

Learning Goals:

- Explain the relationship between bond dipoles and molecular dipole.
- Accurately predict and explain the bond dipoles and molecular dipoles of real molecules.

Comment [1]: This activity could be used in lecture or recitation. It was designed to be used after students are introduced to molecular geometry.

Part I: Explore (5 minutes)

1. Explore the PhET **Molecule Polarity** simulation with your partner or group.

Comment [2]: This section allows students time to explore the simulation. Study results indicate that students find the majority of possible interactions and begin asking their own questions of the sim. **Option:** Exploration time can be prompted **before** handing out activity sheet. The instructor could ask students to share their observations and questions with the class.

Part II: Two Atoms Tab (5-8 minutes)

2. **Explain all the ways** you can change the polarity of the two-atom molecule.

Comment [3]: Students in the study typically started using the sim by exploring the representations and ways to change them – resulting in students exploring ways to change polarity. This question expands on this result by asking students to articulate their findings, and to check if they have found **all** the ways to change polarity. **Option:** The instructor could ask students to share out their list with the class.

3. **Record your ideas** in the table below.

Representation	How does this representation help you understand molecule polarity?
Bond Dipole	
Partial Charges	
Electrostatic Potential	
Electron Density	

Comment [4]: Students typically explored features from top to bottom. This question provides the opportunity to formalize interpretations of each representation, and to make sure **all** student explore all representations. Instructors can check student responses, and probe student ideas further. **Option:** Instructor can lead a class discussion about representations in general, about a specific representation or comparisons between representations – such as “what is the difference between “Electrostatic Potential” and “Electron Density?”

Part III: Three Atoms Tab (5-8 minutes)

4. **Explain any new** ways to change the polarity of the three-atom molecule.
5. **How** does the **ABC-bond angle** effect molecule polarity?
6. **Explain** the relationship between the **bond dipoles** and the **molecular dipole**.
7. **Can** a non-polar molecule contain polar bonds? Use an **example** to explain your answer.

Comment [5]: Students in the study typically looked for differences between Two Atoms and Three Atoms tabs. This question prompts **all** students to do this, and to check that they have found all the differences.

Comment [6]: Some groups did not change the ABC-bond angle during exploration. This question prompts students to find the ABC-bond angle change, and to determine how it effects molecule polarity.

Comment [7]: Students are prompted to explain a key relationship in the concept of molecule polarity. **Option:** The instructor could lead a discussion about student responses and/or give a mini-lecture to present formally the relationship between bond and molecular dipoles.

Comment [8]: This question prompts students to explore a difficult component of molecule polarity. The sim provides the opportunity to explore a dynamic model to aid in constructing an answer. **Option:** The instructor could lead a discussion around student examples.

Part IV: Real Molecules Tab (5-8 minutes)

8. **Predict** the polarity of four real molecules in the simulation. Explain your reasoning before you check your predictions with the simulation.

Comment [9]: This section provides the opportunity to practice what they have learned by predicting the bond and molecular dipoles for real molecules. **Option:** This section could be expanded to include drawing of Lewis Dot structures, naming molecule geometry and then determining bond and molecular dipoles. This could also be done after class if time ran out, or as a follow-up activity or homework assignment.

YOUR PREDICTION		CHECK Your Prediction
Draw Molecule - Include Bond Dipoles and Molecular Dipole	Explain Your Reasoning:	Correct? Explain any differences.