February 18, 2013 Physics 132 Prof. W. Losert

Outline

- Electric Fields
- Electric Potential

Office hours this week:

THURSDAY 4.30-5.30pm Rm 0208 (Course Center)

Ave: 5.1

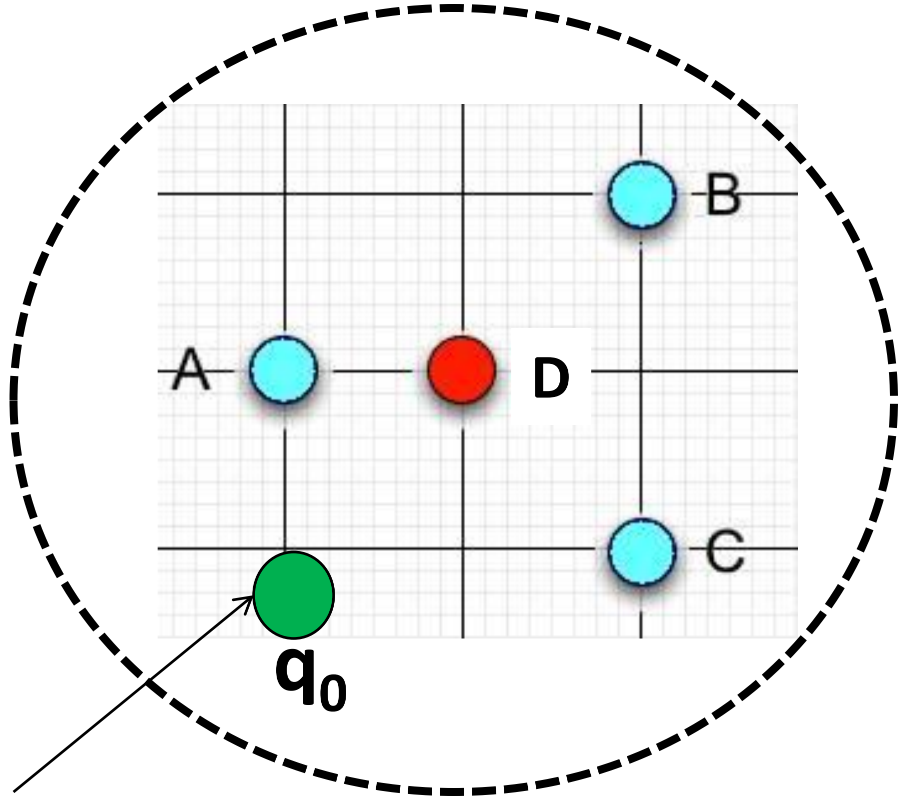
Quiz 3

Correct	CD	(6*10^-4)(J/K)	B	Boltzmann Distribution/Equation/Factor
				P ~ e^(-E/(kT))

$$\Delta S = \frac{Q_A}{T_A} + \frac{Q_B}{T_B} = \frac{-0.5J}{350K} + \frac{0.5J}{250K} = 0.0006J/K$$

$$P = \frac{e^{-\frac{E_1}{kT}}}{e^{-\frac{E_0}{kT}}} = e^{-\frac{(E_1 - E_0)}{kT}} = e^{-\frac{0.015eV}{0.025eV}} = e^{-0.6} = 0.55$$

Our model system:
4 charges and a test charge q_0



Test Charge

Foothold idea: Electric Forces and Fields

When we focus our attention on the electric force on a particular object with charge q_0 (a "test charge") we see the force it feels depends on q_0.

