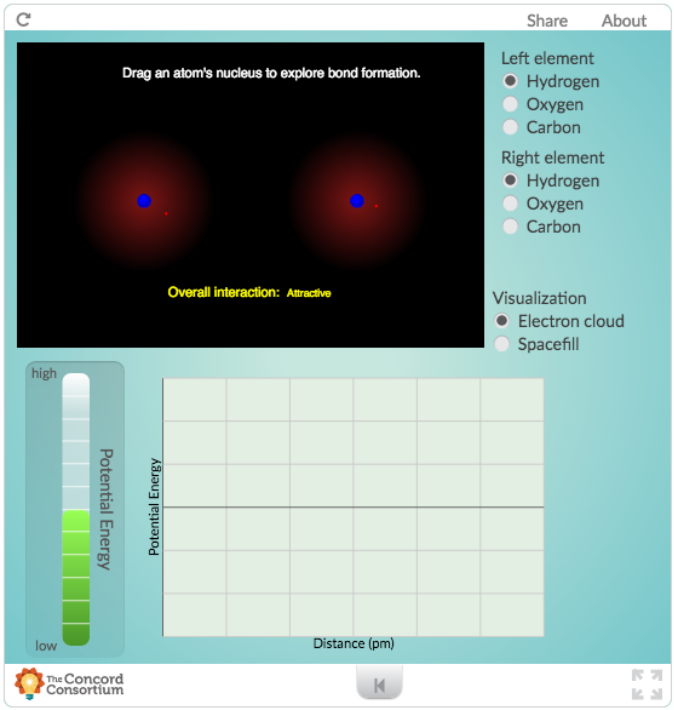
Activity 3.3: When atoms get close to each other, what happens to their potential energy?



In previous investigations, you explored simulations of changes in the potential energy of a spring and a pendulum. Now you will explore a simulation to investigate how the potential energy between two atoms changes when they come together to form a bond.

https://lab.concord.org/embeddable.html#interactives/interactions/forming- molecules-graph-no-axes.json

Question #1

People often think bonds store or hold energy. If that is true, should the energy be high or low when a bond forms?

In this simulation, you will change the distance between two atoms, just as you did in the simulation in Activity 3.2. This time, notice how the atoms' potential energy changes as you move them.

Investigate

Question #2

Using the simulation, find a pattern in how the potential energy of the system changes when the relative distance between two atoms changes. Describe the pattern.

Question #3

Draw a stacked bar graph of potential energy vs. the distance between two atoms that shows when the atoms are too close to form a bond, actually form a bond, and are too far apart to form a bond. Make sure to label your graph.

Question #4

Using the simulation, select three different pairs of atoms. For each pair, find the distance between the two atoms at which the potential energy is lowest. Is the distance the same for all three pairs?

