

**Senior High School**

Department of Education  
National Capital Region

**SCHOOLS DIVISION OFFICE  
MARIKINA CITY**

# **Physical Science**

## **Quarter 1 - Module 5**

### **Rate of Chemical Reaction**

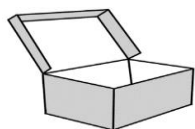


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## What I Need to Know

Naturally, some chemical reactions occur at an instant while others took a long time. Also, some substances are not reactive to other substances even we combine them while others are so reactive. In this module, you will investigate the factors that are needed to have a successful reaction. Besides, you will also understand the factors responsible for changing the rate of reaction. This module would help you in your daily life.

This module is divided into two lessons, namely:

### Lesson 1 – Collision Theory

At the end of this module, you are expected to;

1. state and explain collision theory;
2. describe the rate of chemical reactions of substances;
3. identify favorable conditions for the reaction process to happen;
4. define activation energy;
5. identify and describe factors which can affect the rate of reaction; and
6. use simple collision theory to explain the effects of concentration, temperature, and particle size on the rate of reaction. (S11/12PS-III-f-23)

### Lesson 2 – Catalyst

At the end of this module, you are expected to:

1. define activated complex, homogeneous catalyst, and heterogeneous catalyst;
2. explain the mechanism of a chemical reaction;
3. differentiate between endothermic and exothermic reaction;
4. describe how a catalyst works; and
5. define catalyst and describe how it affects reaction rate. (S11/12PS-III-f-24)



## What I Know

Read the question carefully and encircle the letter of the correct answer.

1. Which of the following statements best describes the rate of a chemical reaction?
  - A. It is the volume in which the reactant particles can occupy.
  - B. It is the speed in which the reactants are converted into a product.
  - C. It is the amount of temperature needed to start a chemical reaction.
  - D. It is the pressure exerted by the reactants during the process of chemical reaction.

2. Which of the following should happen in order for a chemical reaction to occur?
  - A. The reacting particles should collide with each other.
  - B. The reacting particles have sufficient energy to break the bonds between particles.
  - C. The reacting particles should be in an orientation favorable for breaking the bonds between each particle.
  - D. all of the above
  
3. The following factors can affect the rate of chemical reaction EXCEPT \_\_\_\_\_.
  - A. size of the particle
  - B. concentration of particles
  - C. the number of reactants use
  - D. light intensity the mixture is exposed to
  
4. When the temperature is increased in a chemical reaction, the following will happen EXCEPT \_\_\_\_\_.
  - A. increase in the size of particles
  - B. increase in kinetic energy of particles
  - C. increase in the number of collisions between particles
  - D. increase the reaction rate in both endothermic and exothermic reaction
  
5. What will happen if you increase the concentration of the reactants?
  - A. The surface area where particles can easily move in will increase.
  - B. The speed of the movement of each particle will be increased.
  - C. The pressure exerted by each particle to one another will increase.
  - D. The number of collisions between particles of the reactant will increase.
  
6. What do you call the minimum amount of energy required for a chemical reaction to occur?
 

A. Kinetic energy	C. Exothermic energy
B. Activation energy	D. Endothermic energy
  
7. Which of the following conditions will decrease the rate of reaction?
  - A. The size of the particles is big
  - B. The mixture is constantly stirred
  - C. The partial pressure is increased
  - D. The volume of the container is decreased
  
8. The following are factors that can influence the rate of reaction EXCEPT \_\_\_\_\_.
 

A. volume	C. surface area
B. temperature	D. concentration

9. Which of the following best describes a catalyst?
  - A. Increases the activation energy of reacting particles.
  - B. Adds to the concentration of the reactants in a chemical reaction
  - C. Increases the temperature of reacting particles in chemical reaction
  - D. Speeds up the process of a chemical reaction, without being consumed
  
10. What happens to the temperature of the product in an exothermic reaction?
  - A. The temperature of the product is increased
  - B. The temperature of the product is decreased
  - C. The temperature of the product is the same as the reactants.
  - D. Information is incomplete that is why the temperature cannot be determined
  
11. What happens to the temperature of the product in an endothermic reaction?
  - A. The temperature of the product is increased.
  - B. The temperature of the product is decreased.
  - C. The temperature of the product is the same as the reactants.
  - D. Information is incomplete that is why the temperature cannot be determined.
  
12. The reactants, in an endothermic process, have \_\_\_\_\_.
 

A. no energy	C. more energy than the products
B. less energy than the products	D. the same energy as the products
  
13. The reactants, in an exothermic process, have \_\_\_\_\_.
 

A. no energy	C. more energy than the products
B. less energy than the products	D. the same energy as the products
  
14. Catalysts generally react with one or more of the reactants to form a structure, which then reacts to form the final product. What do you call this structure?
 

A. activated catalyst	C. activated reactants
B. activated complex	D. activated products
  
15. The following statements are true about a catalyst EXCEPT \_\_\_\_\_.
  - A. is unchanged chemically
  - B. does not alter the products of the reaction
  - C. has the same mass at the end of the reaction
  - D. none of the above is false.

# Lesson 1

# Collision Theory



## What's In

From the previous module, you have learned the relationship of biological macromolecules on their properties and function. You might have also noticed that those biological macromolecules are composed of two or more atoms of the same or different elements which are chemically combined, this process is called chemical reaction.

Chemical reaction happens when one or more substances known as reactants are combined to form one or more new substances known as products. In order for a chemical reaction to occur the particles of the reactants must collide with one another, this statement is also known as the **Collision Theory**.



