# Pre-Lab Information

Purpose Explore the effects of variables on the rate of chemical reactions.

Time Approximately 45 minutes

Question How do the factors of temperature and surface area affect the rate of chemical reactions?

Hypothesis If temperature and surface area increase, then the time it takes for sodium bicarbonate to completely dissolve will decrease, because increasing both factors increases the rate of a chemical reaction.

Variables *Independent Variable #1*: Temperature of the water

*Independent Variable #2:* Surface area of the sodium bicarbonate

*Dependent Variable:* Time to dissolve sodium bicarbonate

Summary You will establish a baseline for comparison by adding a tablet of sodium bicarbonate to room temperature water and recording the amount of time necessary for it to completely dissolve. You will then repeat the procedure in one series of trials in which you use different temperatures and another series of trials in which you manipulate the available surface area of the tablets. Each time, you will record the time it takes for the sodium bicarbonate to dissolve and compare it to your baseline.

# Safety

* Wear appropriate clothing for working in the lab, including a lab coat or apron.
* Wear protective gloves when handling chemicals and wash your hands thoroughly when the experiment is complete.
* Protect your eyes by wearing safety goggles throughout the experiment.
* Inspect glassware prior to starting your experiment. Check for chips, cracks, or other safety concerns.
* Behave in a way that is purposeful.
* Report all accidents – no matter how big or small – to your teacher.

# Lab Procedure

1. **Gather Materials**

|  |  |  |
| --- | --- | --- |
| * one 400 mL beaker * 15 sodium bicarbonate tablets * water | * stir rod * graduated cylinder * thermometer | * stopwatch * spatula * mortar and pestle |

1. **Establish Baseline for Comparison (Room Temperature Water)**
   1. Use a graduated cylinder to add 250 mL of room temperature water to a beaker.
   2. Stir the water with a stir rod to make sure it is the same temperature throughout the beaker.
   3. Record the temperature of the water in Table A.
   4. Reset the stopwatch to zero. If you do not have a stopwatch, note the time on the clock.
   5. Add 1 sodium bicarbonate tablet to the beaker of water and start the stopwatch.
   6. Carefully watch the tablet as it dissolves. When the tablet can no longer be seen, press stop on the stopwatch. Record the time required for the tablet to fully dissolve in Table A.
   7. Dispose of the solution and rinse out the beaker for the next step.
2. **Increase Accuracy of Baseline Measurement (Room Temperature Water)**
   1. Repeat steps 2a–2g two more times and record your measurements of the time required to dissolve the tablet in Table A. Note any changes to temperature as well.
   2. Add up your measurements and divide by the number of trials to determine the average amount of time required for the tablet to fully dissolve. Record the average time in Table A.
3. **Determine the Effect of Temperature on Reaction Rate (Hot Water)**
   1. Use a graduated cylinder to add 250 mL of hot water to a beaker.
   2. Stir the water with a stir rod to make sure it is the same temperature throughout the beaker.
   3. Record the temperature of the water in Table B.
   4. Reset the stopwatch to zero. If you do not have a stopwatch, note the time on the clock.
   5. Add 1 sodium bicarbonate tablet to the beaker of water and start the stopwatch.
   6. Carefully watch the tablet as it dissolves. When the tablet can no longer be seen, press stop on the stopwatch. Record the time required for the tablet to fully dissolve in Table B.
   7. Dispose of the solution and rinse out the beaker for the next step.
   8. Repeat steps 4a–4g two more times to increase the accuracy of your measurement. Record your data in Table B.
   9. Calculate the average time for the tablet to dissolve under these conditions and record it in Table B.
4. **Determine the Effect of Temperature on Reaction Rate (Cold Water)**
   1. Use a graduated cylinder to add 250 mL of cold water to a beaker.
   2. Stir the water with a stir rod to make sure it is the same temperature throughout the beaker.
   3. Record the temperature of the water in Table C.
   4. Reset the stopwatch to zero. If you do not have a stopwatch, note the time on the clock.
   5. Add 1 sodium bicarbonate tablet to the beaker of water and start the stopwatch.
   6. Carefully watch the tablet as it dissolves. When the tablet can no longer be seen, press stop on the stopwatch. Record the time required for the tablet to fully dissolve in Table C.
   7. Dispose of the solution and rinse out the beaker for the next step.
   8. Repeat steps 5a–5g two more times to increase the accuracy of your measurement. Record your data in Table C.
   9. Calculate the average time for the tablet to dissolve under these conditions and record it in Table C.
5. **Determine the Effect of Surface Area on Reaction Rate (Quarters)**
   1. Use a spatula to break 1 sodium bicarbonate tablet into 4 pieces.
   2. Use a graduated cylinder to add 250 mL of room temperature water to a beaker.
   3. Stir the water with a stir rod to make sure it is the same temperature throughout the beaker.
   4. Record the temperature of the water in Table D.
   5. Reset the stopwatch to zero. If you do not have a stopwatch, note the time on the clock.
   6. Add the 4 smaller sodium bicarbonate pieces to the beaker of water and start the stopwatch.
   7. Carefully watch the pieces as they dissolve. When the pieces can no longer be seen, press stop on the stopwatch. Record the time required for all of the pieces to fully dissolve in Table D.
   8. Dispose of the solution and rinse out the beaker for the next step.
   9. Repeat steps 6a–6h two more times to increase the accuracy of your measurement. Record your data in Table D.
   10. Calculate the average time for the tablet pieces to dissolve under these conditions and record it in Table D.
6. **Determine the Effect of Surface Area on Reaction Rate (Crushed)**
   1. Use a mortar and pestle to crush 1 sodium bicarbonate tablet into a fine powder.
   2. Use a graduated cylinder to add 250 mL of room temperature water to a beaker.
   3. Stir the water with a stir rod to make sure it is the same temperature throughout the beaker.
   4. Record the temperature of the water in Table E.
   5. Reset the stopwatch to zero. If you do not have a stopwatch, note the time on the clock.
   6. Add the sodium bicarbonate powder to the beaker of water and start the stopwatch.
   7. Carefully watch the powder as it dissolves. When the powder can no longer be seen, press stop on the stopwatch. Record the time required for the powder to fully dissolve in Table E.
   8. Dispose of the solution and rinse out the beaker for the next step.
   9. Repeat steps 7a–7h two more times to increase the accuracy of your measurement. Record your data in Table E.
   10. Calculate the average time for the powder to dissolve under these conditions and record it in Table E.
7. **Summarize Data**

