Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Pd: \_\_\_\_\_ Ast: \_\_\_\_\_

**Physical Science Honors**

**CONTROLLING CHEMICAL REACTIONS INVESTIGATION (Demo)**

|  |
| --- |
| **H+** + **HCO3-** 🡪 **H2O** + **CO2** |
| **Figure 1**: Bicarbonate ions and hydrogen ions combine to form water and carbon dioxide. |

**Introduction:** A **chemical reaction** transforms one set of chemical substances into another by breaking existing **chemical bonds** and creating new ones. This is how Alka-Seltzer tablets deliver their medicine into a glass of water! Alka-Seltzer tablets consist of aspirin, citric acid, and sodium bicarbonate (baking soda); all in a solid state. When the tablet is dropped into water, a series of chemical changes occurs.

First, the **ionic** bonds in the citric acid and the sodium bicarbonate *dissociate*, or break apart. This frees up hydrogen (H+) ions from the citric acid to react with bicarbonate (HCO3-) ions from the sodium bicarbonate, producing water and carbon dioxide as shown above in figure 1. This simple reaction is part of a more complicated overall reaction that occurs between the Alka-Seltzer tablet and water. The full chemical equation for this reaction is shown in figure 2.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **C6H8O7 (*aq*)** | + | **3NaHCO3 (*aq*)** | 🡪 | **3H2O (*l*)** | + | **3CO2 (*g*)** | + | **Na3C6H5O7 (*aq*)** |
| citric acid | + | baking soda | 🡪 | water | + | carbon dioxide | + | sodium citrate |
| **Figure 2**: The full chemical equation for the reaction between Alka-Seltzer tablets and water. |

The release of gas from the *aqueous* (water based) solution, called *effervescence*, is an indicator that a chemical reaction has occurred. Chemists can control the rate of a chemical reaction by manipulating variables such as temperature, surface area, and concentration. **Temperature** is a measure of the average kinetic energy of the particles in a substance; in other words, how fast the molecules are moving. **Surface area** is the area of the surface of a chemical, or the molecules of that chemical which are exposed to the reaction at any given time. **Concentration** refers to the amount of one chemical in a given volume of the mixture or solution.

**Your Task:** Conduct a series of **experiments** to determine how the manipulation of these factors affects the reaction between Alka-Seltzer tablets and water.

The guiding questions for this investigation are:

* **How does the *temperature* of reactants affect chemical reactions?**
* **How does the *surface area* of reactants affect chemical reactions?**
* **How does the *concentration* of reactants affect chemical reactions?**

**Materials:** You may use any of the following materials during your investigation.

* Alka-Seltzer *(2 tablets per bottle)*
* Plastic Bottles (3 bottles: A, B, & C)
* Water (Cold, Room Temp., & Hot)
* Balloons (1 per bottle)
* Mortar & Pestle (1 set per group)
* Funnel (1 per group)

**Safety Precautions:**

Wear lab goggles. Treat warm water carefully. Do not taste the tablets or the water.

**Data Collection:**

Use the back of this paper to record your observations for each test.

**Data Analysis:**

Answer the questions on the back of this paper to draw conclusions from your data.

**TEST 1 – Temperature of Reactants**

1. Describe how we manipulated the independent variable in this test.
2. In the table below, describe (write &/or draw) your observations for each sample during this test.

|  |  |  |  |
| --- | --- | --- | --- |
| SAMPLE | A - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | B - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | C - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| OBSERVATIONS |  |  |  |

1. Based on the data above, what do you conclude about the effect of temperature on a chemical reaction?

**TEST 2 – Surface Area of Reactants**

1. Describe how we manipulated the independent variable in this test.
2. In the table below, describe (write &/or draw) your observations for each sample during this test.

|  |  |  |  |
| --- | --- | --- | --- |
| SAMPLE | A - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | B - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | C - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| OBSERVATIONS |  |  |  |

1. Based on the data above, what do you conclude about the effect of surface area on a chemical reaction?

**TEST 3 – Concentration of Reactants**

1. Describe how we manipulated the independent variable in this test.
2. In the table below, describe (write &/or draw) your observations for each sample during this test.

|  |  |  |  |
| --- | --- | --- | --- |
| SAMPLE | A - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | B - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | C - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| OBSERVATIONS |  |  |  |

1. Based on the data above, what do you conclude about the effect of concentration on a chemical reaction?