## What's New

### Activity 1.1. Concept of rate of collision theory

Table 1.1 shows the number of particles in a container and their relative speed. For both slow- and fast-moving particles, rank 1,2,3... each particle according to decreasing number of collisions, then answer the guide questions below.

Table 1.1. Illustration of the Rate of Reaction

Speed	5 particles in a container	10 particles on a container	25 particles on a container
Slow			
Fast			

Guide Questions:

1. The first container contains 5 slow-moving particles, and the second container contains 5 fast-moving particles. Which do you think will have a greater number of collisions for a certain period?
2. What is the relationship between the number and speed of particles involved in the frequency of collision?



## What Is It

**Collision Theory** states that the rate of a chemical reaction is proportional to the number of collisions between reactant molecules. This means if there is a greater number of effective collision between particles of the reactants, there will be a faster reaction rate. For a chemical reaction to happen the particles of the reactants must be able to;

- (a) collide with each other;
- (b) have adequate amount of energy, and;
- (c) must be in a right orientation to break the bonds between each particles of the reactant.

Effective collisions are collision of particles that result into a chemical reaction. For an effective collision to happen particles of the reactant must have at least the minimum energy required to break the bond of the reactants, known as the **activation energy**. If the reactant particles do not have the required activation energy when they collide, they would just bounce off each other without reacting as shown in figure 2.1.

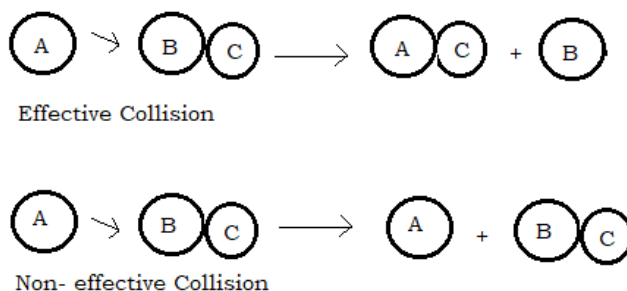


Figure 1.1. Effective and non-effective collision of a single replacement chemical reaction

If a chemical reaction fails most probably it did not meet one or two requirement/s, its either the energy of the reacting particles is below the activation energy or the particles collide at the wrong orientation. To easily understand this concept, analyze Table 1.2.

Table 1.2. Reacting  $X_2$  and  $Y_2$  to form  $2XY$ 

	State	Before	During	After
Reaction Arises	<ul style="list-style-type: none"> <li>sufficient energy</li> <li>correct orientation</li> </ul>			
No Reaction	<ul style="list-style-type: none"> <li>no sufficient energy</li> <li>correct orientation</li> </ul>			
No Reaction	<ul style="list-style-type: none"> <li>sufficient energy</li> <li>incorrect orientation</li> </ul>			

In your past science class, you have probably observed several chemical reactions that can be done in the laboratory like mixing baking soda and vinegar in a volcano project. This type of reaction occurs very fast and will give you result in seconds, but some chemical reactions takes longer time to occur, like rusting.

To increase the rate of chemical reaction the number, force, and effectiveness of collision between particles must be increase. **Rate of Reaction** is the speed at which the product is produced in a chemical reaction. The more collisions between particles of reactants in a given period of time, the faster the rate of reaction will be. There are several factors that affect the rate of reaction – temperature, concentration, particle size, stirring rate, and light intensity.

### Temperature

Increasing the temperature of the reactants will also increase the rate of reaction between reactants because of the following.

- Kinetic energy of particles will increase; thus, movement of each particles will also increase, which at the same time will increase the chances of collision between particles.
- Activation energy of particles will increase; thus, increasing its ability to break the bonds between each particle, which at the same time will also increase the chances of collision between particles.

### Concentration

Increasing the concentration in a chemical reaction will increase the chances of collision between particles, which in return will also increase the rate of reaction between reactant.



Concentration or pressure indicates the number of particles per unit volume. Particles will collide more frequently when there are more particles per unit volume. Here are several ways you can increase the concentration of the particles in a chemical reaction.

1. Increasing the concentration or the number of particles use in a mixture or a solution.
2. Increasing the pressure in gaseous chemical reaction by adding more gas particles
3. increasing the pressure in gaseous chemical reaction by decreasing the volume or space the particles can move in.

### **Particle size**

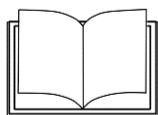
Suppose you have a block, chunks, and shredded pieces of wood. Which will burn faster? The shredded wood will burn faster compared with the chunks and the block of wood. This shows that when the reactant is small in size, it has an increase surface area to volume ratio which will increase the collision between each reactant particles.

### **Stirring rate**

Stirring increases the movement of particles which will increase collision between particles.

### **Light Intensity**

Some chemical reactions are affected by the amount of light they are exposed to. These reactions when place under a light reacts faster than those that are place in the dark.



## **What's More**

### **Activity 1.2. Effect of temperature and particle size on the rate of reaction**

At the end of this activity the students should be able to;

1. understand that factors such as the change in temperature and particle size can hasten or slow down the rate of reaction;
2. compare the effects of temperature and particle size in the rate of reaction; and
3. explain how increase in temperature and size affect the rate of reaction.

