Warm-Up | Properties and Uses of Unsaturated Hydrocarbons

Alkanes

Alkanes:

- are hydrocarbons composed of carbon and hydrogen with single bonds between carbon atoms.
- can be straight [chains] or cyclic structures.
- are named using the following steps:
  - Count the carbon atoms and choose the appropriate root word corresponding to this number.
  - Add the suffix ["-ane"] to the root word.
  - Add the prefix "cyclo-" if [cyclic].

Number of carbons	Root word
1	meth-
2	eth-
3	prop-
4	but-
5	pent-
6	hex-
7	hept-
8	oct-
9	non-
10	dec-

Lesson Objectives

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

- Describe the properties of alkenes, [alkynes], and aromatic hydrocarbons.
- Use the system for naming the ten simplest linear hydrocarbons and isomers that contain double bonds, triple bonds, and [benzene] rings.
- Identify uses of unsaturated hydrocarbons, including uses in pharmaceuticals, [petrochemicals], plastics, and food.

Science Practice: Describe different alkenes and alkynes that can be found in nature.

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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.

C cis isomer

A alkyne

B trans isomer

F alkene

D unsaturated hydrocarbon

E aromatic hydrocarbon

A. a type of hydrocarbon in which there is at least one triple bond between carbon atoms

B. a geometric isomer in which two groups are bonded to different carbons in a double bond in the opposite orientation

C. a geometric isomer in which two groups are bonded to different carbons in a double bond in the same orientation

D. a compound that is composed of carbon and hydrogen and contains at least one double or triple bond between carbon atoms

E. a type of hydrocarbon in which the carbon atoms are bonded in alternating single and double bonds in a ring

F. a type of hydrocarbon in which there is at least one double bond between carbon atoms

Instruction

Properties and Uses of Unsaturated Hydrocarbons

Slide 1

Lesson Question

What are the properties and uses of hydrocarbons that contain at least one double bond?

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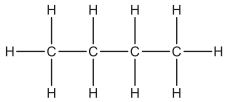
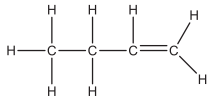
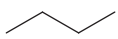
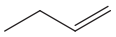
Saturated vs. Unsaturated Hydrocarbons

Saturated hydrocarbons:

- have a maximum number of [hydrogen] atoms bonded to each carbon atom.
- contain single bonds only.

Saturated	Unsaturated
	
	
C_4H_{10}	C_4H_8

Unsaturated hydrocarbons:

- have fewer than a maximum number of hydrogen atoms bonded to each carbon atom.
- contain at least one double or triple [bond].

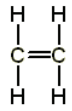
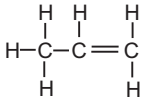
Alkenes

Alkenes are hydrocarbons that contain at least one double bond between carbon atoms.

Alkenes have the form [C_nH_{2n}].

Use the same naming convention as for alkanes, except:

- add the suffix “-ene.”
- add a number prefix indicating the first carbon in the double bond in long chain compounds.

Name	Formula	Structure
Ethene	C_2H_4	
Propene	C_3H_6	

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Slide 2

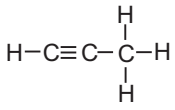
Alkynes

Alkynes are hydrocarbons that contain at least one triple bond between carbon atoms.

Alkynes have the form C_nH_{2n-2}.

Use the same naming convention as for alkanes, except:

- add the suffix "-yne" for an alkyne.
- add a number prefix indicating the first carbon in the triple bond in long chain compounds.

Name	Formula	Structure
Ethyne	C_2H_2	H–C≡C–H
Propyne	C_3H_4	

Slide 5

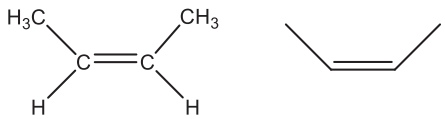
Cis Isomers and Trans Isomers

Cis isomer

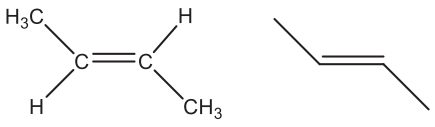
A geometric isomer in which two groups are bonded to different carbons in a double bond in the same orientation

