C q Q_4}{r_4^2}\hat{r}_4 + ...$$

where

$r_1 =$ distance from Q_1 to q $\quad$ $\hat{r}_1 =$ direction from Q_1 to q (mag. 1, no units!)

$r_2 =$ distance from Q_2 to q $\quad$ $\hat{r}_2 =$ direction from Q_2 to q (mag. 1, no units!)

...

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Making sense

- Notice that F_q/q does NOT depend on q!
- For one source charge

$$\vec{F}_q = \frac{k_C q Q_1}{r_1^2}\hat{r}_1 \qquad \vec{E}_q = \frac{\vec{F}_q}{q} = \frac{k_C Q_1}{r_1^2}\hat{r}_1$$

- For many sources

$$\vec{F}_q = \frac{k_C q Q_1}{r_1^2}\hat{r}_1 + \frac{k_C q Q_2}{r_2^2}\hat{r}_2 + \frac{k_C q Q_3}{r_3^2}\hat{r}_3 + ... \qquad \vec{E}_q = \frac{\vec{F}_q}{q} = \frac{k_C Q_1}{r_1^2}\hat{r}_1 + \frac{k_C Q_2}{r_2^2}\hat{r}_2 + \frac{k_C Q_3}{r_3^2}\hat{r}_3 + ...$$

- Why not? Why did I label *E* with a *q*?

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