Reagents:

- 3 pcs. of effervescent tablets (ex. Berroca Tablet)
- room temperature water
- warm water
- cold water

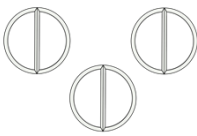
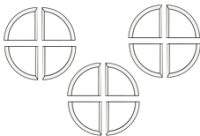

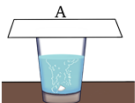

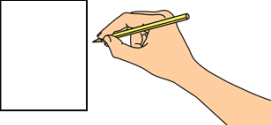
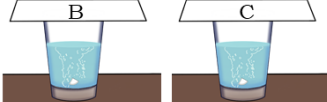
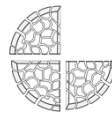



### Materials:

- 3 pc of a transparent cup/ glass with cover
- Tissue paper
- timer

### Procedure:

1. Divide the 3 effervescent tablets into four pieces. By now you have 12 pieces of the tablet.
2. In the 3 cups/ glasses pour water with different temperatures. Label each A. cold water, B. room temperature water, C. hot water
3. Carefully place 1 piece of the effervescent tablet in cup A then quickly cover
4. Time the reaction from the start until it stops.
5. Record the time of reaction in the table given below.
6. Repeat procedure 3 to 5 for cup B and C
7. Discard the solution and clean the cup with tissue paper.
8. Break 3 of the  $\frac{1}{4}$  effervescent tablet into smaller pieces then repeat procedure 2 to 7.
9. Grind 3 of the  $\frac{1}{4}$  effervescent tablet into a powder then repeat procedures 2 to 7.

 Three effervescent tablets	 1. Divide the 3 effervescent tablet into four pieces	 2. In the 3 cups/ glasses pour water with different temperatures. Label each A. cold water, B. room temperature water, C. hot water
 3. Carefully place 1 piece of the effervescent tablet in cup A then quickly cover	 4. Time the reaction from the start until it stops.	5. Record the time of reaction in the table 
 6. Repeat procedure 3 to 5 for cup B and C 7. Discard the solution and clean the cup with tissue paper.	 8. Break 3 of the $\frac{1}{4}$ effervescent tablet into smaller pieces then repeat procedure 2 to 7.	 9. Grind 3 of the $\frac{1}{4}$ effervescent tablet into a powder then repeat procedures 2 to 7.

### Data gathering: Rate of Reaction

Tablet	Time		
	Cold Water	Room Temperature	Cold Water
$\frac{1}{4}$ chunk		$\frac{1}{4}$ chunk	
Small bits and pieces		Small bits and pieces	
Grinded powder		Grinded powder	

Conclusion: Draw your conclusion from the data you gathered above.



## What I Have Learned

### Activity 1.3

Fill in the blanks by writing word/s that will best complete each sentence.

1. Collision theory describes the \_\_\_\_\_ of a chemical reaction.
2. For a chemical reaction to occur the particles must collide and with \_\_\_\_\_ energy to be able to rearrange the bonds between reactant particles.
3. Activation energy is the \_\_\_\_\_ of energy colliding particles must have in order to react.
4. The rate of reaction measures the \_\_\_\_\_ of particles that react in a given time to form products.
5. The rate of reaction can be increased by increasing the \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ of the collisions.
6. The smaller the particle size, the greater the \_\_\_\_\_, which will result in an increase in the reaction rate.
7. Increasing the temperature will increase the \_\_\_\_\_ of particles, which will result in an increase in movement and collision.
8. Increasing the concentration of reactants means you are increasing the \_\_\_\_\_ of particles of a given sample of a substance.
9. Constantly stirring a chemical mixture will increase the \_\_\_\_\_ of particles which will also increase the number of collisions.
10. Placing a chemical reaction under a strong light intensity will \_\_\_\_\_ the rate of reaction.



## What I Can Do

### Activity 1.4

Read and analyze each scenario listed below. Write your answer on a separate sheet of paper.

1. Your parents went to the market and bought a one-week supply of meat and fish. But your refrigerator is not working. How can you prevent these foods from spoilage? Explain your answer.
2. It is 3:00 in the afternoon, and you want to drink a cup of coffee. When you went to the kitchen, you have found out that there is no available instant coffee, only coffee beans. How would you make a cup of coffee using this coffee beans? Explain your answer.
3. In number two, if you are going to put sugar in your coffee, which kind of sugar will you use, sugar in a cube, or fine sugar? Explain your answer.

4. Which will neutralize a given amount of acid faster, one tablet of antacid or two tablets of antacid? Explain your answer.
5. Which would make a marble erode faster, acid with higher concentration, or with lower concentration? Explain your answer.



## Assessment

Read the question carefully and encircle the letter of the correct answer.

1. What does the collision theory tell us?
  - A. It tells us that particles of matter collide constantly to one another.
  - B. It tells us that the collision of particles increases as the kinetic energy of molecules increase.
  - C. It tells us that in a chemical reaction reactant and product must collide for a chemical reaction to happen.
  - D. It tells us that in order for a chemical reaction to occur the reactant particles must collide effectively to one another.
2. How does a chemical reaction occur?
  - A. Collision of particles must effectively occur.
  - B. Right orientation of particles of reactant must occur.
  - C. There should be two or more reactants use in the chemical reaction.
  - D. Both A and B is correct.
3. What is activation energy?
  - A. It is the energy that changes the temperature of the reactants.
  - B. It is the energy required to start the reaction between particles of the reactants.
  - C. It is the energy of particles that activate the change of potential energy to kinetic energy.
  - D. It is the minimum energy required for a particle to start the process of chemical reaction.
4. Which among the following quantities can affect the rate of reaction?
  - A. Distance
  - B. Pressure
  - C. Temperature
  - D. Time
5. How can you increase the rate of reaction?
  - A. Decrease kinetic energy.
  - B. Add more reactant particles.
  - C. Increase the size of the particles.
  - D. Leave the experimental setup undisturbed.





