Catalyst in a Box

Introduction

Catalysts are involved in many reactions and increase the rate of the reaction without being consumed during the reaction. This important function is easily demonstrated using inexpensive classroom materials.

Concepts

- Kinetics
- Catalysts
- Energy of activation
- Reaction rate

Materials

Chalk, one box*
Paper, dark-colored, 2 sheets
Shoe box with lid
Weight, rock or other small, heavy object

**If chalk is not readily available, use any other fragile, inexpensive items such as breakfast cereal, crackers, pretzels, etc.*

Safety Precautions

This activity is considered nonhazardous. Follow all normal laboratory safety guidelines.

Procedure

1. Show students one piece of chalk and explain that one piece of chalk represents a very large organic molecule, similar to the molecules found in heavy crude oil. The goal of this demonstration is to break the very large molecule into smaller molecules that will be more usable in future manufacturing processes [see *Discussion*].
2. Remove half of the pieces of chalk from their box and place them in a shoe box.
3. Place the lid on the shoe box.
4. Grasp the box with both hands (so the chalk does not fly out) and vigorously shake the box for 15 seconds.
5. Open the box and pour the "products" onto a piece of dark paper.
6. Have the students examine the "products" and observe how well the reaction occurred.
7. Place the remaining whole pieces of chalk in the empty shoe box.
8. Also place a "catalyst" in the box with the chalk. The catalyst can be a rock, weight, or any other unbreakable, heavy object.
9. Close the box, grasp the box firmly with both hands, and shake for 15 seconds.
10. Open the box and remove the catalyst—show that the catalyst is unchanged.
11. Pour the "products" onto a second piece of dark paper.
12. Have the students compare the products from the first reaction with the products from the catalyzed reaction and ask the following questions.

Which reaction went faster and/or further? *(The one with the catalyst.)*

What if the first reaction was shaken longer (a longer reaction time), would both products look similar? *(Yes)*

Does the catalyst change the reaction products, or just speed the reaction up? *(Speeds it up.)*

Has the catalyst changed? *(No)*

Can the catalyst be used again and again? *(Yes)*

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The chalk pieces may be disposed of according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, conservation of energy and increase in disorder

Discussion

A catalyst increases the rate of a reaction by lowering the activation energy of the reaction. The reduction of the activation energy is due to the catalyst interacting with the reactants or a reactive intermediate to provide an alternative reaction pathway. This alternative reaction pathway has a lower activation energy than the non-catalyzed reaction and this increases the rate of the reaction. The catalyst does not affect the relative energies of reactants and products, only the activation energy and the rate of the reaction (see Figure 1).

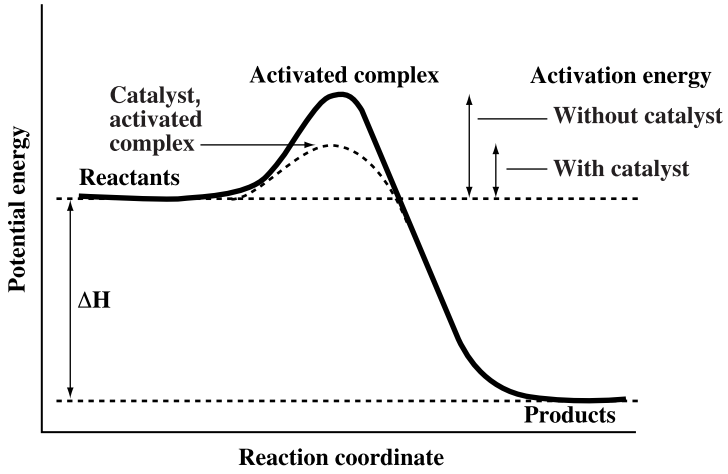

Figure 1.

This demonstration also simulates a very common petrochemical process called cracking. Crude oil contains very high molecular weight, non-volatile organic molecules that are not usable as gasoline. The refinery breaks these molecules down to lower-molecular weight, volatile, organic compounds that are suitable for gasoline and plastics production. The use of catalysts increases the cracking efficiencies of this process.

Tip

- For more labs and activities on catalysts and reaction rates, purchase the *Flinn ChemTopic™ Labs*, Volume 14, *Kinetics* (AP6369).

Acknowledgment

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