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Demonstration Model of an Organic Catalyst

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DEMONSTRATION MODEL OF AN ORGANIC CATALYST

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Introductory high school biology courses generally include a discussion of enzymes. Enzymes, commonly defined as biological catalysts, speed up biochemical reactions and are involved in nearly every biochemical process that occurs in a living organism. Many texts currently being used provide diagrams of enzyme action and a discussion of the "lock and key fit" of enzyme and substrate. Laboratory manuals accompanying these texts frequently indicate the usefulness of the chewed cracker experiment to demonstrate the presence and action of salivary amylase. Though this experiment uses an enzyme, it does not always accomplish the desired result — to enable the students to understand the catalytic action of an enzyme.

A very simple and effective alternative is the sugar cube exercise described here. Though it does not use an enzyme, this investigation does illustrate the function of a catalyst in a chemical reaction.

Students will need the following materials:

- 2 sugar cubes (as used in coffee)
- small quantity of finely divided ash (cigarette ash works very well)
- 3 watch glasses
- several matches
- several wood splints
- 3 pieces of fine wire

Direct the students to rub ash thoroughly into all surfaces of one sugar cube.

Next they must tie a wire (Fig. 1) around each of the sugar cubes and bend the third wire (Fig. 1) so as to hold a bit of ash. If fine metal screening is available, small pieces may be substituted for the wires.

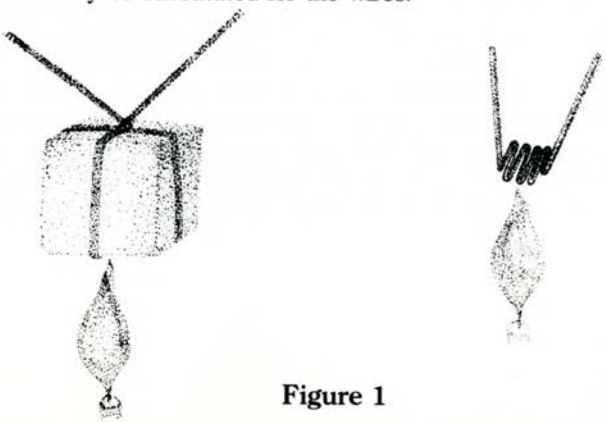

Figure 1

Students should hold the sugar cube without ash above a watch glass and then place a lighted splint under the cube. The heat will cause the cube to melt and caramelize and drip into the watch glass without any sign of combustion.

The sugar cube with ash rubbed into its surface should then be held over a watch glass and a lighted splint placed under it. This cube will burn with a blue-green flame until the sugar is completely consumed.

As a control, the combustion of a small mass of ash should also be attempted. When it becomes obvious that the ash will not burn, students should be asked to explain their results.

The heat provided by the burning splint is adequate to melt (phase change) and to caramelize (chemical change) the sugar. The ash will not ignite, which indicates that it contains no combustible materials, but it can act as a catalyst. The catalytic effect causes the second cube to ignite. Though a complete explanation of activation energy and the lowering of it by a catalyst may not be needed, an introduction to these concepts could prove useful. A graph similar to Fig. 2 could be used to illustrate the energy needed to burn the cube with and without the catalyst. This can be explained as a lowering of the "activation energy" for this reaction.

Though some may argue that this explanation is too detailed for a high school biology class, it is important that students have a grasp of the relationship between biology and chemistry, as well as an honest explanation of the processes being investigated. This illustration is extremely simple and may be completed in one 45-minute class period. It uses common substances, is quickly prepared and the results are easily discussed by students. From this point, a logical extension might be the discussion of the catalytic effects of enzymes and their role in a biological system.

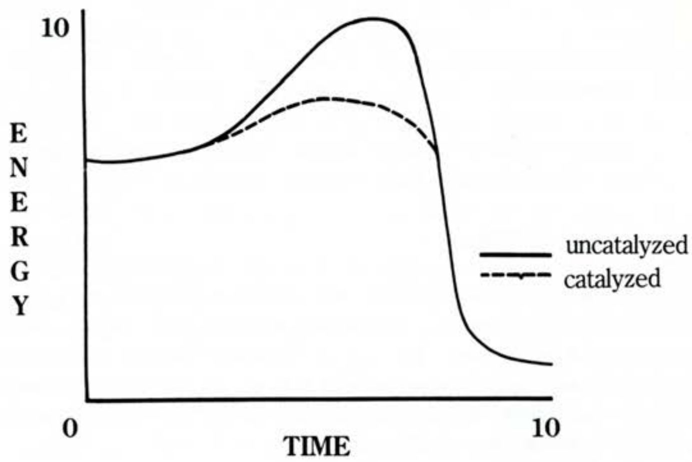

Figure 2

This graph represents a typical energy of reaction curve for a chemical reaction involving a catalyst. The units are arbitrary in this example as they serve only to indicate the trends in the process.