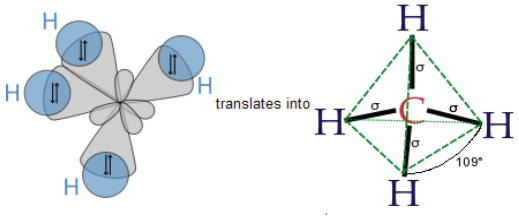
Edgenuity

Warm-Up | Organic Compounds

All about Carbon

Data Type	Data
Atomic number	6
Symbol	C
Name	Carbon
Average atomic mass	12.0107
Electron configuration	$[He]2s^2 2p^2$



Lesson Objectives

By the end of this lesson, you should be able to:

- Describe carbon's unique bonding characteristics that make the diversity of carbon compounds possible.
- Read and draw structural formulas of organic compounds.
- Explain the difference between structural isomers and geometric isomers.

Science Practice: Use different models to represent the same idea (ball-and-stick models, space-filling models, and structural formulas) and explain the usefulness and limitations of each kind of model.

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Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you.

B hydrocarbon

C isomer

D organic compound

E structural isomers

A geometric isomers

A. compounds that have the same molecular formula and sequence of atoms but different three-dimensional arrangements of atoms

B. a molecule made up entirely of hydrogen and carbon atoms

C. a compound that has the same molecular formula as another compound, but a different structural formula

D. a member of a large class of substances whose molecules contain carbon atoms covalently bonded to other carbon atoms and commonly to hydrogen, oxygen, or nitrogen atoms

E. compounds that have the same molecular formula but whose atoms are bonded together in different sequences

Instruction | Organic Compounds

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Lesson Question What is unique about carbon and its compounds?

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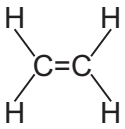
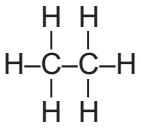
Characteristics of Carbon

- Four [covalent] bonds (single, double, or triple)
- Insoluble in water
- Usually in [nonelectrolytes]
- Low [melting] point
- Short life of atomic carbon
- Slow reaction rate
- High [activation] energies to begin reactions
- Formation of a variety of compounds
- Fourth most abundant [element] in the universe (by mass)
- Important to the formation of life on [Earth]





H–C≡C–H

Carbon: Diversity of Carbon Compounds

Organic compounds are members of a large class of [substances] whose molecules contain carbon atoms covalently bonded to other carbon [atoms] and commonly to atoms such as hydrogen, [oxygen], and nitrogen.

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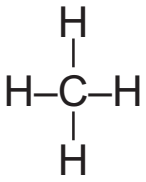
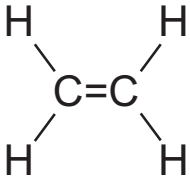
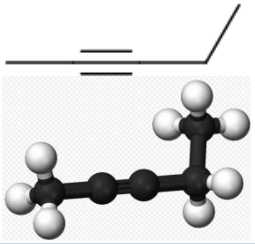
Carbon: Diversity of Carbon Compounds



Methane (CH_4)



Ethene (C_2H_4)

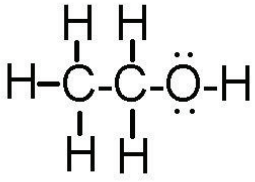


2-Pentyne (C_5H_8)

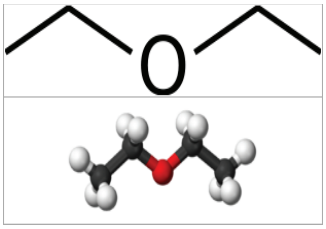
Hydrocarbons are molecules made up entirely of hydrogen and carbon atoms.