## Additional Activities

In this activity you will be able to:

1. Describe how rust occurs.
2. Discuss conditions that increases the rate of rusting in metals.
3. Identify and explain some ways to prevent rusting in metals.

Materials:

6 pcs of 2 x 2 inches of steel wool pads

Salt

Water

Vinegar

2 of the following

a. clear fingernail polish

c. furniture polish

b. spray-on car wax

d. vegetable oil

6 small jars or containers

Procedure:

1. label your jars A to F.
2. In jar A, pour in  $\frac{2}{3}$  cups of regular water. Place a piece of steel wool inside.
3. In jar B, pour in  $\frac{2}{3}$  cups of salt and water solution. Place a piece of steel wool inside.
4. In jar C, pour in  $\frac{2}{3}$  cups of vinegar and water solution. Place a piece of steel wool inside.
5. "Pre-treat" your steel wool pads by coating them in any of the following: clear nail polish, spray-on car wax, vegetable oil, and furniture polish.
6. In jars D and E, pour in  $\frac{2}{3}$  cups of regular water. Place your pretreated pieces of steel wool inside each jar. Make sure you label what substances you use to pretreat your steel wools.
7. In jar F, place a piece of steel wool inside. This is your control variable.
8. Inspect the steel wool pads from day 1 to day 5. Take pictures of the pads.
9. Record and rank the experimental variables in jars A to C according to which rusted first, second, and third.
10. Identify which pre-treatment solution (jars D and E) works best in slowing down the formation of rust.

Post laboratory questions:

On a separate sheet of paper, answer the following questions.

1. Which setup rusted first A, B, or C? Which is last?
2. What do you think is the reason behind your answer in number 1?
3. How does rust form?
4. Which setup shows slow rusting of the steel wool D or E? What do you think is the reason behind your answer?
5. How can you prevent rusting?



## Lesson 2

## Catalyst



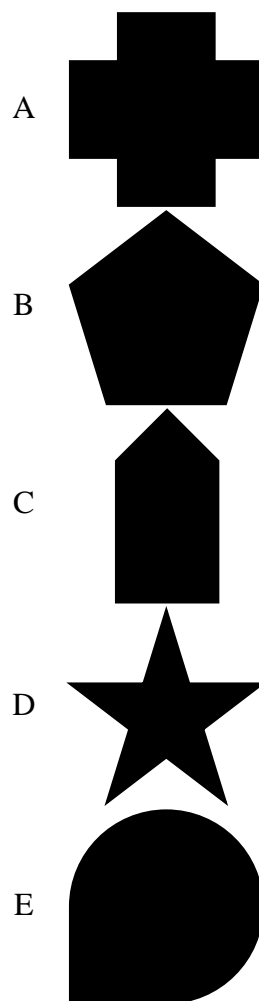
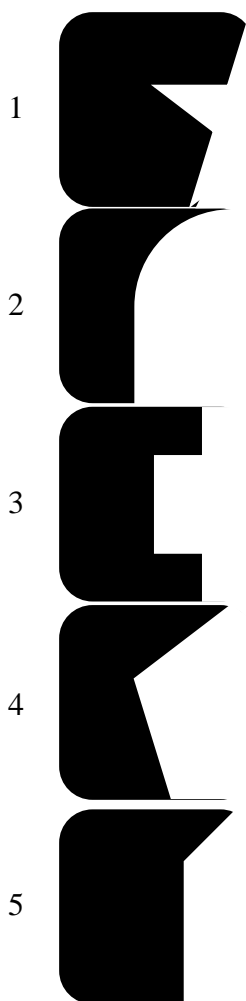
As mentioned in the previous lesson one of the factors that can influence the rate of reaction is by the use of a catalyst. **Catalyst** are substances that can be used to change the rate of the reaction without being consumed during the process. Thus, it would not change the desired products afterward.



When you were young, you probably have a shape-sorter toy. This activity will help you to remember that game which would help you to understand the mechanism of catalyst.

### Activity 2.1. Match them up!

Match the shape and the corresponding hole where it would likely to attach.





# What Is It

## Mechanism of Reactions

As mentioned, in order for a chemical reaction to happen, collisions of reactant particles should occur effectively. But not all collisions are effective collisions. This is because reactant particles in a given sample of a substance have different amount of kinetic energy and that only a small number of the particles have the activation energy and the right orientation to break bonds so that a chemical reaction can take place. As shown in figure 2.1

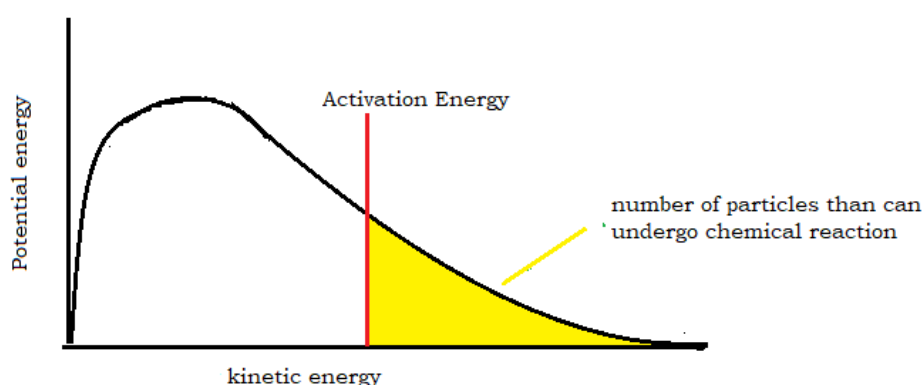


figure 2.1. kinetic energy of particles at a constant temperature.

