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# *Chemistry 2, Lesson 5*

## *Reaction Rate*

The purpose of the completed lab was to explore the rate of a chemical reaction at di erent temperatures and with di erent reactant particle sizes. The question we sought to answer was as follows: what are the e ects of temperature and a reactant's particle size on reaction rate? We hypothesized that, if you increase the temperature of a reaction, then the reaction rate will increase because particles experience more collisions at higher temperatures. Further, we hypothesized that, if you decrease the particle size of a reactant, then the reaction rate will increase because more of the reactants' surface area is exposed allowing more particles to make contact with each other. The experiment's controlled variables are listed below.

- reactant volume and type
- solvent volume and type
- beaker size and material

The independent variables were particle size and temperature. The dependent variable was reaction rate.

The materials used in our experiment are listed below.

- 250 mL graduated cylinder
- Thermometer
- Water
- Timer
- Four 250 mL beakers
- Seven 1,000 mg e ervescent tablets
- Two pieces of filter paper
- 600 mL beaker
- Ice
- Hot plate

The procedure we followed is listed below.

1. Gather materials.
2. Measure the reaction rate at approximately 20°C.
   a. Using a graduated cylinder, fill a 250 mL beaker with 200 mL of water.
   b. Measure the temperature of the water and record it in the correct row of Table A.
   c. Reset the timer. Start the timer as you place a full tablet into the beaker.
   d. Record the reaction time on the Data Sheet in the correct row of Table A.
   e. Compute the reaction rate to the nearest mg/L/sec. Record it in the last column of Table A.

3. Measure the reaction rate at approximately 40°C. Repeat Step 2, heating the water to approximately 40°C using a hot plate during sub-step a.

4. Measure the reaction rate at approximately 65°C. Repeat Step 2, heating the water to approximately 65°C using a hot plate during sub-step a.

5. Measure the reaction rate at approximately 5°C. Repeat Step 2, heating the water to approximately 5°C inside an ice bath during sub-step a. (To create an ice bath, place 100 mL of ice and 100 mL of water in a 600 mL beaker of ice water and wait until the temperature reaches approximately 5°C. To save time, you may wish to set up the ice bath, using an additional 250 mL beaker, while working on Step 4.)

6. Measure the reaction rate for a full tablet.

   a. Using a graduated cylinder, fill a 250 mL beaker with 200 mL of water.

   b. Reset the timer. Start the timer as you place the tablet in the beaker.

   c. Record the reaction time on the Data Sheet in the appropriate row of Table B.

   d. Compute the reaction rate to the nearest mg/L/sec. Record it in the last column of Table B.

7. Measure the Reaction Rate for a Partially Broken Tablet Repeat Step 6, but this time break the tablet into eight small pieces on a piece of filter paper. Make sure to place all of the pieces into the beaker at the same time.

8. Repeat Step 6, but this time crush the tablet into tiny pieces on a piece of filter paper. Make sure to place all of the pieces into the beaker at the same time.

9. Clean up. Dispose of all samples according to your teacher's directions.

The data collected during the experimentation is recorded below.

| | *Measured Reaction Temperature (°C)* | *Mass of Tablet (mg)* | *Volume of Water (L)* | *Reaction Time (s)* | *Reaction Rate (mg/L/sec)* |
|---|---|---|---|---|---|
| ≈20°*C* | 24 | 1000 | 0.2 | 34.2 | 146.1988 |
| ≈40°*C* | 40 | 1000 | 0.2 | 26.3 | 190.1141 |
| ≈65°*C* | 65 | 1000 | 0.2 | 14.2 | 352.1127 |
| ≈5°*C* | 3 | 1000 | 0.2 | 138.5 | 36.1011 |

| | *Relative Particle Size (Small, Medium, Large)* | *Mass of Tablet (mg)* | *Volume of Water (L)* | *Reaction Time (s)* | *Reaction Rate (mg/L/sec)* |
|---|---|---|---|---|---|
| *Full Tablet* | Large | 1000 | 0.2 | 34.5 | 144.9275 |
| *Broken Tablet* | Medium | 1000 | 0.2 | 28.9 | 173.0104 |
| *Crushed Tablet* | Small | 1000 | 0.2 | 23.1 | 216.4502 |

It is clear that increase in solvent temperature results in an increase in the rate of reaction. Water near freezing temperature is very notably slow, with the solute taking several times longer to react than within any other tested temperature. Likewise, it is clear that surface are and reaction rate are positively correlated. The broken-up tablet dissolves at about 150% the rate at which the unbroken tablet dissolves. Each of our hypotheses was proven correct by our experimentation. We successfully experienced an increase in reaction rate when either temperature or solute surface surface area increased.

We are aware of possible sources of error in our experimentation. It is possible that, in breaking up a tablet, small portions of it are lost and never accounted for. Further, the surface temperature of each tablet may have been inconsistent, and it is unclear if such an inconsistency may a ect reaction rate. In future, we may account for these potential errors through more accurate tablet break-up methods, accountance of further variables, and otherwise furthered commitment to accuracy.