

November 30, 2016

Physics 131

Prof. E. F. Redish

- **Theme Music:** Pete Seeger  
*The Demi Song\**

- **Cartoon:** S. Harris

\* A chemistry TA



"I HAD A BETTER GRASP OF THINGS WHEN PHYSICS DEALT MOSTLY WITH FALLING BODIES."

11/30/16

Physics 131

1

## Foothold ideas:

### Energies between charge clusters

- Atoms and molecules are made up of charges.
- The potential energy between two charges is

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

**No vectors!**

- The potential energy between many charges is

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

**Just add up  
all pairs!**

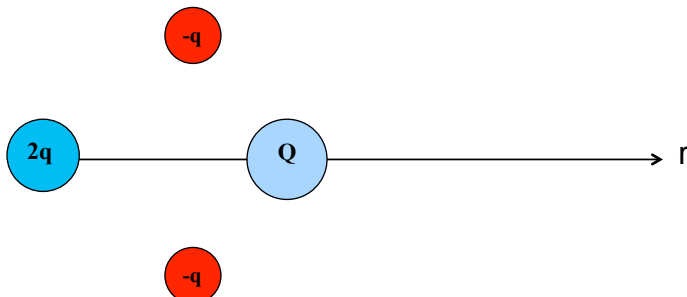


11/30/16

Physics 131

8

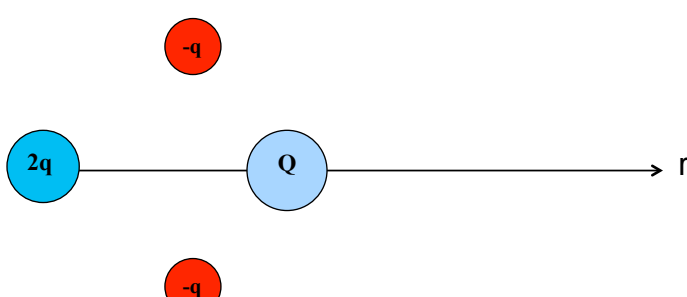
How many interactions in the system have an electric potential energy? (Equivalently: How many “ $1/r$ ” terms will we have to add up to get the total electric PE?)



The diagram shows a horizontal line with an arrow pointing to the right labeled  $r$ . On the left end of the line is a blue circle labeled  $2q$ . In the middle of the line is a blue circle labeled  $Q$ . Above the line and below the line are two red circles, each labeled  $-q$ .

11/30/16 Physics 131 **9**

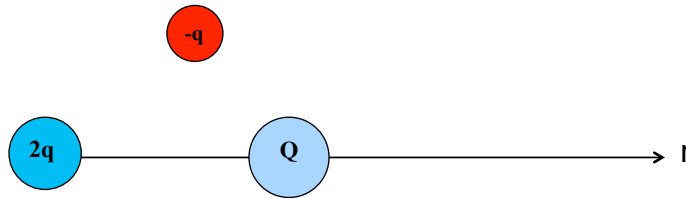
How many of those potential energies change when the charge  $Q$  moves to the right?



The diagram is identical to the one above, showing a horizontal line with an arrow pointing to the right labeled  $r$ . On the left end of the line is a blue circle labeled  $2q$ . In the middle of the line is a blue circle labeled  $Q$ . Above the line and below the line are two red circles, each labeled  $-q$ .

11/30/16 Physics 131 **10**

Sketch a graph of the extra potential energy from adding  $Q$  as a function of position  $r$  of charge  $Q$



$$\Delta U = k_c Q \sum_{i=1}^3 \frac{q_i}{r_{Q \rightarrow q_i}} = k_c Q \left( \frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} \right)$$

11/30/16

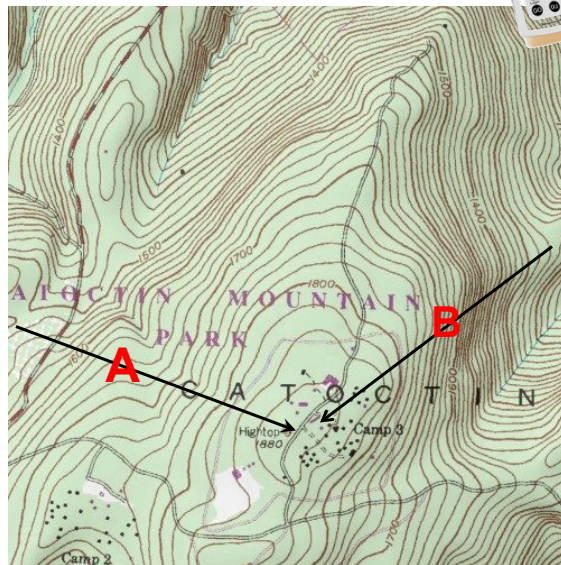
Physics 131

11

## Contour plots/Topographical maps



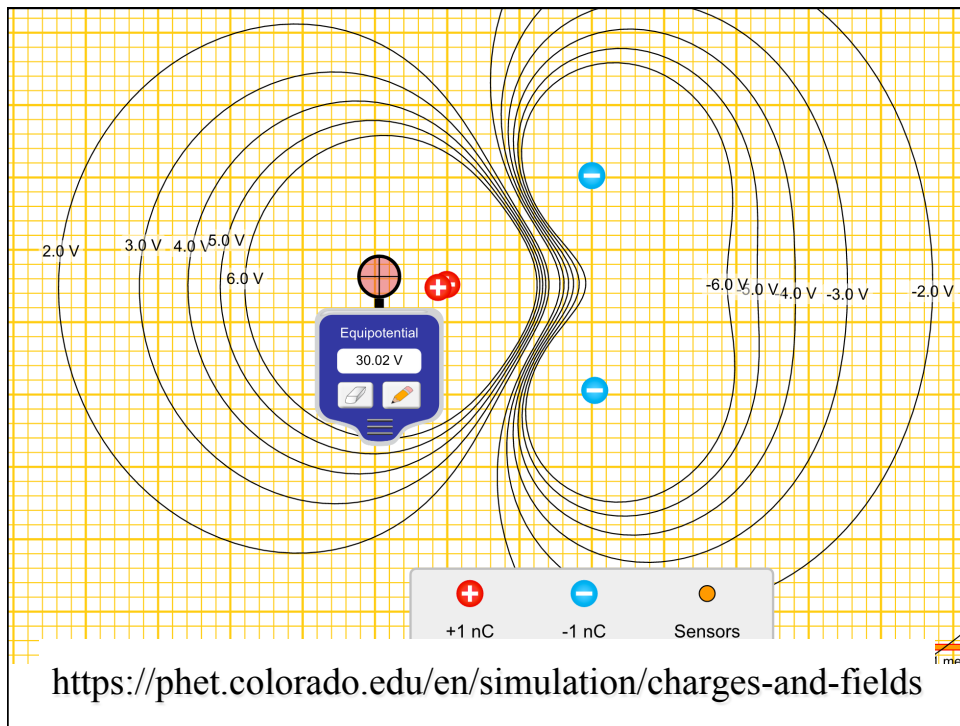
- Contour plots show the topography of a region by drawing lines to show a constant height above sea level.
- Which path would you prefer to walk from a parking lot to the top of the mountain? Why?



11/30/16

Physics 131

12



### A 3D representation