Increasing the temperature of the reactants will increase the number of particles that have the activation energy and orientation needed for the chemical reaction to occur. As shown in figure 2.2.

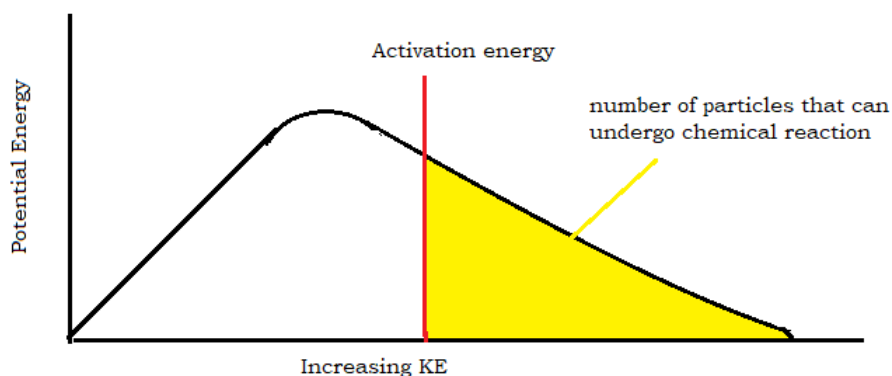


figure 2.2. kinetic energy of particles at an increasing temperature.

## Types of Chemical Reaction

### Endothermic Reaction

An endothermic reaction is a chemical reaction that absorbs heat from its environment. The absorbed energy provides the activation energy for the reaction to occur. Figure 2.2. shows that in an endothermic reaction the energy of the reactants X and Y is less than the energy of the product Z. This implies that at the end of the chemical reaction the products temperature is greater than that of the reactants.

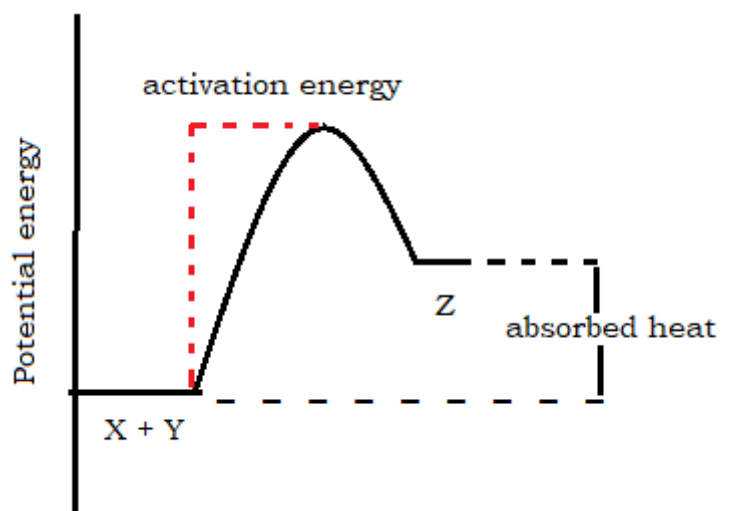


Figure 2.2. Endothermic activation energy diagram

### Exothermic Reaction

An exothermic reaction is any chemical reaction that releases heat to the environment. Figure 2.3. shows that in an exothermic reaction the energy of the reactants X and Y is greater than the energy of the product Z. This implies that at the end of the chemical reaction the products temperature is less than that of the reactants.

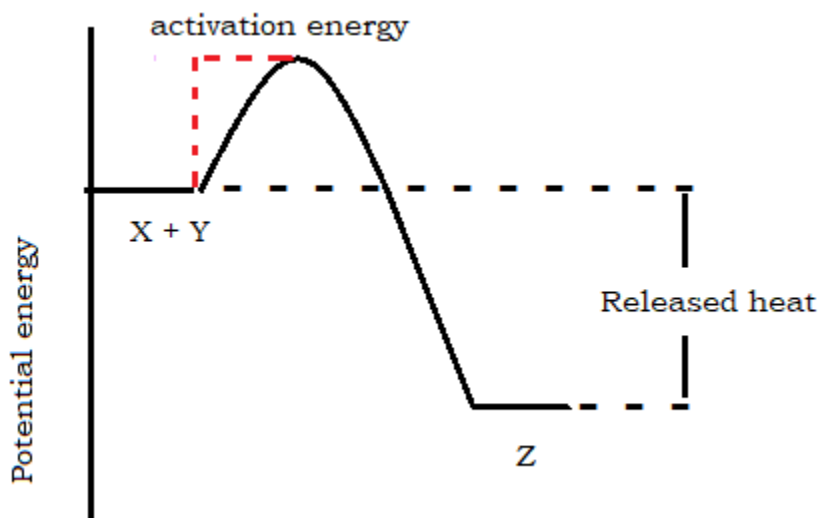


Figure 2.3. Exothermic activation energy diagram



## What are catalysts?

**Catalysts** are substances that create an alternative path of reaction that changes the reaction rate. It could be a solid, liquid, or gas. A catalyst increases the rate of a chemical reaction and is not consumed during the reaction; thus, it does not change the product of the reaction. The chemical and physical property of a catalyst remains the same at the end of a chemical reaction.

