Honors Biology Name:

*Factors that Affect the Rate of Photosynthesis Investigation*

**Learning Goal:** You will be able to manipulate variables and determine which factors have the greatest effect on the rate of photosynthesis.

**Success Criteria:** You will complete this investigation and turn in the questions with answers that are supported by data presented in a data table and a graph.

**Background Information:** Photosynthesis happens in some bacteria, algae, and plants. If we want to investigate the rates of photosynthesis, we need to use one of these organisms. For this investigation we are going to use plants. Photosynthesis happens primarily in the leaves of plants, so we will use leaves to investigate the rate of photosynthesis. Leaves are made of cells, inside these cells are organelles called chloroplasts. Inside the chloroplasts are stacks of Thylakoids surrounded by a liquid called stroma. Photosynthesis happens in the Thylakoids and in the stroma.

We are going to create “discs” of leaves, we will do this by using a hole punch on the leaves. The discs are made of cells, but there is air trapped between the cells (they get there through the Stoma of the leaves). To make this procedure work we have to get the air out from the spaces and replace it with a water solution. Once the leaves are full of the solution they will no longer float in water. As photosynthesis progresses, oxygen is produced and the solution in the leaves is forced out, and replaced by the oxygen gas. Once the spaces are full of oxygen gas the discs will begin to float. This is how we can tell photosynthesis is occurring.

One of our solutions will contain Sodium bicarbonate, this is ordinary baking soda. The Sodium bicarbonate (NaHCO3) contains Carbon and Oxygen atoms needed by the chloroplast to do photosynthesis (It takes the place of the Carbon dioxide in the equation). The other solution will contain just water without Sodium bicarbonate, this will act as our control group. Both solutions will contain soap because the leaves are slightly hydrophobic and will not sink with out the soap. The soap makes the leaves hydrophilic, so they are able to sink once the air is removed.

Once you do the basic investigation, we are also going to see what other factors might affect the rate of photosynthesis. We will change the temperature of the water and change the type of light that hits the plant discs. You will need to create data tables that organize the information from both investigations.

**Materials:**

* Sodium bicarbonate and soap solution
* Soap solution
* Spinach leafs
* Hole punch
* Timer
* Light source (florescent)
* Light source (Incandescent)
* Plastic cup
* Syringe
* Ice
* Hot plate

**Procedure:**

1. Use a hole punch to cut 20 uniform leaf discs.
2. Remove the plunger form the syringe and place 10 leaf discs into the syringe barrel. Replace the plunger, being careful not to crush the leaf discs. Push on the plunger until only a small volume of air and leaf discs remain in the barrel.
3. Pull a small volume of Sodium bicarbonate and soap solution into the syringe. Tap the syringe to suspend the leaf discs in the solution.
4. Holding a finger over the syringe opening, draw back on the plunger to create a vacuum, hold this vacuum for about 20 seconds. While holding the vacuum, shake the syringe vigorously (try not to slip and spill the contents).
5. Check and see if the discs have sunk to the bottom, if not repeat step 4 until they all sink (this may take several times).
6. Pour the discs with the solution into the plastic cup. Add more Sodium bicarbonate and soap solution until the total depth of the liquid equals 2 cm.
7. Repeat steps 2-6, but instead of Sodium bicarbonate and soap solution, just use the soap solution. This is your control group (you should label it).
8. Put both samples under a light source and start the timer. At the end of each minute, record the number of floating discs (In a data table you have made—use your appendix I gave you). (You may need to gently swirl the cup to dislodge discs stuck to the sides). Continue timing until all discs are floating.
9. You will repeat steps 1-8 except using the Sodium bicarbonate and soap solution in both. You will change one variable in each trial, temperature on one and type of light in the other.
10. Create a graph comparing your four samples and their rate of photosynthesis (Use the appendix as a guide).

**Clean-up:** When finished discard the plant leaf discs in the trash, pour the solutions down the sink, and wash and dry the plastic cups. Wipe up your station and have me sign here \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for ten points.

**Questions:**

1. Molecules move faster when they have more energy. Using this bit of information and data from your investigation, explain how temperature affects the rate of photosynthesis.
2. Different light bulbs emit different wavelengths of light. Compact florescent bulbs emit light in the blue and green spectrum, while incandescent bulbs emit light in the red spectrum. Using this bit of information and data from your investigation, explain how different wavelengths of light affect the rate of photosynthesis.
3. As photosynthesis occurred the discs began to float in the solution. This was because oxygen filled the spaces between the cells. Where did this oxygen come from? Why is that process that made the oxygen important to photosynthesis?