Carbon: Diversity of Carbon Compounds

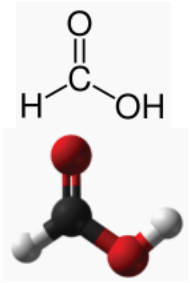
Oxygen-containing compounds



Ethanol (CH_3CH_2OH)



Diethyl ether $(C_2H_5)_2O$



Formic acid (HCOOH)

Proteins (nitrogen), DNA/RNA (phosphorus), antibiotics (sulfur)

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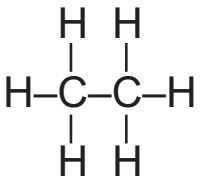
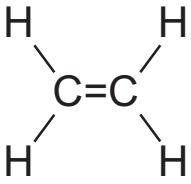
Structural Formulas of Organic Compounds

Molecular formula: C_2H_6

Structural formula:





Skeletal formula:

Cs are not labeled.

Hs bonded to Cs are assumed.

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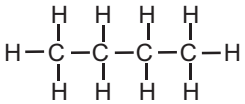
Five Models of Butane

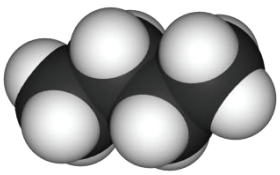
Molecular formula: C_4H_{10}

Structural formula:

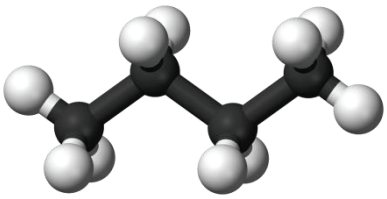


Skeletal formula:

Space-filling model:



Ball-and-stick model:



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Advantages and Disadvantages of Different Types of Models

Type of Model	Advantages	Disadvantages
Molecular formula	Shows chemical [composition]	No structural information
Structural formula	Shows chemical connectivity	Minimal [three-dimensional] structural information
[Lewis] structure	Shows chemical connectivity and all valence electrons	Minimal three-dimensional structural information
Space-filling model	Three-dimensional representation of molecule clearly visible	Difficult to see interior bonds
Ball-and-stick model	Atoms, bonds (single, double, or [triple]), and general shape visible	Poor representation of actual [bonds] and atoms
Skeletal formula	Focus on nonhydrocarbon components and functional groups	Not all atoms or bonds are shown

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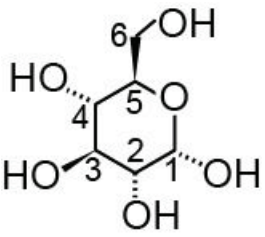
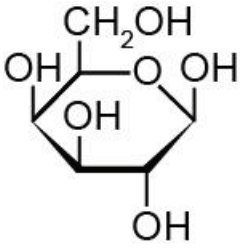
Isomers

Isomers are compounds that have the same molecular [formula], but different structural formulas.

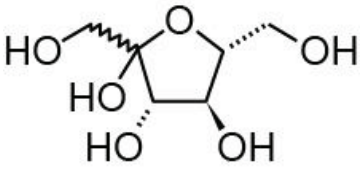
Structural isomers are isomers in which atoms bond in a different [order].



[Glucose], **blood**



Galactose, milk



Fructose, [fruit]

Example of Isomers

Example: C_6H_{14}

- C_6H_{14} in a straight chain is [hexane].
- Shorten the chain by two carbons to get butane.
- A [methyl] group is a carbon surrounded by three [hydrogens].

There are [five] different valid structure diagrams for C_6H_{14}.

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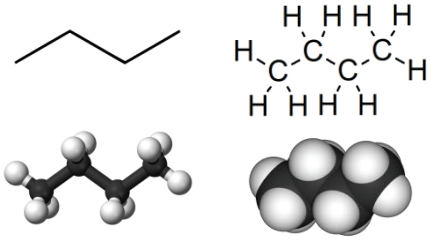
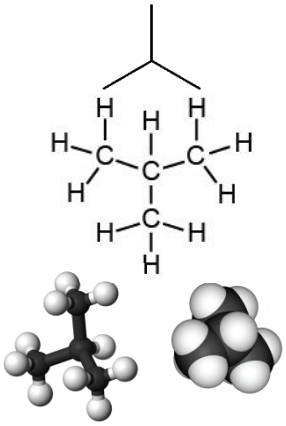
Isomers Using Models