There are two major types of catalyst, homogeneous and heterogeneous catalyst. **Homogeneous catalysts** are catalysts that is in the same state or phase with the reactants. Example if the reactants are in liquid form the catalyst is also in liquid form. **Heterogeneous catalysts** are catalysts that is in different state or phase with the reactants. Example if the reactants are in liquid form the catalyst is in solid form.

## Catalyzed vs Uncatalyzed Reaction

The amount of product of both reaction is the same but the speed of the process of reaction is different. Catalyzed reactions produce the same amount of product but at a faster rate.

For a catalyst to increase the speed of the reaction it has to lower the activation energy, or the minimum amount of energy needed to start a chemical reaction. A catalyst can lower the activation energy use in a reaction by:

- Rearranging the orientation of the particles in a reactant in such a way that breaking their bonds would be easier.
- Forming an intermediate reactant called activated complex.

Note that catalyst does not increase the number of collision rather it increases the number of effective collision of reactant particles at a lower activation energy. As shown in figure 2.4.

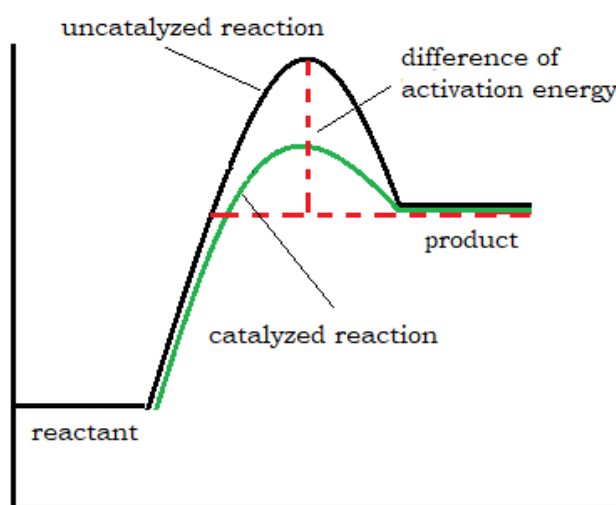
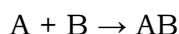


Figure 2.4. Progress of Reaction

## Steps of uncatalyzed reaction

Given the following reactants A and B to yield product AB, the following steps are followed in an uncatalyzed reaction.

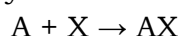
A reacts with B to form AB



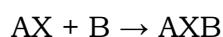
## Steps of catalyzed reaction

Given the following reactants A and B, adding a catalyst X will yield the product AB and X.

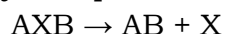
Step 1. Catalysts X is added to Reactant A to form AX



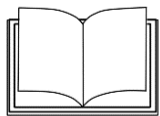
Step 2. AX reacts with reactant B to form AXB



Step 3. AXB yields product AB and X



In the second step the reaction between AX and reactant B form AXB which is known as the **activated complex**. This activated complex is an intermediate structure formed that will eventually yield the product of a chemical reaction. In this case you might have observed that the catalyst change during the process of the reaction, but at the end of the process of chemical reaction it will return to its original state.



## What's More

### Activity 2.2. Catalytic reaction

At the end of this activity the students are expected to:

1. Identify the reactant/s, catalyst/s, and product/s involved in this simple experiment
2. Demonstrate a simple catalytic reaction.
3. Explain the process of a simple catalytic reaction.

Materials:

- |                      |                                 |
|----------------------|---------------------------------|
| 1. Hydrogen peroxide | 3. Toothpick                    |
| 2. Yeast             | 4. Small transparent cup/ glass |

Procedure:

1. Measure 10 ml of hydrogen peroxide and pour it into a cup. Observe for a few seconds.
2. Add a 0.1 g or a pinch of baker's yeast into the cup with a hydrogen peroxide. Stir gently with a toothpick.
3. Observe what happens.

### Post laboratory questions

In a separate sheet of paper answer the following.

1. Which substance did you used as your reactant? Which is the catalyst?
2. What did you observed while the reaction process is taking place? Draw your experimental setup.
3. What type of chemical reaction did you observed? Synthesis or decomposition reaction? Explain your answer.
4. What is the product/s of this chemical reaction?
5. Why is there no observable change in step 1? Without the baker's yeast, will the chemical reaction still happen? Explain your answer.



## What I Have Learned

### Activity 2.3

Fill in the blank with word/s that will best complete the following sentences.

1. Catalyst increases the rate of reaction by \_\_\_\_\_the activation energy needed to start a chemical reaction.
2. Besides an effective collision, \_\_\_\_\_orientation of the reacting particles must also be present in order for a chemical reaction to occur.
3. If a homogeneous catalyst is used in a chemical reaction it means that the reactants and the catalyst is in the same \_\_\_\_\_.
4. If you used a gaseous reactant and a solid catalyst, this means the catalyst you used is a \_\_\_\_\_.
5. A catalyst does not increase the collision of reacting particles rather it increases the \_\_\_\_\_of the collisions.
6. An endothermic reaction is a chemical reaction that \_\_\_\_\_heat from its environment.
7. In an endothermic reaction the energy of the reactants is \_\_\_\_\_than that of the product.
8. In an exothermic reaction the energy of the reactants is \_\_\_\_\_than that of the product.
9. The amount of yield produced in an uncatalyzed reaction is \_\_\_\_\_that of a catalyzed reaction.
10. A catalyst provides an alternative pathway for the reaction by forming a substance that would produce the desired product. This substance is called\_\_\_\_\_.



