March
April
2020

AIM
- What is collision theory?
- What affects the rates of reactions?

AGENDA
- YOYO
- Collision Theory Activity
- Rates of Reaction Notes
- Practice Questions

YOYO

HOMEWORK
- Follow calendar on website

1

YOYO:

- What must happen in order for hockey or a soccer player to score the winning goal?

2

Collision Theory

Let's Play Ball

3

Collision Theory – Introduction

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.

4

Collision Theory – 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!"

Question: Did a reaction take place between **Reactant A** and **Reactant B** in Scenario1? Why or why not? Explain your reasoning in terms of the *nature* of the collision.

NO! The ball and bat did not come in contact with one another.

5

Collision Theory – 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!"

Question: 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.

NO! The ball was not moving fast enough for the bat to hit it

6

Collision Theory – 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!"

Question: 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.

NO! The ball and bat did not hit each other in the right spot

7

Collision Theory – 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!"

Question: 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.

YES! The ball had enough speed, the bat had enough speed, and they both hit each other in the right spot!

8

Collision Theory – Question #5

Based on your responses to Questions1-4 and your reasoning, what insight has your team gained about the term effective collision?

- Effective collision – the particles must actually collide with PROPER ENERGY and PROPER ORIENTATION (angle).

9

Collision Theory – Question #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…

- The particles collide with proper energy and orientation

10

Factors Affecting Rates of Reaction

Let's Speed It Up

11

Background Info:

- There are SIX Factors that affect the rate of reaction by changing the number if effective collisions that take place between particles
- The more effective collisions, the faster the reaction

12

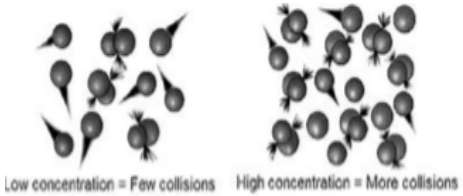
Types of Reactant

- **IONIC** substances react **FASTER** They easily break into **IONS** when you dissolve them
  - $AgNO_{3(s)} \rightarrow Ag^{+} + NO^{3-}$
- **COVALENT** substances react **SLOWER** - Requires more energy/time to break bonds
  - $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$

13

Concentration

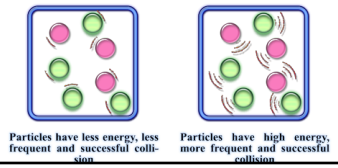
- **INCREASE** concentration **INCREASE** the reaction rate (speed)
- More particles increase chance of effective collisions



14

Temperature

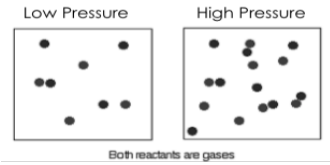
- **INCREASE** temperature **INCREASE** the reaction rate (speed)
- Increases the **NUMBER** effective collisions
- Reactants have **MORE ENERGY** when colliding
  - Think… a 5mph "fender bender" and a 50 mph "high speed crash)



15

Pressure

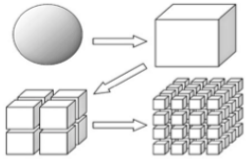
- **INCREASE** pressure **INCREASE** the reaction rate (speed)
- **AFFECTS GASES ONLY**
- Due to an increase in concentration



16

Surface Area

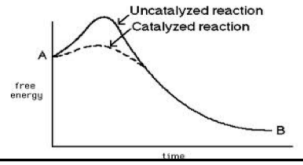
- **INCREASE** surface area **INCREASES** the reaction rate (speed)
- Due to more exposed particles that can react (more effective collisions)



17

Catalyst

- **INCREASES** the rate of reaction by **LOWERING** the activation energy
- Is **NOT** consumed in the reaction



18

19

Catalyst: Elephant Toothpaste Demo

- The Reaction:
- $2\ H_2O_{2(aq)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$

The reaction with the catalyst:

- $H_2O_{2(aq)} + I^-_{(aq)} \rightarrow OI^-_{(aq)} + H_2O_{(l)}$
- $H_2O_{2(aq)} + OI^-_{(aq)} \rightarrow I^-_{(aq)} + H_2O_{(l)} + O_{2(g)}$

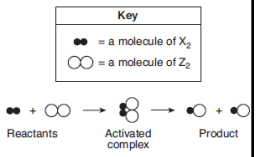
Is this endothermic or exothermic?

$2\ H_2O_{2(aq)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$ + heat

20

Practice Question #1

The equation below represents a reaction between two molecules, X_2 and Z_2. These molecules form an "activated complex," which then forms molecules of the product.



Which diagram represents the most likely orientation of X_2 and Z_2, when the molecules collide with proper energy, producing an activated complex?

a. 

b. 

c. 

d. 

21

Practice Question #2

A chemical reaction occurs when reactant particles

a. Are separated by great distances
b. Have no attractive forces between them
c. Collide with proper energy and proper orientation
d. Convert chemical energy into nuclear energy

22

Practice Question #3

A reaction is most likely to occur when the colliding particles have proper orientation and

a. Mass
b. Volume
c. Half-life
d. Energy

23

Practice Question #4

What is required for a chemical reaction to occur?

a. Standard temperature and pressure
b. A catalyst added to the reaction system
c. Effective collisions between reactant particles
d. An equal number of moles of reactants and products

24

Practice Question #5

As the temperature of a chemical reaction in the gas phase is increased, the rate of the reaction increased because

a. Fewer particle collisions occur
b. More effective particle collisions occur
c. The required activation energy increases
d. The concentration of the reactants increases

25

Practice Question #6

As the temperature of a reaction increases, it is expected that the reacting particles collide

a. More often and with greater force
b. More often and with less force
c. Less often and with greater force
d. Less often and with less force

26

Practice Question #7

A 5.0 gram sample of Fe(s) is to be placed in 100 millilters of HCl(aq). Which changes will result in the fastest rate of reaction?

a. Increasing the surface area of Fe(s) and increasing the concentration of HCl(aq)
b. Increasing the surface area of Fe(s) and decreasing the concentration of HCl(aq)
c. Decreasing the surface area of Fe(s) and increasing the concentration of HCl(aq)
d. Decreasing the surface area of Fe(s) and decreasing the concentration of HCl(aq)

27

Practice Question #8

At STP, which 4.0 gram zinc sample will react fastest with dilute hydrochloric acid?

a. Lump
b. Bar
c. Powdered
d. Sheet metal

28

Practice Question #9

A catalyst increases the rate of a chemical reaction by

a. Providing an alternate reaction pathway
b. Providing the required heat of reaction
c. Increasing the potential energy of the products
d. Increasing the activation energy of the reaction

29

Practice Question #10

Given the balanced equation representing a reaction:

$$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$$

Which set of reaction conditions produced $H_2(g)$ at the fastest rate?

a. A 1.0 lump of Zn(s) in 50.0 mL of 0.5M HCl(aq) at 20.0°C
b. A 1.0 lump of Zn(s) in 50.0 mL of 0.5M HCl(aq) at 30.0°C
c. 1.0 g of powdered Zn(s) in 50.0 mL of 1.0M HCl(aq) at 20.0°C
d. 1.0 g of powdered Zn(s) in 50.0 mL of 1.0M HCl(aq) at 30.0°C

30