Butane



Isobutane



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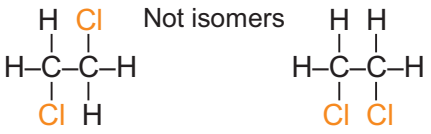
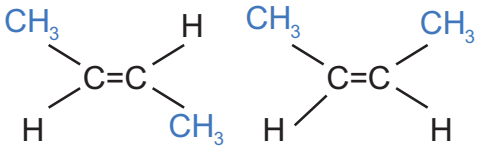
Geometric Isomers

Geometric isomers are isomers in which atoms bond in the same order, but have different three-dimensional

orientations .

- Occur when there is a restricted rotation
- Are common when there is a carbon-carbon double bond
- Have structural formulas with limitations





Geometric isomers

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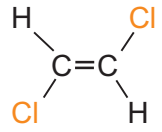
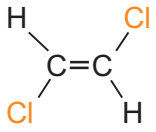
Cis and Trans Isomers

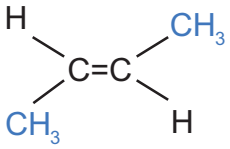


trans-1,2-dichloroethene

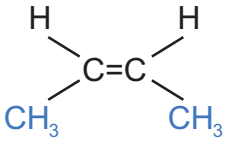


cis-1,2-dichloroethene

Geometric isomers



trans-but-2-ene

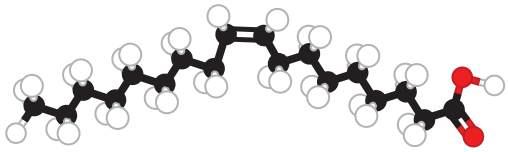


cis-but-2-ene

Examples of Geometric Isomers

Two isomers of $C_9H_{17}C_9H_{17}O_2$

- Oleic acid is a cis fat.



- Elaidic acid, an isomer of oleic acid, is a trans fat.

It's a liquid at room temperature, and it's a liquid at body temperature.

Summary | Organic Compounds

Lesson Question

What is unique about carbon and its compounds?

Answer

(Sample answer) Organic compounds are compounds that are based on carbon. There are different kinds of models for representing these molecules. The reaction rates of carbon-based molecules are generally quite slow. Living things on earth are all carbon-based life forms.

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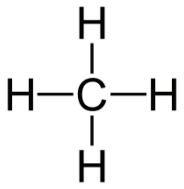
Carbon Bonds

Characteristics of carbon:



- Covalent bonding
- Insoluble in water
- Usually [nonelectrolytes]
- Low melting point
- Slow reaction rate
- High activation [energies] to begin reactions
- Formation of a variety of compounds
- Important to the formation of life on Earth

Methane

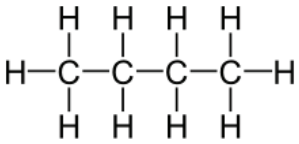
CH_4

Summary | Organic Compounds

Slide 2

Structural Formulas

- Are a graphical representation of the molecular structure
- Allow the [chemist] to visualize the molecules and the changes that occur

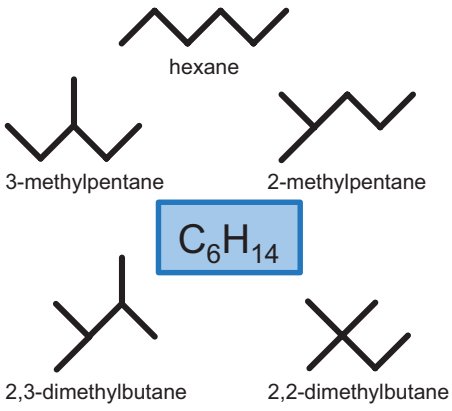


Butane

Isomers

Isomers are compounds that have the same molecular formula but [different] structural formulas.

[Structural] **isomers** are isomers in which atoms bond in a different order.



Summary | Organic Compounds

Use this space to write any questions or thoughts about this lesson.