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Course: FVS Chemistry AB 19.3

Teacher: Kerr (sorry about the stretched out formatting; the writing just wouldn't fit)

Question: What are the effects of temperature and a reactant's particle size on reaction rate?

Claim: If you increase the temperature of a reaction, then the reaction rate will increase because particles experience more collisions at higher temperatures.

Claim 2: 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 eachother.

Evidence:

Table A: Variation of Temperature

Trials	**Measured Reaction Temperature** ($°C$)	**Mass of Tablet** (mg)	**Volume of Water** (L)	**Reaction Time** (s)	**Reaction Rate** ($\frac{\frac{mg}{L}}{s}$)
$\approx 20°C$	$24°C$	1,000	0.2	34.2	146
$\approx 40°C$	$40°C$	1,000	0.2	26.3	190
$\approx 65°C$	$65°C$	1,000	0.2	14.2	352
$\approx 5°C$	$3°C$	1,000	0.2	138.5	36

Table B: Variation of Particle Size (All at Room Temperature)

Trials	**Relative Particle Size (Small, Medium, Large)**	**Mass of Tablet** (mg)	**Volume of Water** (L)	**Reaction Time** (s)	**Reaction Rate** ($\frac{\frac{mg}{L}}{s}$)
Full Tablet	Large	1000	0.2	34.5	145
Eight Pieces	Medium	1000	0.2	28.9	173
Tiny Pieces	Small	1000	0.2	23.1	216

The first claim is proven true by the evidence because the reaction rates do, in fact, increase with increasing temperatures. This is seen in the similar ordering of trials across both features. The temperatures (T_k is the temperature of the kth trial) are, in order: $T_4 < T_1 < T_2 < T_3$. The reaction rates are, by a similar convention, $R_4 < R_1 < R_2 < R_3$. This clearly shows correlation of the two variables. In each of the trials, potentially confounding variables were controlled for—the mass of the tablet, volume of water in the beaker, and particle size (none of the tablets were crushed).

The second claim follows a similar line of reasoning. Table B follows the changes in tablet size by crushing them into larger numbers of pieces (consequently, each piece has a smaller volume and disproportionately larger surface area and total surface area by the square-cube law). The reaction rate is highest for tiny pieces, slightly lower for eight pieces, and lowest for full, uncrushed tablets (as calculated from the increasing reaction times of the trials in the same order). This part of the experiment also controlled for similar variables: temperature was always room temperature as no heating or cooling occurred, and the masses/volumes of reactants were unchanged between trials.

Justification (Reasoning) of the Evidence:

Both of these results make sense within the context of collision theory. The temperature increases both the number of collisions because it is the same as kinetic energy and thus average velocities of the particles (faster particles cause more collisions) and it increases the number of effective collisions. The number of effective collisions increase because as the velocity of the particles go up, it becomes far more likely that the kinetic energy of a given collision is above the activation energy of the reaction.

The second result can be justified similarly. The more pieces into which the tablet is crushed, the more of the "internal" surface area is exposed to the water. The more surface area is exposed to the water, the more chances there are for the water molecules to collide with the antacid's molecules, and the more reactions occur.