Define quantity that does not depend on charge of test object "test" charge -> **Electric Field E**

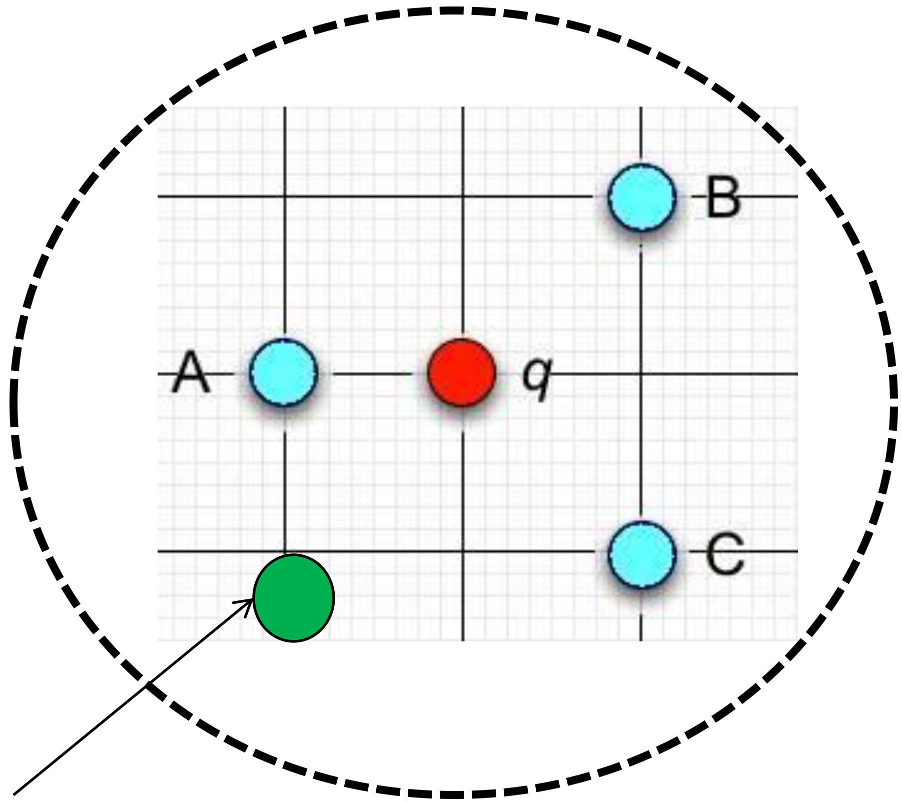
$$\vec{F}_{q_0}^{E\,net} = \frac{k_C q_0 q_1}{r_{01}^2}\hat{r}_{1\to0} + \frac{k_C q_0 q_2}{r_{02}^2}\hat{r}_{2\to0} + \frac{k_C q_0 q_3}{r_{03}^2}\hat{r}_{3\to0} + \ldots \frac{k_C q_0 q_N}{r_{0N}^2}\hat{r}_{N\to0}$$

$$\vec{F}_{q_0}^{E\,net} = q_0\vec{E}(\vec{r}_0)$$

$$\vec{E}(\vec{r}_0) = \frac{k_C q_1}{r_{01}^2}\hat{r}_{1\to0} + \frac{k_C q_2}{r_{02}^2}\hat{r}_{2\to0} + \frac{k_C q_3}{r_{03}^2}\hat{r}_{3\to0} + \ldots \frac{k_C q_N}{r_{0N}^2}\hat{r}_{N\to0}$$

E is defined everywhere in space not just in places where charges are present

Does the potential energy of the system change when I add a test charge?



Test Charge

Foothold ideas: Electrostatic Potential energy and Electrostatic Potential

- Again we focus our attention on a test charge!
- Usual definition of "electrostatic potential energy": How much does the energy of our system change if we add the test charge

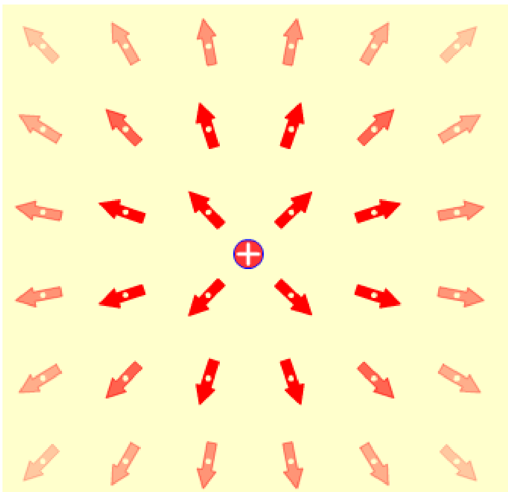
It's really a change in potential energy!