Transfer your data for volume, temperature, and the calculated averages from Tables A–E to the Summary Tables F and G for easy comparison of each of the variables.

1. **Construct Graphs** 
   1. Follow these directions to construct graphs of your data. Sketch your graphs in your Lab Report Guide, Section 2.
   2. Construct a bar graph that compares the average time to dissolve the sodium bicarbonate for the three temperatures that you calculated to determine whether temperature does have an effect on the rate of a chemical reaction.
   3. Construct a bar graph that compares the average time to dissolve the sodium bicarbonate for the three different surface areas that you calculated to determine whether surface area does have an effect on the rate of a chemical reaction.

# Data

Record your data in the tables below.

### Table A: Baseline Data for Tablet in Room Temperature Water

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Volume (mL)** | **Temp.**  **(oC)** | **Start Time** | **End Time** | **Elapsed Time (s)** |
| **Trial #1** |  |  |  |  |  |
| **Trial #2** |  |  |  |  |  |
| **Trial #3** |  |  |  |  |  |
| **Average Time for Tablet to Dissolve** | | | | |  |

### Table B: Time to Dissolve Tablet in Hot Water

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Volume (mL)** | **Temp.**  **(oC)** | **Start Time** | **End Time** | **Elapsed Time (s)** |
| **Trial #1** |  |  |  |  |  |
| **Trial #2** |  |  |  |  |  |
| **Trial #3** |  |  |  |  |  |
| **Average Time for Tablet to Dissolve** | | | | |  |

### Table C: Time to Dissolve Tablet in Cold Water

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Volume (mL)** | **Temp.**  **(oC)** | **Start Time** | **End Time** | **Elapsed Time (s)** |
| **Trial #1** |  |  |  |  |  |
| **Trial #2** |  |  |  |  |  |
| **Trial #3** |  |  |  |  |  |
| **Average Time for Tablet to Dissolve** | | | | |  |

### Table D: Time to Dissolve Tablet When Quartered

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Volume (mL)** | **Temp.**  **(oC)** | **Start Time** | **End Time** | **Elapsed Time (s)** |
| **Trial #1** |  |  |  |  |  |
| **Trial #2** |  |  |  |  |  |
| **Trial #3** |  |  |  |  |  |
| **Average Time for Tablet to Dissolve** | | | | |  |

### Table E: Time to Dissolve Tablet When Crushed

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Volume (mL)** | **Temp.**  **(oC)** | **Start Time** | **End Time** | **Elapsed Time (s)** |
| **Trial #1** |  |  |  |  |  |
| **Trial #2** |  |  |  |  |  |
| **Trial #3** |  |  |  |  |  |
| **Average Time for Tablet to Dissolve** | | | | |  |

**Summary Tables**

### Table F: Summary Table for the Effect of Temperature

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Volume**  **(mL)** | **Temp.**  **(oC)** | **Average Time**  **(s)** |
| **Hot Water** |  |  |  |
| **Room Temperature** |  |  |  |
| **Cold Water** |  |  |  |

### Table G: Summary Table for the Effect of Surface Area

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Volume**  **(mL)** | **Temp.**  **(oC)** | **Average Time**  **(s)** |
| **Tablet Form** |  |  |  |
| **Quartered** |  |  |  |
| **Crushed** |  |  |  |