• **Theme Music:** Maynard Ferguson
  
  *High Voltage*

• **Cartoon:** Wiley Miller
  
  *Non-Sequitur*
The Electric Potential

\[ V(\vec{r}) = \frac{\Delta U(\vec{r})}{q} \]

\[ V(\vec{r}) = \sum_{j=1}^{N} \frac{k_c q_j}{|\vec{r} - \vec{r}_j|} \]

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Foothold idea:
Fields

- **Test particle**
  - We pay attention to what force it feels. We assume it does not have any affect on the source particles.

- **Source particles**
  - We pay attention to the forces they exert and assume they do not move.

- **Physical field**
  - We consider what force a test particle would feel if it were at a particular point in space and divide by its coupling strength to the force. This gives a vector at each point in space.

\[
\vec{g} = \frac{1}{m} \vec{W}_{E\rightarrow m} \quad \vec{E} = \frac{1}{q} \vec{F}_{\text{all charges} \rightarrow q} \quad V = \frac{1}{q} U^{\text{elec}}_{\text{all charges} \rightarrow q}
\]
Explore the potential near a point charge

The electric potential

- The electric potential is a tricky concept.
- The electric potential at a given point is NOT the “electric energy per charge”.
- It is the EXTRA electric energy added if a test charge is placed at that given point divided by the amount of that charge.

\[
U = \sum_{i>j=1}^{N} \frac{k_c q_i q_j}{r_{ij}}
\]

\[
U_0(\vec{r}) = \sum_{i>j=0}^{N} \frac{k_c q_i q_j}{r_{ij}} = q_0 \sum_{j=1}^{N} \frac{k_c q_j}{r_{0j}} + U
\]

\[
\Delta U(\vec{r}) = q_0 \sum_{j=1}^{N} \frac{k_c q_j}{r_{0j}}
\]

\[
V(\vec{r}) = \frac{\Delta U(\vec{r})}{q_0} = \sum_{j=1}^{N} \frac{k_c q_j}{r_{0j}}
\]
Foothold ideas:
Electric potential energy and potential

- The potential energy between two charges is
  \[ U_{12}^{elec} = \frac{k_e Q_1 Q_2}{r_{12}} \]

- The potential energy of many charges is
  \[ U_{12...N}^{elec} = \sum_{i<j=1}^{N} \frac{k_e Q_i Q_j}{r_{ij}} \]

- The potential energy added by adding a test charge \( q \) is
  \[ \Delta U_q^{elec} = \sum_{i=1}^{N} \frac{k_e q Q_i}{r_{iq}} = qV \]