Carbon Builds Molecules

How four bonds create different organic structures

CHE.12.1 "Enrichment: Construct explanations to explain the bonding characteristics of carbon that result in the formation of basic organic molecules."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline statements that explain how carbon bonds to itself or other atoms. Circle two examples where a bonding choice changes a molecule's structure or behavior.

From Stove Fuel to Plastic

1. On a camping trip, the fuel in a small stove may contain propane. Its molecules are built around carbon, an atom with four outer electrons that can share electrons to make four covalent bonds. Hydrogen makes only one such bond, so carbon can attach to hydrogen while still bonding to other carbon atoms. In propane, three carbon atoms form a chain with single bonds between neighboring carbons. The remaining bonds connect to hydrogen, giving the formula C_3H_8. Carbon's ability to bond to itself and fill its four bonding positions helps create stable molecules with different sizes and shapes.

2. Carbon can also share two pairs of electrons with another carbon atom. This makes a double bond, which uses two of each carbon's four bonding positions. Compare ethane, C_2H_6, with ethene, C_2H_4. Both have two carbon atoms, but ethane has a single carbon-to-carbon bond and ethene has a double bond. Because the double bond takes up more bonding positions, ethene has room for fewer hydrogen atoms. Bonds can change a molecule's behavior too: ethene can react to form long chains used in polyethylene plastic, while ethane does not form those chains as readily.

3. Carbon's four bonds do not force it to make straight chains. Carbon atoms can also branch or connect into rings, producing many arrangements from the same kind of atom. Other atoms can join the framework. In methanol, CH_3OH, one carbon bonds to three hydrogen atoms and an oxygen atom. That oxygen also bonds to hydrogen. The presence of oxygen changes how this molecule interacts with water compared with a molecule made only of carbon and hydrogen. To explain a basic organic molecule, trace which atoms connect, count carbon's four bonds, and link that structure to the molecule's possible forms or behavior.

2 ANSWER WITH EVIDENCE

Use the passage

1. How can the carbon atoms in propane form a chain and still bond to hydrogen?

2. Ethane and ethene each have two carbon atoms. Explain why ethene has fewer hydrogen atoms.

3. Why can carbon atoms form rings as well as chains?

4. How does the carbon atom in methanol bond to oxygen without exceeding four bonds?

3 YOUR TURN

Your own words

Write a condensed structural formula for a molecule with exactly three carbon atoms and one oxygen atom. Use only single bonds and add enough hydrogen so each carbon has four bonds and oxygen has two. In two or three sentences, explain how carbon bonds to itself and how your structure meets both bond counts.

ANSWER KEY

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HIGH SCHOOL · CHE.12.1

PART 1 · READ AND MARK

Underline statements that explain how carbon bonds to itself or other atoms. Circle two examples where a bonding choice changes a molecule's structure or behavior. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How can the carbon atoms in propane form a chain and still bond to hydrogen?	**Each carbon can make four bonds. After bonding to neighboring carbon atoms, it uses its remaining bonds to attach to hydrogen.**
2	Ethane and ethene each have two carbon atoms. Explain why ethene has fewer hydrogen atoms.	**Ethene's carbon-to-carbon double bond uses two bonding positions on each carbon, leaving fewer positions for hydrogen than ethane's single bond.**
3	Why can carbon atoms form rings as well as chains?	**Carbon can bond to other carbon atoms in different arrangements while filling its four bonding positions.**
4	How does the carbon atom in methanol bond to oxygen without exceeding four bonds?	**The carbon makes one bond to oxygen and three bonds to hydrogen, for four bonds total.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

$CH_3CH_2CH_2OH$ has three carbon atoms joined in a chain. Each carbon has four bonds: the first has three bonds to hydrogen and one to carbon, the middle has two to hydrogen and two to carbon, and the last has two to hydrogen, one to carbon, and one to oxygen. Oxygen has two bonds, one to carbon and one to hydrogen.

Accept any valid condensed structure with three carbons, one oxygen, only single bonds, and the correct bond counts. The explanation should connect carbon's ability to bond to itself with the structure the student wrote.