

Model: Fields and Forces**Act 9.1.5 Electrical Forces and Fields (FNTs from DLM11)****45 minutes****Learning Goals:**

- Solidify understanding of connections between charges, forces, and fields.
- Examine analogy with gravitational fields noting similarities and differences
- Understand how an electric field affects a non-polar molecule

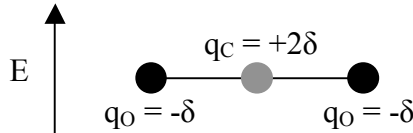
Act 9.1.6 Forces on Polar Molecules**35 minutes****Learning Goals:**

- Understand forces of attraction between polar molecules (thus, understand some of the basis for hydrogen bonds)
- Understand motion of an electric dipole in a uniform electric field

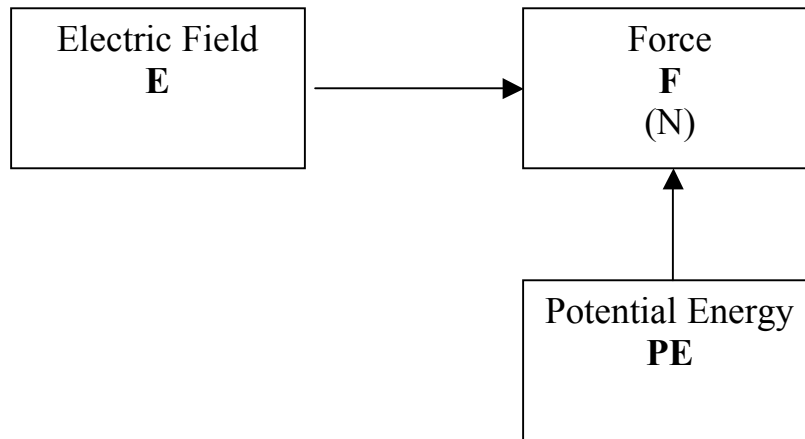
Model: Fields, Forces, Potential & Potential Energy**Act 9.2.1 Electric Forces and Bond Energies****60 minutes****Learning Goals:**

- Starting making connections back to the energy language of 7A.
- Be able to determine forces from potential energy graphs and construct potential energy graphs from forces.
- Understand how two uncharged non-polar molecules or atoms can still have an attractive electrical interaction between them.

1. CO₂ (shown below) is a linear molecule and is not polar (i.e. there is no clear negatively charged side or positively charged side). Suppose this molecule is placed in a **uniform** electric field pointing up the page as shown.



- a) (solidification) What direction is the C pushed by this electric field? What direction is an O pushed by this electric field?
 - b) (application) Model the chemical bonds as springs that bend and describe how this electric field changes the molecule. Does the molecule become polar?
2. Our electric model includes three main ideas, at this point: electric **force**, electric **field**, and electric **potential energy**. Summarize the relationship between these main ideas, for the case of a single charge in an electric field field (do NOT assume the electric field is from a point charge).
- a. (Solidification) For each arrow below, explain how one would get from one quantity (like **E**) to the next quantity (like **F**).
 - b. (Solidification) Fill in the units for **electric field** and **potential energy**.
 - c. (Introduction) One quantity important to electrical interactions has not yet been discussed. This box would go in the lower-left corner. Assuming the relationships for going from left to right are the same for each row, what equation would connect the new quantity (**V**) to PE? Assuming the relationships for going from bottom to top are the same in each column, what equation would connect the new quantity (**V**) to the electric field?



3. (Review/Introduction) In Physics 7B, you studied a particular type of electrical phenomena: current moving in a circuit. At the time, we studied it in terms of fluid flow—now we want to begin understanding it in terms of the **Electric Field and Force Model**.

- a. In the circuit shown to the right, which way does the current flow?
- b. Around the circuit, voltage increases through some elements and decreases through others. Start at the positive terminal of the battery and travel with the current. Decide if voltage increases or decreases across each element.
- c. Repeat **b**, explaining if energy increases or decreases.