Trans isomer

A geometric isomer in which two groups are bonded to different carbons in a double bond in the opposite orientation



cis-2-butene



trans-2-butene

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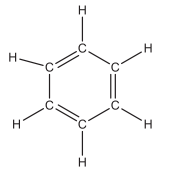
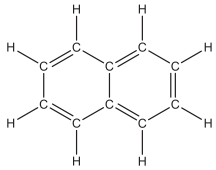
Aromatic Hydrocarbons

Aromatic hydrocarbons:

- have ring structures that contain alternating [single] and double bonds.
- are based on the simplest aromatic hydrocarbon, benzene.
- are flat, [planar] molecules.



benzene



naphthalene

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Boiling Points of Alkenes and Alkynes

Alkene	Boiling point (°C)
ethene	−104
propene	−47
1-butene	−6
1-pentene	31
1-hexene	64
1-heptene	94

Alkyne	Boiling point (°C)
ethyne	−84
propyne	−23
1-butyne	10
1-pentyne	40
1-hexyne	71
1-heptyne	99

As the length of the chain [increases], so does the boiling point. This makes sense because the longer the chains, the more the molecules stick to each other because of [Van der Waals] forces, because of those intermolecular attractions. As the chain increases in length, it's more difficult for a molecule to escape the liquid and enter the gaseous space.

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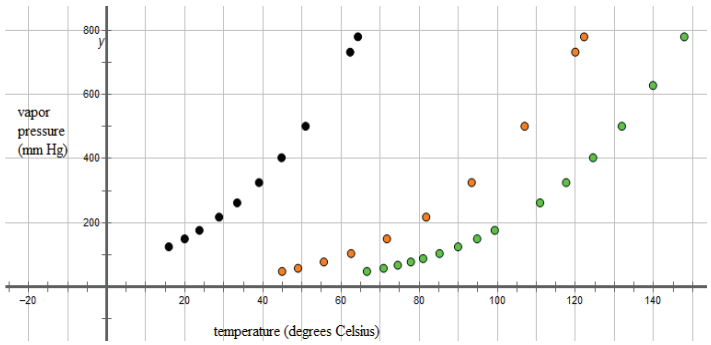
Vapor Pressures of Alkenes

Vapor pressure = pressure exerted by vapor when [liquid] and vapor are in [equilibrium]

- Black = 1-hexene
- Orange = 1-octene
- Green = 1-nonene



Shorter chains and smaller molecules [boil] more easily at lower temperatures than larger [molecules].

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Properties of Alkenes, Alkynes, and Aromatic Hydrocarbons

- [Combustibility]: Almost all hydrocarbons are combustible.
- Solubility: Almost no hydrocarbons are water soluble.
- Boiling point: Alkynes have higher boiling points than alkenes or aromatic hydrocarbons.
- [Density]: Alkenes, alkynes, and aromatic hydrocarbons all have lower densities than water.
- Acidity: Alkenes tend to be neutral, while alkynes tend to be [acidic].

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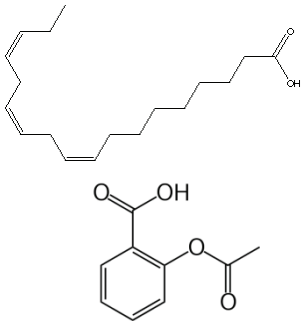
Food and Medicines

Polyunsaturated margarine:

- contains [fatty] acids derived from alkenes.

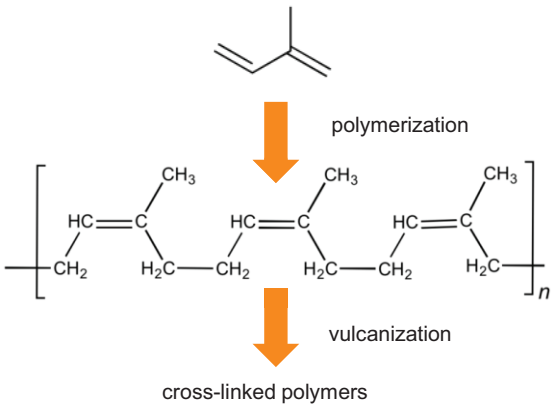
Aspirin and other [analgesic] medicines:

- contain compounds derived from aromatic hydrocarbons.



