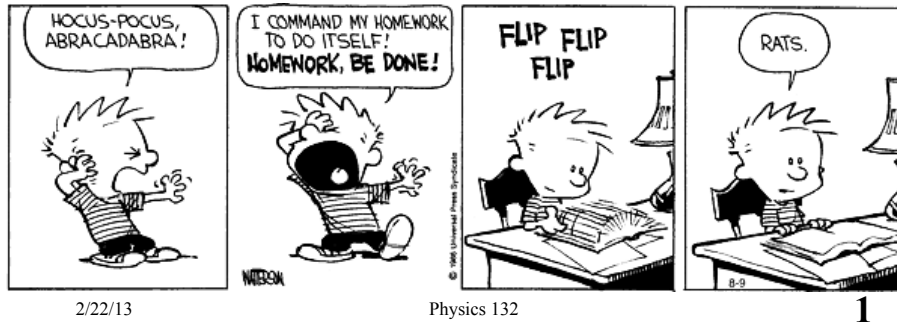


February 22, 2013 Physics 132 Prof. E. F. Redish

- **Theme Music: Joni Mitchell**
Electricity
- **Cartoon: Bill Watterson**
Calvin & Hobbes



Recap: Scalar 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).
- An *potential energy field* is the assignment of a potential energy that a test charge would feel (add to the system) if placed at each point in space.
- A *gravitational, electric potential* is a potential energy field with something (a “coupling strength”) divided out so the field no longer depends on what test object is used.

$$gh = \frac{\Delta U_m^{\text{grav}}}{m} \quad V = \frac{\Delta U_q^{\text{electric}}}{q} \quad V(\vec{r}) = - \int_{\text{ref. pt.}}^{\vec{r}} \vec{E}(\vec{r}') \cdot d\vec{r}'$$

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Foothold ideas: Electric potential energy and potential



- The potential energy between two charges is
- The potential energy of many charges is
- The potential energy added by adding a test charge q is

$$U_{12}^{elec} = \frac{k_C Q_1 Q_2}{r_{12}}$$

$$U_{12\dots N}^{elec} = \sum_{i<j=1}^N \frac{k_C Q_i Q_j}{r_{ij}}$$

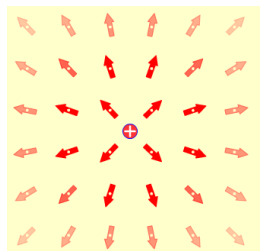
$$\Delta U_q^{elec} = \sum_{i=1}^N \frac{k_C q Q_i}{r_{iq}} = qV$$

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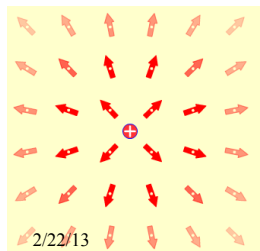
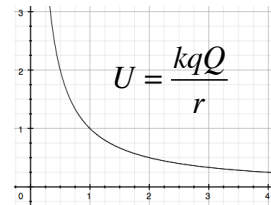
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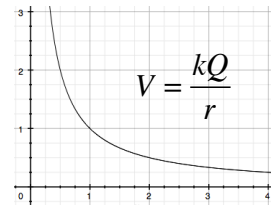
Positive test charge near a single (+) source charge



Potential energy
of a positive test charge
near a positive source.



Electric Potential
of a positive test charge
near a positive source.

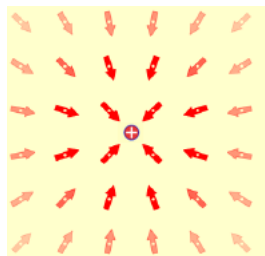


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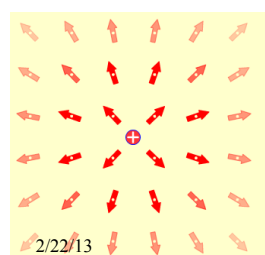
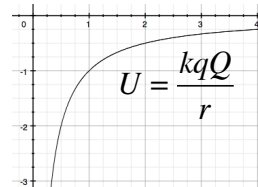
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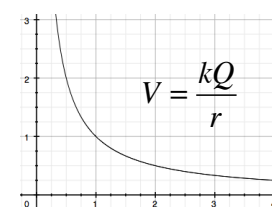
Negative test charge near a single (+) source charge



Potential energy
of a negative test charge
near a positive source.



Electric Potential
of a negative test charge
near a positive source.



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Representations

■ Representing E

- Arrows (length shows $|E|$)
- Arrows (fixed length, color or width shows $|E|$)
- Field lines (show direction only)
- Field lines (color shows $|E|$)

■ Representing V

- 1D: Graph
- 2D: Isoclines (lines of equal value)
- 3D: Equipotential surfaces (surfaces of = value)

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