

In the **Atomic Interactions** simulation, students investigate how the relationship between attractive and repulsive forces govern the interaction between atoms.

The screenshot shows the PhET Atomic Interactions simulation interface. It features a central graph of Potential Energy vs. Distance Between Atoms, a 3D model of two atoms, and a control panel on the right. Callout boxes highlight the following features:

- ZOOM** in or out on the graph: A callout points to the zoom-in and zoom-out icons in the top left corner of the graph area.
- VIEW** the interaction between atoms: A callout points to the 3D model of two atoms at the bottom of the graph.
- DRAG** the unpinned atom or the dot on the graph: A callout points to the unpinned atom in the 3D model.
- CHOOSE** pairs of atoms to investigate or create a custom set: A callout points to the atom selection menu on the right, which lists Neon, Argon, and Oxygen, along with a 'Custom Attraction' option.
- HIDE** or show forces between atoms: A callout points to the 'Hide Forces' section in the control panel, which includes options for 'Total Force', 'Attractive (van der Waals)', and 'Repulsive (electron overlap)', each with a corresponding force arrow icon.

## Complex Controls

The background of the simulation can be changed for easier projection by going to the PhET menu bar, selecting Options, and checking Projector mode.



## Model Simplifications

- The interaction between the two atoms is modeled using the Lennard-Jones potential.
- The atomic radius, which corresponds to  $\sigma$  (sigma), is the Van der Waals radius.
- When selecting pairs of atoms, the oxygen-oxygen selection is the only one in which the atoms bond. When the bond forms, the shaking of the left atom is meant to represent the energy transferred away from the bonded pair.
- For the oxygen-oxygen bonding interaction, epsilon ( $\epsilon$ ) roughly corresponds to the average bond energy. Sigma ( $\sigma$ ) was calculated based on the average bond length as the bottom of the potential energy well is located at the equilibrium bond distance.

## Insights into Student Use

- The force arrows are off by default as students initially found them overwhelming in interviews.
- Student interviews also indicated that students found the force arrows helpful for making sense of the potential energy graph.

## Suggestions for Use

### Sample Challenge Prompts

- Describe how attractive and repulsive forces influence the attraction between two atoms.
- Explain the relationship between the attractive forces between atoms and the potential energy graph for the atom pair.
- Compare and contrast the behavior and potential energy graph for bonded and unbonded atom pairs.
- Explain what the values of  $\sigma$  and  $\epsilon$  represent for a bonded atom pair.
- Describe the interaction of two atoms in a covalent bond. Based on this interaction, define “bond length”.

See all published activities for Atomic Interactions [here](#).

For more tips on using PhET sims with your students, see [Tips for Using PhET](#).