Name: ______________________

Chemical Equilibrium Introduction Activity

Objective
This activity is designed to introduce the concept of chemical equilibrium. At the end of this activity you should be able to recognize that when equilibrium is reached the rate of the forward and reverse reactions are equal and the concentration of products and reactants remain constant. You will also understand that equilibrium can be approached from many starting points and both directions.

Directions
Complete each of the following tasks using the tables on this activity sheet.
1. Break up into groups of 2 or 4 students
2. Get 50 small items (toothpicks, matches, pennies) and an activity sheet
3. Divide your group into two smaller groups – Reactants and Products
4. The Reactants and Products should start with the designated number of items and reaction rate from the activity table.
5. For each step the Reactants and Products should calculate how many of their items will “react” and be transferred to the other side.
   o If the calculated value is equal or greater than --.5, round up to the next whole number.
   o If the calculated value is less than --.5, round down to the last whole number.
   o The calculated values should be entered into the data table.
   o The two groups will they swap their reacted items.
6. Repeat step 5 until equilibrium is reached.
7. Repeat the process for the values given for Activity 2 and 3.
8. When you finish all three activities, review your data and answer the questions that follow.

ACTIVITY 1 – Start with equal number of reactants and products. The rate of the forward reaction is greater than the rate of the reverse reaction.

<table>
<thead>
<tr>
<th>Step</th>
<th>Reactants - Rate $R \rightarrow P = 0.5$</th>
<th>$0.5$</th>
<th>Products - Rate $R \rightarrow P = 0.25$</th>
<th>$0.25$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Initial]</td>
<td>Amount Reacted</td>
<td>Amount Formed</td>
<td>[Initial]</td>
</tr>
<tr>
<td>Initial</td>
<td>50</td>
<td>25</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td>1</td>
<td>38</td>
<td>19</td>
<td>16</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>35</td>
<td>18</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>17</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>Final</td>
<td>33</td>
<td>17</td>
<td>17</td>
<td>33</td>
</tr>
</tbody>
</table>
**ACTIVITY 2** – There are more reactants than products at the start of the reaction. The rate of the forward reaction is greater than the rate of the reverse reaction.

<table>
<thead>
<tr>
<th>Step</th>
<th>Reactants - Rate $\text{R} \rightarrow \text{P} = 0.5$</th>
<th>Products - Rate $\text{R} \rightarrow \text{P} = 0.25$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Initial] Amount Reacted Amount Formed</td>
<td>[Initial] Amount Reacted Amount Formed</td>
</tr>
<tr>
<td>Initial</td>
<td>40   20    5       25   20    5       20   35</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>25   13    9       21   35    9       13   39</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>21   11    10      20   39    10      11   40</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20   10    10      20   40    10      10   40</td>
<td></td>
</tr>
<tr>
<td>Final</td>
<td>20   10    10      20   40    10      10   40</td>
<td></td>
</tr>
</tbody>
</table>

**ACTIVITY 3** – There are no products present at the beginning of the reaction. The temperature has increased and is higher than in Activities 1 and 2.

<table>
<thead>
<tr>
<th>Step</th>
<th>Reactants - Rate $\text{R} \rightarrow \text{P} = 0.75$</th>
<th>Products - Rate $\text{R} \rightarrow \text{P} = 0.125$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Initial] Amount Reacted Amount Formed</td>
<td>[Initial] Amount Reacted Amount Formed</td>
</tr>
<tr>
<td>Initial</td>
<td>40   30    0       10   0     0       30   30</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10   8     4       6    30    4       8    34</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6    5     4       5    34    4       5    35</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5    4     4       5    35    4       4    35</td>
<td></td>
</tr>
<tr>
<td>Final</td>
<td>5    4     4       5    35    4       4    35</td>
<td></td>
</tr>
</tbody>
</table>

1. Review your data and answer the following questions:
   - How did you recognize when equilibrium was reached? The [Final Concentration] for the Reactants and Products stayed the same when equilibrium was reached.
   - Compare the rate of the forward and reverse reactions when equilibrium is reached? The rates of the forward and reverse reactions stayed the same (.75 and .125) throughout the process, but the amount of Reactant and Product that reacted became the same.
   - What happens to the concentration of products and reactants when equilibrium is reached? The concentration of the Reactants and Products stayed the same at equilibrium.
   - Do you have to initially have the same number of Products and Reactants present to reach equilibrium? No. Regardless of the starting concentration of Products and Reactants, equilibrium will be reached as the reaction proceeds.
   - For Activity 3, were the forward and reverse reactions exothermic or endothermic? Since the rate of the forward reaction increased with a temperature increase (.5 to .75), it must be endothermic. Since the rate of the reverse reaction decreased (.25 to .125) with a temperature increase, it must be exothermic.