Circle one: **YES** or **NO**

Question #5

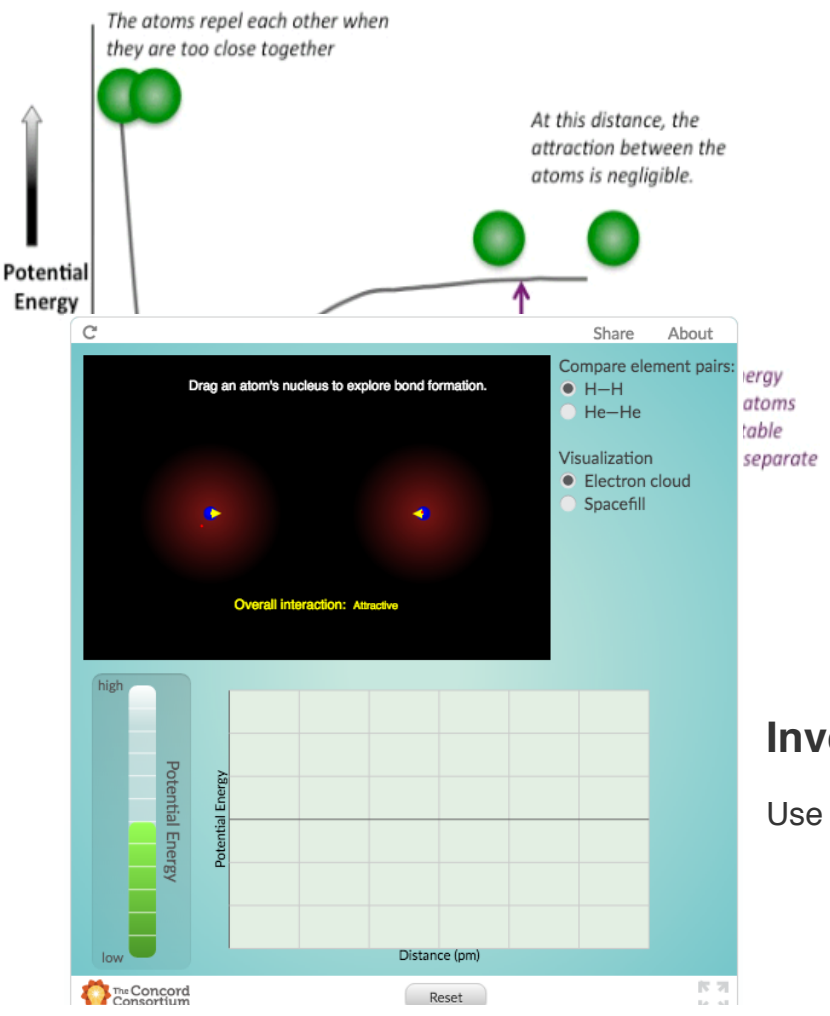
What patterns do you notice when comparing the points where the potential energy is lowest for different pairs of atoms?

Question #6

Use ideas of energy, stability and attractive and repulsive forces to explain why two separate atoms form a bond.

Are all molecules more stable than separate atoms?

Many substances, such as oxygen gas (O_2), water (H_2O), and ammonia (NH_3), are made up of molecules.



However, some substances, such as helium gas (He), are made up of single atoms. Why is helium made up of single atoms rather than molecules? To answer this question, you need to compare the potential energy of the separate atoms with their potential energy when they are together in a molecule. In the figure, the difference in the potential energy between Point 1 (stable molecule) and Point 2 (individual atoms staying separate) is called the *binding energy* of the molecule.

Investigate

Use the simulation to investigate the

change in potential energy as you change the distance between two atoms. Observe the graph below the atoms to see a trace of the energy as you change the distance.

Question #7

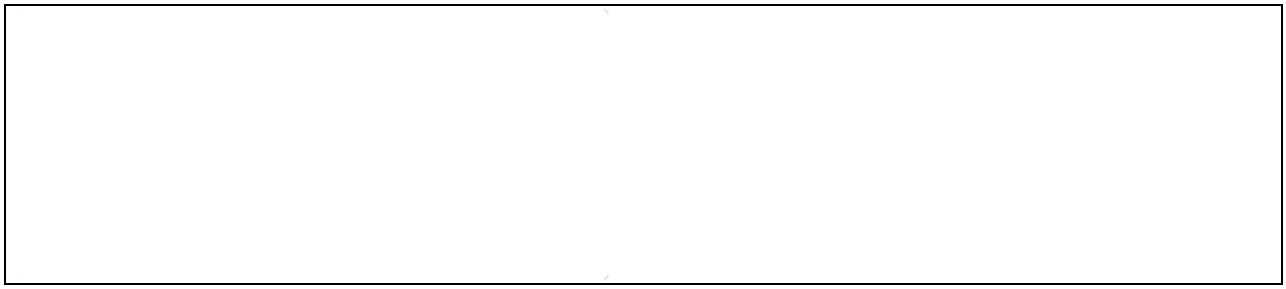
Observe what happens when two hydrogen atoms (H–H) move close together. Draw a snapshot of the atoms when their potential energy is lowest.

