PhEt Reversible Reactions Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Setup -** Search “PhET Reversible Reactions” simulation. Open and run the simulation.
2. **Explore!** Click on everything to find the variables and observe how they affect the reaction. (Don’t just try to max out the computer’s memory chip.)
3. **Reaction Conditions**: Move the position of the reactants, transition state, and products wherever you wish and choose a temperature. **Be reasonable!!**

Reactants \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Transition state \_\_\_\_\_\_\_\_\_\_\_\_\_

Products \_\_\_\_\_\_\_\_\_\_\_\_\_ Temp \_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Design!** You will run three trials. Each one should have 100 total molecules**.** *Start with different amounts of A and B for each*trial. Place the starting amounts in the table at time 0. Record the amount of A and B in the chamber every 20 seconds for 5 minutes.

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| Trial 1 | | | Trial 2 | | | Trial 3 | | |
| Time | A | B | Time | A | B | Time | A | B |
| 0  (initial) |  |  | 0  (initial) |  |  | 0  (initial) |  |  |
| 20 |  |  | 20 |  |  | 20 |  |  |
| 40 |  |  | 40 |  |  | 40 |  |  |
| 60 |  |  | 60 |  |  | 60 |  |  |
| 80 |  |  | 80 |  |  | 80 |  |  |
| 100 |  |  | 100 |  |  | 100 |  |  |
| 120 |  |  | 120 |  |  | 120 |  |  |
| 140 |  |  | 140 |  |  | 140 |  |  |
| 160 |  |  | 160 |  |  | 160 |  |  |
| 180 |  |  | 180 |  |  | 180 |  |  |
| 200 |  |  | 200 |  |  | 200 |  |  |
| 220 |  |  | 220 |  |  | 220 |  |  |
| 240 |  |  | 240 |  |  | 240 |  |  |
| 260 |  |  | 260 |  |  | 260 |  |  |
| 280 |  |  | 280 |  |  | 280 |  |  |
| 300 |  |  | 300 |  |  | 300 |  |  |
| Final A:B Ratio | | | Final A:B Ratio | | | Final A:B Ratio | | |

1. Which side of the reaction is favored (are there more reactants or products) for the experiment you set up? Why is that so?
2. Graph the concentration (number of molecules) of both molecules A and B vs time. You should have two separate curves (A and B).

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1. What is happening to the concentrations at the beginning of the experiment? How does that differ from what is happening at the end of the experiment? Mark a vertical line on the graph at the point where equilibrium is established.
2. All three trials started at different amounts. How did the final ratios of A to B compare?
3. Did the reaction ever stop?

Teacher Tips:

* During the **exploration** section, students often go to the extremes of temperature, activation energy, and number of particles. While humorous, it detracts from the point of the exercise and often creates a lag in the computers. Any correlation to the variables and equilibrium position is rendered inert under the most extreme circumstances. Attempt to focus the students to investigate one variable at a time in a reasonable way.
* **Prior Knowledge** – a working knowledge of potential energy diagrams is helpful, although exothermic and endothermic reaction conditions are not explicitly taught, they can either be **reinforced** (if learned prior) or **introduced** (if they will be learned after). Students should also be able to identify variables and make predictions. A **modification** of this could include creating a table of variables and how it effects the number of particles on each side of the reaction or rate.

**Learning Objectives:**

There has been some discussion in the education world lately as the validity of giving the students learning objectives before an inquiry activity is conducted. Some would argue explicit learning objectives may detract from the students curiosity and ability to discover their own relationships if they already know what they are supposed to be investigating. The following learning objectives have been left off the student worksheet on purpose. They can be given before or after the activity.

1. Define activation energy and graphically determine the activation energy requirements that take place during a reaction.
2. Sketch and analyze graphs showing changes in reactant and product concentrations as reactions proceed towards equilibrium
3. State the characteristics of a system at equilibrium.
4. Use a potential energy diagram to determine whether reactants or products are favored during a reaction.