## What I Can Do

### Activity 2.4

Research how catalysts are used in industry, agriculture, or in medicine. In your journal notebook write a short report summarizing your findings on how catalysts are used in one of this application. You may use the rubric below as your guide in writing your report.

Title of your paper: Role of catalysts in \_\_\_\_\_.

Grading Criteria	5	4	3	2
Content	Content and explanations are very comprehensive: All parts of a journal are evidently seen and well written	Contents and explanation are comprehensive: All parts of a journal are evidently seen.	Content and explanations lack details: Some parts of a journal are missing.	Content and explanation are unclear and irrelevant to the topic
Organization of thoughts and ideas.	Ideas are logically structured.	Ideas are structured.	Ideas are slightly unstructured.	Ideas is discussed randomly
Mechanics of writing	Flawless spelling and punctuation.	Few or no spelling errors; some minor punctuation mistakes.	Several spelling and punctuation errors.	Many instances of incorrect spelling and punctuation.



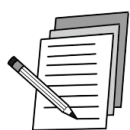
## Assessment

Read the question carefully and encircle the letter of the correct answer.

- What is the relationship of reaction rate in a particular chemical reaction?
  - Reaction rate tells us how long the reaction will last.
  - Reaction rate tells us how fast the chemical reaction will end.
  - Reaction rate tells us the amount of product that will be produced after the chemical reaction ends.
  - Reaction rate tells us that the number of reactants dictates how fast the chemical reaction will be.



2. When does the collisions between two reacting particles do not result in the formation of the product?
  - A. When there is not enough concentration of reactant particles.
  - B. When energy between particles is very low, collision of particles cannot happen.
  - C. When there is not enough number of particles that can collide with one another.
  - D. When there is unequal energy of particles, some collision just bounces off from one another.
  
3. How does a catalyst help in increasing the rate of reaction?
  - A. It decreases the concentration of reactants.
  - B. It increases the number of collision between particles.
  - C. It increases the activation energy of the reacting particles.
  - D. It decreases the activation energy of the reacting particles.
  
4. What is the difference between endothermic and exothermic reaction?
  - A. In endothermic reaction the energy of reactants is less than that the energy of the products.
  - B. In endothermic reaction the energy of reactants is greater than the energy of the products.
  - C. In endothermic reaction heat is released after the reaction while in exothermic reaction heat is absorbed during reaction.
  - D. In endothermic reaction the temperature of the reactant is less than the temperature of the reactant in endothermic reaction
  
5. What is an activated complex in a chemical reaction?
  - A. It provides an alternative pathway for the reaction.
  - B. It is a substance produced at the end of the reaction.
  - C. It is a structure that is consumed during the reaction of the reactants.
  - D. It is a structure formed from the combination of a catalyst and a reactant.

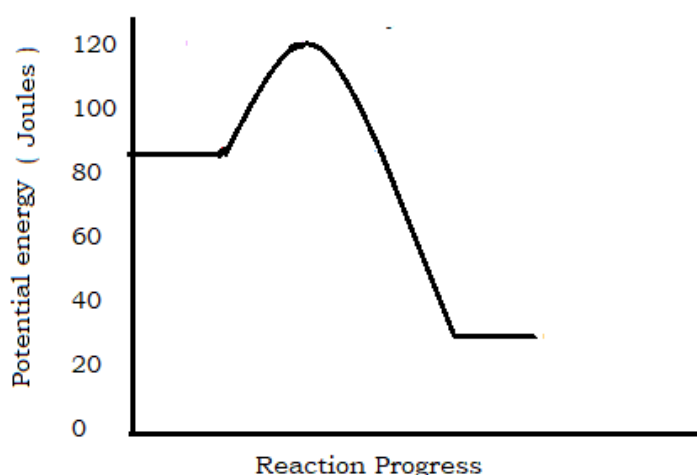


## Additional Activities

On a separate sheet of paper, use the chemical reaction progress graph below to answer what is ask in the following numbers.

1. Label the reactant, product, and activation energy.
2. Draw and label what would the graph look like if a catalyst is added to the chemical reaction.
3. Compare the energy of the reactant and product after the reaction is completed.
4. How much energy is needed to activate the uncatalyzed reaction?
5. How much energy is needed to activate the catalyzed reaction?

6. Is the reaction endothermic or exothermic? Explain your answer.



## Posttest

Read the question carefully and encircle the letter of the correct answer.

- Which of the following conditions will decrease the rate of reaction?
  - The size of the particles is big
  - The mixture is constantly stirred
  - The partial pressure is increased
  - The volume of the container is decreased
- Which of the following should happen in order for a chemical reaction to occur?
  - The reacting particles should collide with each other.
  - The reacting particles have sufficient energy to break the bonds between particles.
  - The reacting particles should be in an orientation favorable for breaking the bonds between each particle.
  - all of the above
- The following factors can affect the rate of chemical reaction EXCEPT \_\_\_\_\_.
  - size of the particle
  - concentration of particles
  - the number of reactants use
  - light intensity the mixture is exposed to
- The following are factors that can influence the rate of reaction EXCEPT \_\_\_\_\_.
 

<ol style="list-style-type: none"> <li>volume</li> <li>temperature</li> </ol>	<ol style="list-style-type: none"> <li>surface area</li> <li>concentration</li> </ol>
---	---

5. When the temperature is increased in a chemical reaction, the following will happen EXCEPT\_\_\_\_\_.
  - A. increase in the size of particles
  - B. increase in kinetic energy of particles
  - C. increase in the number of collisions between particles
  - D. increase the reaction rate in both endothermic and exothermic reaction
  
6. Which of the following statements best describes the rate if a chemical reaction?
  - A. It is the volume in which the reactant particles can occupy.
  - B. It is the speed in which the reactants are converted into a product.
  - C. It is the amount of temperature needed to start a chemical reaction.
  - D. It is the pressure exerted by the reactants during the process of chemical reaction.
  
