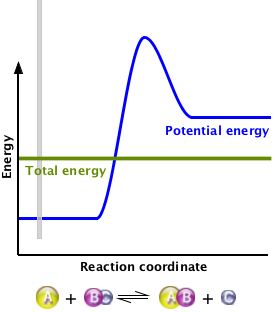
**PhET: Reactions and Rates**

*Getting Started: Go to* <http://standring.weebly.com/unit-6---thermochemistry.html> run the simulation at the bottom of the page.

Part 1: Single Collision

*Learning Goals: By looking at a single chemical reaction, you will understand the conditions necessary for a successful chemical reaction according to Collision Theory as well as the uses of a potential energy diagram.*

Procedure:

1. Make sure you are on the “single collision” tab.
2. Click on the plus sign next to ‘energy view’ to view the potential energy diagram.
3. Starting with the ‘straight shot,’ play with the different reactions.
4. Try designing your own.
5. Change the launcher options to angled shot. (Top right box)
6. Play with the different reactions, try designing your own.

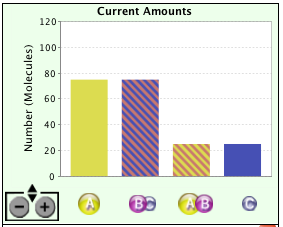
Analysis:

1. Pick one of the reactions (can be design your own). Draw the potential energy diagram below.
2. Label the reactants, products, and activated complex.
3. Draw the line segments representing the activation energy and reaction energy. Label.
4. On your diagram, draw the line representing where the total energy needs to be in order to have a successful reaction. Label.
5. Do the reactants or the products have more energy?
6. Is this reaction endothermic or exothermic?

Part 2: Many Collisions

*Learning Goals: By analyzing graphs and patterns, you will understand how systems reach and behave at dynamic equilibrium.*

Procedure:

1. Change to the tab labeled ‘Many Collisions.’
2. Under options, select ‘bar graph.’ Zoom the bar graph out until you can see the 100 label of the y-axis.
3. Add 100 molecules of each of the reactants to the equilibrium mixture.
4. Let the reaction continue for AT LEAST 5 MINUTES, until the counts stay relatively steady. Make note of how the values change and the final values.
5. Clear the container.
6. Now, add 100 molecules of each of the PRODUCTS to the equilibrium mixture.
7. Let the reaction continue for AT LEAST 5 MINUTES, until the counts stay relatively steady. Make note of how the values change and the final values.

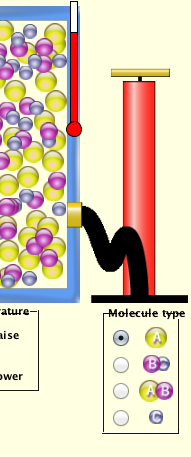
Analysis:

1. What do you notice about the position of the equilibrium? Is it favored to the reactants or products?
2. Compare the equilibrium position to the potential energy diagram for the reaction you drew in part one. What do you notice?
3. How did the reaction rates of the forward and backward reaction change as the system got close to equilibrium?
4. You saw what happened when we started with only reactants, and with only products. What do you predict would happen if we started with half and half? Why?
5. These numbers are VERY small compared to the actual interactions of molecules, try to think of how small 200 is compared to a mole, 6.02 x 1023. Our numbers fluctuated quite a bit, how much do you think the fluctuation is at such large numbers?

**PhET Mini-Lab: Reactions and Rates (2)**

Part 3: Rate Experiments

*Learning Goals: Using the simulation, you will investigate how the equilibrium position shifts when something upsets the system.*

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Procedure:

1. Switch to the “Rate Experiments” tab.
2. Select options to display bar graph and energy diagram.
3. Add molecules to the system and allow it to reach equilibrium as we did in Part 2.
4. Now, select a molecule under the ‘pump’ to pump into the system.
5. Add two ‘pumps’ of that molecule. Note how the numbers of the molecules in the system change and the rate at which they change.
6. Let the system reach equilibrium. Note how the equilibrium position has changed.
7. Try again with a different molecule.
8. Once the system is at equilibrium, change the temperature in the system. Note how reaction rates and the position of equilibrium change.

Analysis:

1. How did adding a reactant or a product affect the rates of the reactions as soon as it was added?
2. How did adding a reactant or product change the position of the equilibrium once a new equilibrium was established?
3. How did changing the temperature affect the system?