Rubber

- Rubber trees carry out [polymerization] reactions to form latex.
- People extract liquid [latex] from trees.
- The [vulcanization] process is used to crosslink chains to form solid rubber.



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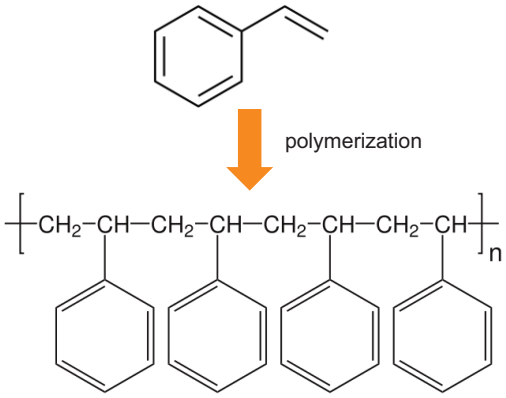
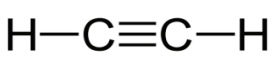
Polystyrene

- Styrene polymerizes to form polystyrene.
- Polystyrene is rigid with lots of air pockets, which makes it a good insulator.



Acetylene

- The common name for ethyne is acetylene.
- Acetylene is used as a fuel in:
  - welding torches.
  - gas lamps.
  - electric generators.



Summary | Properties and Uses of Unsaturated Hydrocarbons

Lesson Question

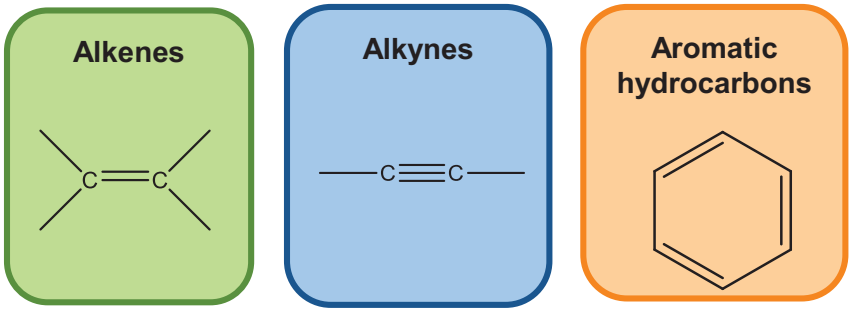
What are the properties and uses of hydrocarbons that contain at least one double bond?

Answer

(Sample answer) Alkenes, alkynes, and aromatic compounds are unsaturated hydrocarbons. They are made of only carbon and hydrogen and have at least one double or triple bond. These are combustible and have lower density than water.

Slide 2

Alkenes, Alkynes, and Aromatic Hydrocarbons



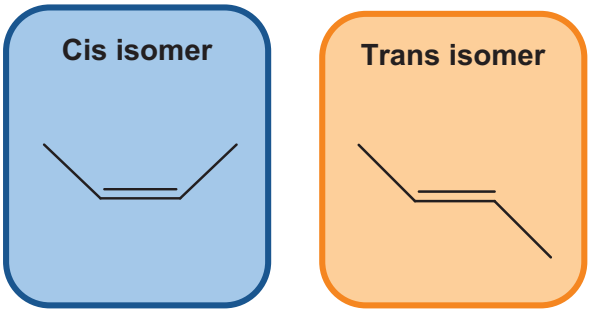
C_nH_{2n} | C_nH_{2n-2}

The ring is a benzene ring, which has a formula C_6H_6.

Summary | Properties and Uses of Unsaturated Hydrocarbons

Slide 2

Cis Isomers and Trans Isomers



There are two kinds of [geometric] isomers around unsaturated bonds.

Physical Properties of Alkenes and Alkynes

- Combustibility: Almost all hydrocarbons are [combustible].
- Solubility: Almost no hydrocarbons are [water] soluble.
- Boiling point: Alkynes have higher boiling points than alkenes or aromatic hydrocarbons.
- Density: Alkenes, alkynes, and aromatic hydrocarbons all have lower densities than water.
- Acidity: Alkenes tend to be neutral, while alkynes tend to be acidic.

Summary | Properties and Uses of Unsaturated Hydrocarbons

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