Collision Theory - Impact for a Chemical Reaction

Why?

The collision theory states that a chemical reaction can only occur between particles when they collide (hit each other). The collision between reactant particles is necessary but not sufficient for a reaction to take place. The collisions also have to be effective. It is important to understand the exact nature of an effective collision since this determines whether or not particles actually react with each other and form new products.

Learning Objectives

- Identify the requirements needed for a successful reaction to occur between reactant particles.

Success Criteria

- Explain the meaning of an effective collision.
- Explain the requirements needed for a reaction to occur between reactant particles.

Resources

- Judith Gould, *Three Strikes Equals a Hit*, STANYS Science Teacher Bulletin (2000).
- Zumdahl, Zumdahl and DeCoste. 2002. World of Chemistry. Houghton Mifflin, pp. 537 - 541

Prerequisites

- Chemical reaction nomenclature
- Balancing chemical reactions
- Lewis structures (electron-dot-diagrams)

New Concepts

- Collision theory
- Effective collision
- Activation energy

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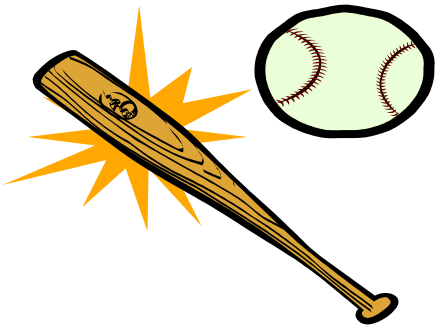
Model: Collision Theory

In the picture below, the baseball bat represents **Reactant A** and the baseball represents **Reactant B**. A reaction will only be successful if the batter hits a homerun. If the batter does not hit a homerun, the reaction will be considered a failure. Now, read the four scenarios below and answer the key questions that follow.



Scenario 1: The pitcher throws a fastball down the middle of the plate. The batter takes a mighty swing and totally misses the ball. The umpire yells, "Strike one!"

Scenario 2: The pitcher throws an off-speed pitch and the batter checks his swing. The batter just barely makes contact with the ball and it dribbles down in front of the batter's feet into foul territory. The umpire yells, "Foul ball; strike two!"

Scenario 3: The pitcher throws a curve ball that looks like it might catch the outside corner of the plate. The batter swings with all his strength, but the bat grazes the underside of the ball and the ball skews off to the right, flying into the crowd. The umpire yells, "Foul ball, still two strikes!"

Scenario 4: The pitcher throws another fastball down the middle of the plate. The batter swings and wallops the ball high into the air and the ball clears the center field wall that reads 410 feet. The ump yells, "Homerun!"

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Key Questions

1. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 1? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

2. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 2? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

3. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 3? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

4. Did a reaction take place between **Reactant A** and **Reactant B** in Scenario 4? Why or why not? Explain your reasoning in terms of the nature of the collision.

5. Based on your responses to Key Questions 1-4 and your reasoning, what insight has your team gained about the term effective collision?

6. Based on your answer to Key Question 5, complete the following statement: Collision theory states that a reaction is most likely to occur if…

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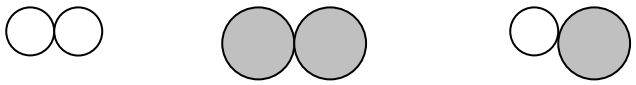
7. With your group, develop a different analogy/model to explain the collision theory to someone who is not in your group.

Exercise

1. Hydrogen gas and iodine vapor combine to form hydrogen iodide gas, as shown in the equation $H_2 + I_2 \rightarrow 2\ HI$. Using the representations shown below, draw a diagram to show an orientation for the reactant molecules that could produce an effective collision capable of producing two hydrogen iodide molecules.



H_2 I_2 HI

2. Using the representations shown in question 1, draw a diagram to show an orientation for the reactant molecules that would NOT produce an effective collision.

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