Name: ______________________

**Cellular Respiration and pH**

**Background**
In order for cells to function, they must have energy. They acquire this energy by breaking down a sugar known as glucose through the following chemical equation:

\[ C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \]

This chemical reaction is known as cellular respiration. Notice that one of the products of this reaction is carbon dioxide. Carbon dioxide, when added to water, creates a weak acid called carbonic acid through the following chemical reaction:

\[ CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^- \]

Note: We make soft drinks by adding carbon dioxide into solution. So, what are we consuming when we drink a Coke?

Because of the weak acid produced by carbon dioxide, we can detect its presence by using an acid-base indicator called bromothymol blue. Bromothymol blue (or BTB for short) is blue in a solution with a pH of 7 or above. The solution will turn to a green color when the pH falls below 7 and then to a yellow color.

**Problem**
Can we use the pH properties of BTB to detect CO$_2$ in our exhaled breath? How will exercise affect the amount of product produced?

**Materials** (per group)
2 beakers of BTB solution
1 straw
Stopwatch or other timing device

**Safety**
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Use caution when blowing into the BTB solution so it doesn’t splash out of the beaker.
- **DO NOT INHALE THE SOLUTION!!!** Take your mouth off of the straw in order to inhale.
- When you complete the lab, pour the BTB solution down the sink and wash the beaker with soap and water. Straws should be thrown away.

**Procedure**
1. Put on your goggles.
2. Acquire your materials.
3. Record the initial color of both solutions of BTB.
4. While at rest have one group member, “the participant” use the straw to blow into one of the beakers of BTB solution.
5. The other partner will use a stopwatch to time how long it takes for the solution to change from blue to yellow.
6. Record the time and final color of this first solution in the data table below.
7. “The participant” will then run in place or in circles for a total of 3 minutes.
8. At the end of the 3 minutes “the participant” should immediately begin blowing into the second solution of BTB.
9. The partner will use a stopwatch to time how long it takes for the solution to change colors.
10. Record the time and final color of this second solution in the data table below.

Data

<table>
<thead>
<tr>
<th>Solution 1</th>
<th>Initial Color</th>
<th>Time to Change</th>
<th>Ending Color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Solution 2</td>
<td>Initial Color</td>
<td>Time to Change</td>
<td>Ending Color</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

Analysis

1. What caused the color change in the BTB?

2. Was there a difference in the time it took for the color change after exercise? Why?

3. What comparison can you make about the concentration of CO₂ in solution before blowing into the solution and after blowing into the solution and why?

4. What can you tell about the final pH of the solution?

5. What is the limitation of BTB in telling us pH?