Shapes of Carbon Compounds

Molecular Geometry

Introduction

The tetrahedral shape or molecular geometry around carbon atoms in organic compounds is not a familiar structure to most students. Many students have difficulty visualizing structures of molecules in three dimensions. Building a paper model of a tetrahedron and placing a molecular (ball-and-stick) model of methane (CH_4) into the tetrahedron can help students to understand the relationship between chemical bonding and molecular geometry.

Concepts

- Organic chemistry
- Molecular geometry
- VSEPR theory

Materials

Acetate transparencies, 8.5″ × 11″, 1 sheets
Card stock or cardboard, 8.5″ × 11″, 3 sheets
Compass
Metric ruler
Molecular model set
Scissors
Tape, transparent

Safety Precautions

The materials in this activity are considered nonhazardous. Please follow all normal classroom or laboratory safety guidelines.

Procedure

1. Draw an equilateral triangle, 15 cm to the side, onto each of three pieces of card stock and onto an acetate sheet.
2. Bisect (mark the midpoint on) each of the sides of the equilateral triangles and draw lines joining the midpoints of pairs of sides on each triangle. See Figure 1.
3. Cut out each equilateral triangle and lightly score the internal lines in each triangle. Fold and tape the resulting figure to form a tetrahedron.
4. Build two "ball-and-stick" models of a methane molecule (CH_4) using a molecular model set.
5. Place a methane molecule (model) into an open card-stock tetrahedron. Notice how the methane molecule fits inside the tetrahedron.
6. Place a methane model inside the transparent (acetate) tetrahedron to make the effect even more evident.

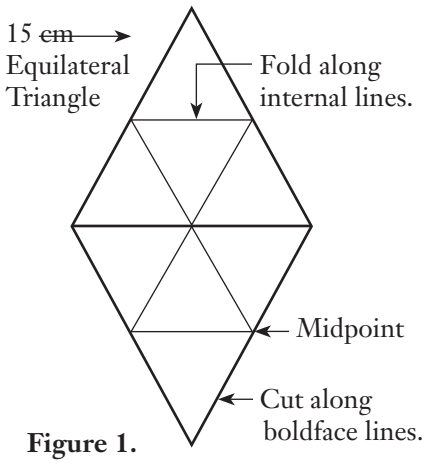

Figure 1.

7. Pairs of tetrahedral card-stock structures can be used to illustrate the shapes of organic compounds having two carbon atoms, including ethane (C_2H_6), ethylene (C_2H_4), and acetylene (C_2H_2).

Tips

- To show the relationship between tetrahedral and cubic structures, draw the outline of an expanded (opened up) cube on a sheet of card stock or an acetate transparency (use the following outline as a guide). The length of the side of the cube should be 5.3 cm, so that the diagonal of the side of the cube will be 7.5 cm.

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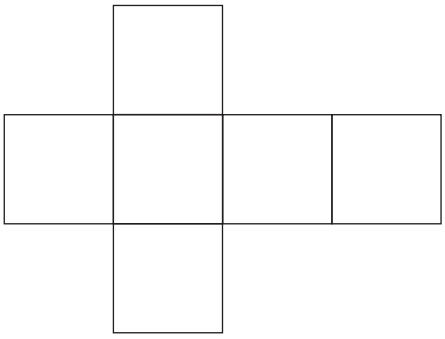

5.3 cm

- Cut out the outline of the cube, score the internal lines, and fold the figure to form a cube.
- Place one of the models of a tetrahedron into the cube. Notice that the tetrahedron is formed by joining the opposite corners of a cube. This illustrates the relationship between tetrahedral and cubic structures.

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter
Content Standard G: History and Nature of Science, nature of scientific knowledge

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Shapes of Carbon Compounds* activity, presented by Irwin Talesnick, is available in *Molecular Geometry* and in *Structures of Organic Compounds*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Shapes of Carbon Compounds* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP5454	Organic Teacher Model Set

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.