7. What do you call the minimum amount of energy required for a chemical reaction to occur?
 

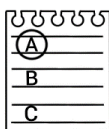
A. Kinetic energy	C. Exothermic energy
B. Activation energy	D. Endothermic energy
  
8. What will happen if you increase the concentration of the reactants?
  - A. The surface area where particles can easily move in will increased.
  - B. The speed of the movement of each particles will be increased.
  - C. The pressure exerted by each particles to one another will increase.
  - D. The number of collisions between particles of the reactant will increased.
  
9. Catalysts generally react with one or more of the reactants to form a structure, which then reacts to form the final product. What do you call this structure?
 

A. activated catalyst	C. activated reactants
B. activated complex	D. activated products
  
10. The following statements are true about a catalyst EXCEPT\_\_\_\_\_.
  - A. is unchanged chemically
  - B. does not alter the products of the reaction
  - C. has the same mass at the end of the reaction
  - D. none of the above is false
  
11. Which of the following best describes a catalyst?
  - A. Increases the activation energy of reacting particles.
  - B. Adds to the concentration of the reactants in a chemical reaction.
  - C. Increases the temperature of reacting particles in chemical reaction.
  - D. Speeds up the process of a chemical reaction, without being consumed.



12. The reactants, in an endothermic process, have \_\_\_\_\_.  
A. no energy  
B. less energy than the products  
C. more energy than the products  
D. the same energy as the products
13. What happens to the temperature of the product in an exothermic reaction?  
A. The temperature of the product is increased.  
B. The temperature of the product is decreased.  
C. The temperature of the product is the same as the reactants.  
D. Information is incomplete that is why the temperature cannot be determined.
14. The reactants, in an exothermic process, have \_\_\_\_\_.  
A. no energy  
B. less energy than the products  
C. more energy than the products  
D. the same energy as the products
15. What happens to the temperature of the product in an endothermic reaction?  
A. The temperature of the product is increased.  
B. The temperature of the product is decreased.  
C. The temperature of the product is the same as the reactants.  
D. Information is incomplete that is why the temperature cannot be determined.





## Lesson 1

### What's New

Slow moving particles – ranks 1, 2, and 3

Fast moving particles – ranks 1, 2, and 3

Guide Questions:

1. Because fast moving particles move fast, they have more probability of colliding with one another.
2. The more the number and the faster the speed of particles in given sample of a substance the more frequent they will collide with each other.

### What's More

Answers may vary

### What I Have Learned

- |                                  |                   |
|----------------------------------|-------------------|
| 1. Rate of reaction              | 6. surface area   |
| 2. sufficient/ enough            | 7. kinetic energy |
| 3. minimum amount                | 8. number         |
| 4. number of particles           | 9. movement       |
| 5. effectivity, force, frequency | 10. increased     |

### What I Can Do

Answers may vary

### Additional Activity

Answers may vary

## Lesson 2

### What's New

1. D
2. E
3. A
4. B
5. C

### What's More

Answers may vary

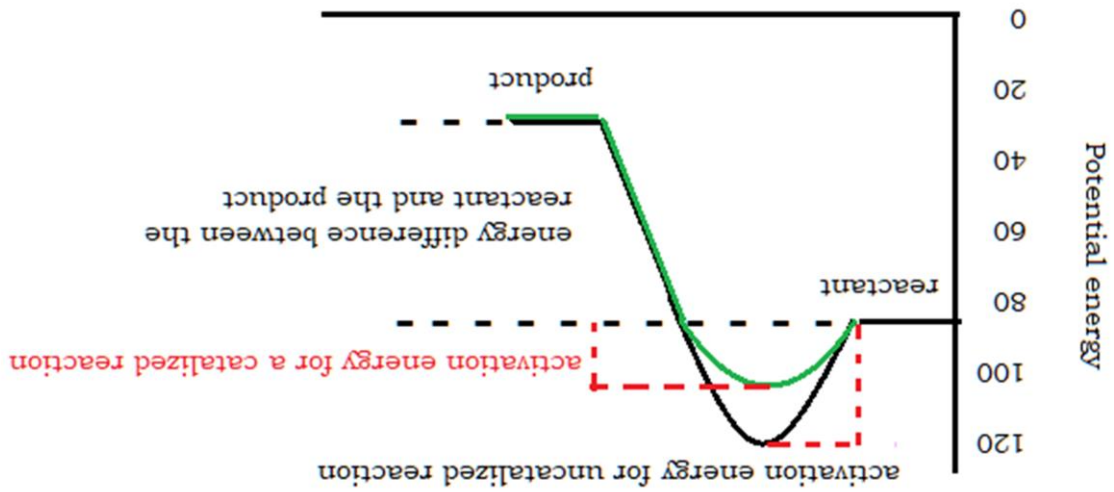
### What I Have Learned

1. Decreasing
2. Right/ correct
3. State/phase
4. Heterogeneous catalyst
5. Effectivity

### What I Can Do

Answers may vary

### Additional Activity



1. The energy of the reactant at the start of the reaction is roughly 90 J while the energy of the product is only 30 J
2. 120 J
3. 100 J
4. Exothermic because the decrease in energy is the result of the released of heat to the environment



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