Carbon-Carbon Multiple Bonds: Structure and Function

A Carolina Essentials™ Activity

Student Worksheet

Background

Structure and function are closely related. You can see evidence of this in many of the products you encounter daily. Look at the collage below.

MATERIALS

Molymod® Molecular Model Set

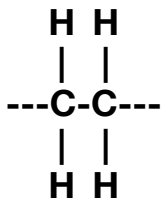
Colored pencils

Phenomenon

All these items are made from the same basic unit, ethylene. What do you think allows for the wide variety of properties among the materials?

Ethylene is an organic compound that consists only of carbon and hydrogen. In fact, it is one of a series of three 2-carbon compounds in which the ratio of carbon to hydrogen changes. The first compound in the series is **ethane**. The formula for ethane is C_2H_6. Ethane is considered saturated because it contains the maximum number of hydrogen bonds possible, and the carbon-to-carbon bond is a single bond.

If 2 hydrogens are removed from ethane, a double bond forms between the 2 carbons, yielding the molecule **ethene**, with the formula C_2H_4. Two more additional hydrogens can be removed, resulting in a triple bond between the carbons. Now the formula is C_2H_2 and the name of the molecule is **ethyne**. This activity allows you to see the structural changes that take place as hydrogens are removed and multiple bonds form.



Where does ethylene fit in the series? Ethene, C_2H_4, can be forced to break its double bond without adding the 2 hydrogens, making the monomer ethylene. Ethylene is a reactive species that bonds with other ethylene monomers, which results in the polymer polyethylene.

Monomers can bond to each other where the electrons from the double bond are no longer paired, (dotted lines), resulting in polymers that may be a few to tens of thousands of units long.

Can you think of another possible structure for the ethylene monomer? Sketch it below.

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As you saw in the phenomenon collage, polyethylene can take the form of a flexible foam, a stretchy film, or a rigid solid with varying degrees of hardness. Polyethylene products are real-world examples of the way molecular structure influences function.

Essential Question

Why is the molecular-level structure important in the functioning of designed materials?

Activity Objectives

1. Build models, then describe how double and triple carbon-to-carbon bonds change the structure of ethane.
2. Using the monomer ethylene, design 3 polymer molecular structures and explain how the structure may influence properties and functions.

Activity Procedures

1. Build a model of the **ethane molecule C_2H_6**. All valence level electrons are accounted for in bonds.
2. Make a 3-dimensional sketch of the model.
3. Build a model of the **ethene molecule C_2H_4**. All valence level electrons are accounted for in bonds.
4. Make a 3-dimensional sketch of the model.
5. Build a model of the **ethyne molecule, C_2H_2**. All valence level electrons are accounted for in bonds.
6. Make a 3-dimensional sketch of the model.
7. Design polyethylene structures that would function as a foam, film, and rigid solid. To simplify your design, use 10 to 15 monomers of ethylene. See the monomer structure for ethylene in the background section.

Data and Observations

Ethane

Ethene

Ethyne

Polyethylene

Continued on next page.

Analysis and Discussion

1. Moving from ethane to ethyne, describe what happened to the ratio of carbon atoms to hydrogen atoms and how the change affected the structure of the molecule. You may insert your diagrams as evidence of changes.

2. In a well-written statement, explain why each of your polyethylene structures will function as a foam, film, or rigid solid.

3. Check your design skills. Research the types of polyethylene and their structures and uses. Write a detailed explanation of at least 3 types. Evaluate the design of your ethylene polymers for structure and function based on your research.