

Activity 3.4: How are bonds formed and broken?

In a previous activity, you learned that substances are made up of individual atoms or groups of atoms called *molecules*. A molecule forms when the forces of attraction and repulsion between two atoms are balanced, electrons are shared, and the potential energy of the molecule is lower than the potential energy of the separate atoms. In this activity, you will learn more about the relationship between energy and the formation and breaking of bonds, using the ideas of energy transfer and conversion.

Question #1

In the demonstration, is energy **converted** from one form to another when the billiard balls collide? What evidence supports your claim?

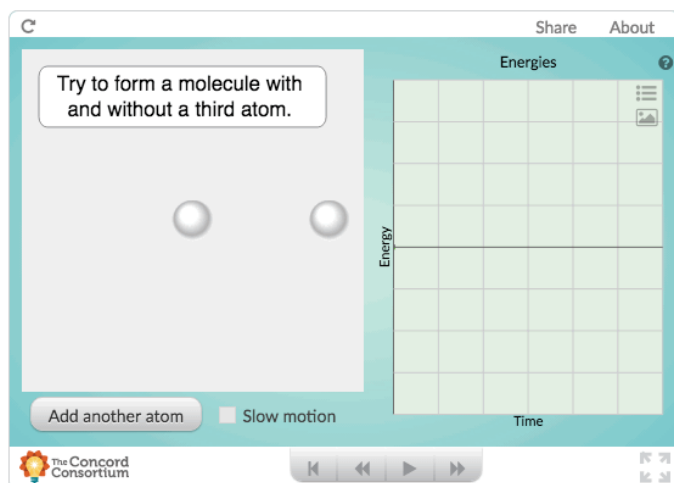
Question #2

Is energy **transferred** from one thing to another when the billiard balls collide? What evidence supports your claim?

Question #3

Is energy conserved in this demonstration? What evidence supports your claim?

How does a bond form?



<https://lab.concord.org/embeddable.html#interactives/interactions/forming-molecular-bond-no-axes.json>

Use the simulation to explore what happens to energy when individual atoms collide.

Question #4

Describe what happens in the simulation when there are only two atoms and they collide.

Question #5

Draw a snapshot of the simulation after the atoms have collided. On the graph, label the potential and kinetic energy traces.

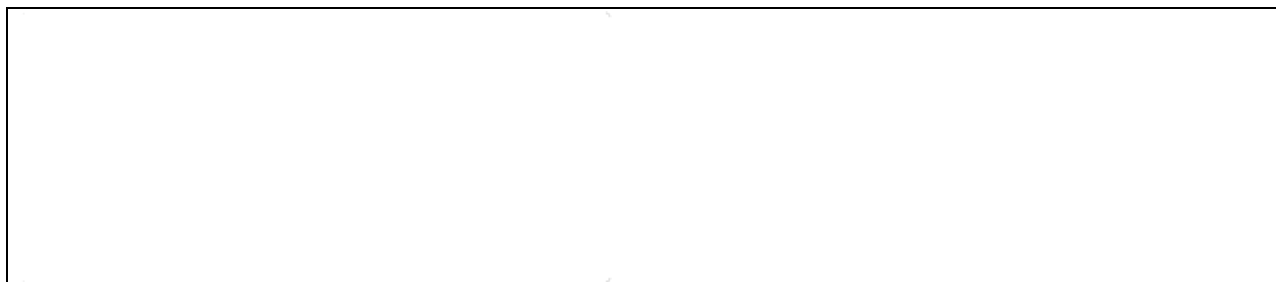
When the potential energy is at its lowest point, attractive and repulsive forces are balanced, but the two atoms do not form a molecule. Why doesn't a stable bond form?

Hint: Think about what the kinetic energy trace tells you about the speed of the two atoms.

Question #6

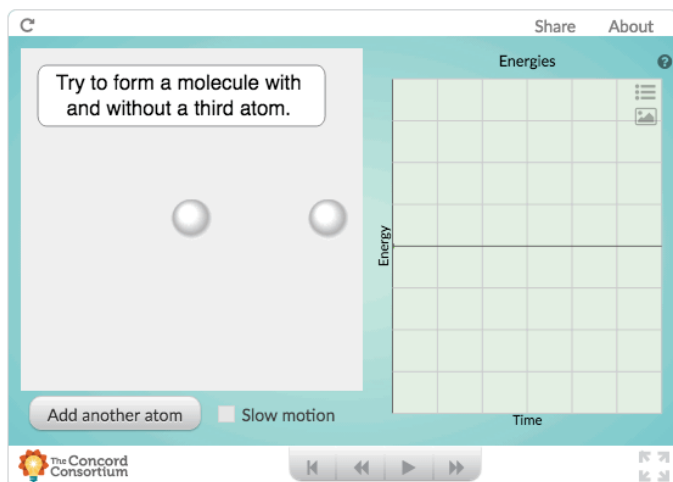
Add a third atom to the simulation. Try a variety of positions for the third atom until you find a way for it to enable the formation of a bond between the first two atoms.

Draw a snapshot of the molecule that was formed after adding the third atom, and label the trace of the kinetic energy of the third atom.



How is energy involved when a bond forms?

Recall the demo in which a tennis ball and basketball were dropped together. Think about how it might connect to the role of the third atom in the simulation you just explored. How can the transfer of energy between the basketball and tennis ball help us understand the transfer of energy between atoms when they form a molecule?



<https://lab.concord.org/embeddable.html#interactives/interactions/forming-molecular-bond-no-axes.json>

Question #7

When two atoms form a molecule, the molecule has lower energy than the two separate atoms. However, when only two atoms are present, they bounce off each other and do not form a molecule. Explain what happens to the energy of the atoms when there are only two atoms and they collide.

Question #8

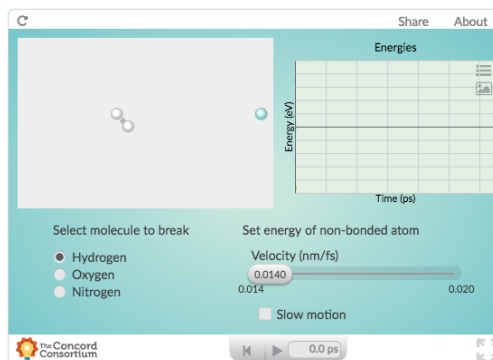
Draw a snapshot and use it to draw a model that shows the role of the third atom when two atoms form a molecule. Make sure to show what happens to the energy of the atoms.

How is energy involved when a bond breaks?

When atoms bond together to form a molecule, the potential energy decreases and available energy is transferred to the surroundings.

Investigate

Use the simulation to explore how energy is involved when a molecule breaks apart into individual atoms.



Question #9

How does the speed of the third atom change after it hits the molecule?

Question #10

What does the change in speed tell you about the kinetic energy of the **third atom** at the moment it hits the molecule?

Question #11

What happens to the energy of the **atoms in the molecule** at the moment it is hit by the third atom? How can you tell?

Question #12

What is the role of the third atom when the bonds of the molecule break? Explain.

Question #13

Construct a model to show the process of bond breaking. Your model should include energy and forces.

Conclusion

Energy is involved when a bond forms and when it breaks. Based on things you learned in this activity, answer the questions below focusing on how energy changes when bonds form.

Question #14

Is there energy available to transfer to the surroundings when bonds break? Justify your answer.

Question #15

Is there energy available to transfer to the surroundings when bonds form? Justify your answer.