Question #8

In the graphs is the energy at a high point or low point when the atoms form a bond?

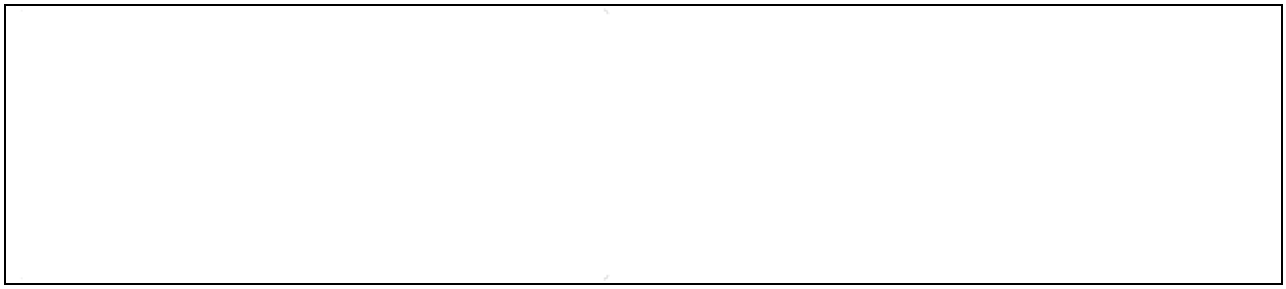
Question #9

According to the graphs, do bonds have high energy or low energy?



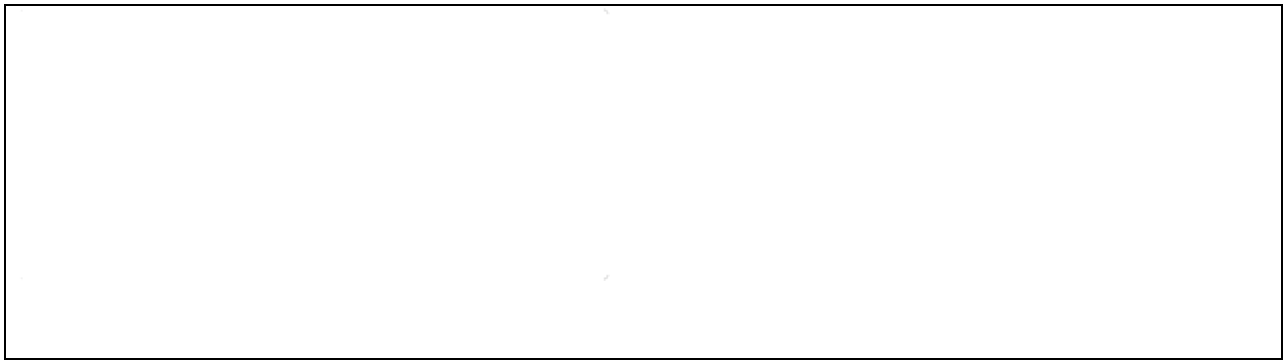
Question #10

Observe what happens when two helium atoms (He– He) move close together. Draw a snapshot of the atoms when their potential energy is lowest.



Question #11

Select the hydrogen atoms (H–H) and change the distance between them until you see the complete trace of potential energy vs. distance in the graph below the atoms. Then draw a snapshot and indicate on the graph the binding energy of two hydrogen atoms.



Question #12

Select the helium atoms (He–He) and change the distance between them until you see the complete trace of potential energy vs. distance in the graph below the atoms. Draw

and indicate on the graph the binding energy of two helium atoms.

Question #13

Based on your answers to the two previous questions, compare the binding energy of two hydrogen atoms with the binding energy of two helium atoms.

Question #14

Why do hydrogen atoms form a molecule but helium atoms do not? In your answer, make sure to include potential energy, and electrons.

Question #15

Describe what causes two atoms to bond together to form a molecule. Your description should include force, potential energy, and electrons.