$$U_{q_0}^{elec}(\vec{r}_0) = \frac{k_C q_0 q_1}{r_{01}} + \frac{k_C q_0 q_2}{r_{02}} + \ldots + \frac{k_C q_0 q_N}{r_{0N}} = \sum_{i=1}^{N} \frac{k_C q_0 q_i}{r_{0i}}$$

- We ignore the electrostatic potential energies of all other pairs (since we assume the other charges do not move)
- We can pull the test charge magnitude out of the equation and obtain en **electrostatic potential**

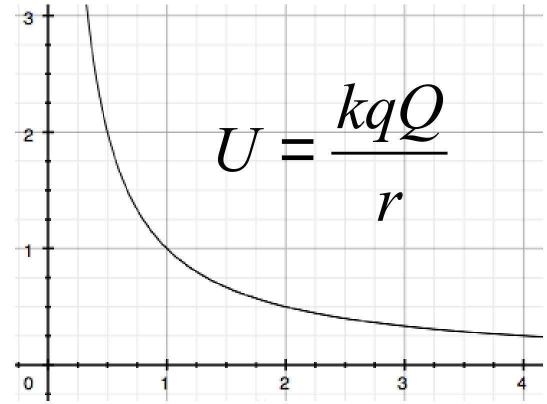
$$V(\vec{r}_0) = \frac{U_{q_0}^{elec}(\vec{r}_0)}{q_0} = \frac{k_C q_1}{r_{01}} + \frac{k_C q_2}{r_{02}} + \ldots + \frac{k_C q_N}{r_{0N}} = \sum_{i=1}^{N} \frac{k_C q_i}{r_{0i}}$$

Positive test charge with positive source

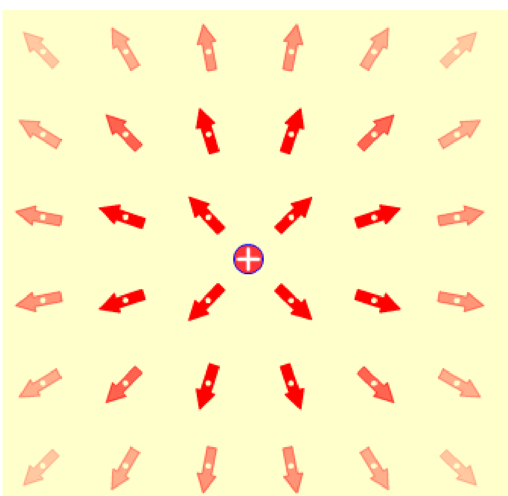


<u>Potential energy</u>

of a positive test charge near a positive source.

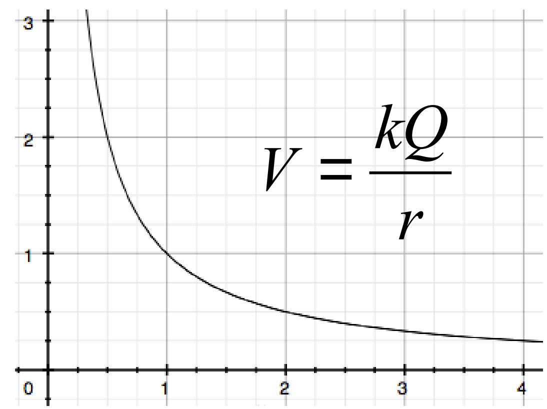


$$U = \frac{kqQ}{r}$$



<u>Electric Potential</u>

of a positive test charge near a positive source.



$$V = \frac{kQ}{r}$$

What happens when I change the sign of the test charge

1. Potential energy graph changes
2. Electrostatic potential graph changes
3. Both change
4. Neither of the graphs changes