American Association of Chemistry Teachers

Plop, Fizz: How to Affect the Rate of a Chemical Reaction

**Background**
A chemical reaction is a process where one or more substances (reactants) are chemically changed into one or more new substances (products). In industry, companies try to control the rate of chemical reactions to make them useful and safe. There are several ways to affect how quickly the reaction occurs. We will investigate three of these factors: temperature, particle size (surface area), and the amount of the reactants (concentration).

**Problem**
How do temperature, surface area, and concentration affect the rate of a chemical reaction?

**Prelab Questions**
1. What affect do you think increasing the temperature of one of the reactants will have on the rate of the chemical reaction? Why do you think this?

2. What affect do you think increasing the surface area (decreasing the particle size) of one of the reactants will have on the rate of the chemical reaction? Why do you think this?

3. What affect do you think increasing the concentration (how much) of one of the reactants will have on the rate of the chemical reaction? Why do you think this?

**Materials**
- Room temperature water
- Hot water
- Cold (ice) water
- One 400 mL beaker
- One mortar and pestle
- 8 Alka-Seltzer tablets
- One thermometer
- One stopwatch or timer
- Cell phone camera (optional)

**Safety**
- Always wear safety goggles when using chemicals in the lab.
- The final solutions may be discarded into the sink.
- Follow teacher instructions for how to clean up your materials.
- Wash your hands thoroughly before leaving the lab.

**Procedure**
The Effect of Temperature:
1. Pour 300mL of room temperature water into the 400mL beaker. This will be your control.
2. Place the thermometer into the center of the water.
3. Once the temperature reading stabilizes, record the temperature in the data table below.
4. Get ready to start the stopwatch/timer.
5. Start the timer as you drop one Alka-Seltzer tablet into the water.
6. Time how long it takes the tablet to finish visibly reacting with the water.
7. Record the time (in seconds) in the data table below.
8. Also rate the strength of the reaction on a scale of 0 – 5, with 0 being no reaction and 5 being a reaction that would overflow the beaker. You may use a camera to photograph or record a video of the reaction to help in your decision.
9. Record the strength of the reaction in the data table below.
10. Rinse out the beaker thoroughly with water.
11. Repeat steps 1 – 10 with the cold water.
12. Repeat steps 1 – 10 with the hot water.

The Effect of Surface Area:
1. Pour 300mL of room temperature water into the 400 L beaker.
2. Take one Alka-Seltzer tablet and place it in the mortar.
3. Use the pestle to crush the tablet into a fine powder.
4. Get ready to start the stopwatch/timer.
5. Start the timer as you pour the crushed Alka-Seltzer tablet from the mortar into the water.
6. Time how long it takes the tablet to finish visibly reacting with the water.
7. Record the time (in seconds) in the data table below.
8. Also rate the strength of the reaction on a scale of 0 – 5, with 0 being no reaction and 5 being a reaction that would overflow the beaker. You may use a camera to photo or record a video of the reaction to help in your decision.
9. Record the strength of the reaction in the data table below.
10. Rinse out the beaker thoroughly with water.
11. Repeat steps 1 – 10 but use the mortar and pestle to crush the tablet into larger sized pieces.
12. Repeat steps 1 – 10 with one uncrushed tablet (this is the control).

The Effect of Concentration:
1. Pour 300mL of room temperature water into the 400 mL beaker.
2. Break one Alka-Seltzer tablet in half.
3. Break one of the half tablets in half again to make it a quarter of a tablet.
4. Get ready to start the stopwatch/timer.
5. Start the timer as you drop the quarter tablet into the water.
6. Time how long it takes the tablet to finish visibly reacting with the water.
7. Record the time (in seconds) in the data table below.
8. Also rate the strength of the reaction on a scale of 0 – 5, with 0 being no reaction and 5 being a reaction that would overflow the beaker. You may use a camera to photo or record a video of the reaction to help in your decision.
9. Record the strength of the reaction in the data table below.
10. Rinse out the beaker thoroughly with water.
11. Repeat steps 1 – 10 with the half tablet.
12. Repeat steps 1 – 10 with the whole tablet (this is the control).
Data

The Effect of Temperature:

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time (seconds)</th>
<th>Strength Rating (0 – 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

The Effect of Surface Area:

<table>
<thead>
<tr>
<th>Surface Area</th>
<th>Time (seconds)</th>
<th>Strength Rating (0 – 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Powder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larger Pieces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Effect of Concentration:

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Time (seconds)</th>
<th>Strength Rating (0 – 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter (0.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half (0.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole (1.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. On graph paper, make a line graph of the temperature vs. time. The x-axis should be temperature while the y-axis should be time.

2. On graph paper, make a bar graph of the temperature vs. strength. The x-axis should be temperature while the y-axis should be strength.

3. On graph paper, make a bar graph of the surface area vs. time. The x-axis should be surface area while the y-axis should be time.

4. On graph paper, make a bar graph of the surface area vs. strength. The x-axis should be surface area while the y-axis should be strength.

5. On graph paper, make a line graph of the concentration vs. time. The x-axis should be concentration while the y-axis should be time.

6. On graph paper, make a bar graph of the concentration vs. strength. The x-axis should be temperature while the y-axis should be strength.
Analysis
Write an analysis for each of the variables that we investigated. Write your analysis in paragraph form using the CER format by making a claim (C) and supporting the claim with evidence (E) from your observations, data tables, and graphs, as well as reasoning what you know about chemical reactions (R).

Temperature:

Surface Area:

Concentration:

Conclusion
1. Using the temperature data and graph, explain how you can predict the reaction rate of a temperature that is between what you tested and the room temperature water. Use actual temperature values and times in your explanation.

2. Using the concentration data and graph, explain how you can predict the reaction rate of a concentration that is different than what was tested. Use actual concentration amounts and times in your explanation.