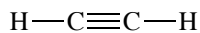


11.5 Alkenes and Alkynes



Ethyne, commonly called acetylene, is used in welding, in which it reacts with oxygen to produce flames with temperatures above 3300 °C.



Learning Goal Identify structural formulas as alkenes, cycloalkenes, and alkynes, and write their IUPAC or common names.

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Alkenes and Alkynes

Alkenes and alkynes are families of hydrocarbons that

- contain double and triple bonds, respectively
- are called unsaturated hydrocarbons because they do not contain the maximum number of hydrogen atoms
- react with hydrogen gas to increase the number of hydrogen atoms and become alkanes

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

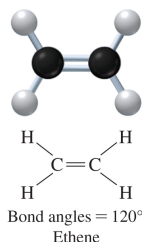
© 2015 Pearson Education, Inc.

Identifying Alkenes

Alkenes contain one or more carbon-carbon double bonds.

In ethene, C_2H_4 , two carbon atoms are connected by a double bond.

Each carbon atom in the double bond is attached to two hydrogen atoms and has a trigonal planar arrangement with bond angles of 120°.



Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Ethene, C₂H₄

Ethene, C₂H₄, more commonly called ethylene,

- is an important plant hormone involved in promoting the ripening of fruit such as bananas
- accelerates the breakdown of cellulose in plants, which causes flowers to wilt and leaves to fall from trees



Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.

Identifying Alkynes

Alkynes contain one or more carbon–carbon triple bonds.

In ethyne, C₂H₂,

- two carbon atoms are connected by a triple bond
- each carbon is also bonded to one H atom



Each carbon atom in the triple bond has a linear arrangement with bond angles of 180°.

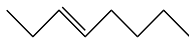
Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.

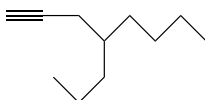
Study Check

Identify the following compounds as an alkene or alkyne:

A.



B.



Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.

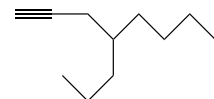
Solution

Identify the following compounds as an alkene or alkyne:

A. alkene



B. alkyne



Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.

Naming Alkanes, Alkenes, and Alkynes

The IUPAC names for alkenes and alkynes

- are similar to those of alkanes
- use the alkane name with the same number of carbon atoms, replacing the *ane* ending with *ene*

Cyclic alkenes are named as cycloalkenes.

TABLE 11.6 Comparison of Names for Alkanes, Alkenes, and Alkynes

| Alkane | Alkene | Alkyne |
|---------------------------------------|------------------------------|---------------------------------------|
| $\text{CH}_3\text{—CH}_3$ | $\text{H}_2\text{C=CH}_2$ | $\text{HC}\equiv\text{CH}$ |
| Ethane | Ethene (ethylene) | Ethyne (acetylene) |
| $\text{CH}_3\text{—CH}_2\text{—CH}_3$ | $\text{CH}_3\text{—CH=CH}_2$ | $\text{CH}_3\text{—C}\equiv\text{CH}$ |
| Propane | Propene | Propyne |

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.

Guide to Naming Alkenes and Alkynes

Guide to Naming Alkenes and Alkynes

STEP 1

Name the longest carbon chain that contains the double or triple bond.

STEP 2

Number the carbon chain starting from the end nearer the double or triple bond.

STEP 3

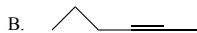
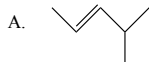
Give the location and name for each substituent (alphabetical order) as a prefix to the alkene or alkyne name.

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.

Study Check

Write IUPAC names for each of the following:



Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Solution

STEP 1 Name the longest carbon chain that contains the double or triple bond.

A.

ANALYZE THE PROBLEM

Feature
double bond

Type
alkene

IUPAC Naming
replace *ane* ending with *ene*



five carbon atoms—pentene

B.

ANALYZE THE PROBLEM

Feature
triple bond

Type
alkyne

IUPAC Naming
replace *ane* ending with *yne*



six carbon atoms—hexyne

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Solution

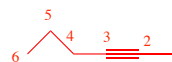
STEP 2 Number the carbon chain starting from the end nearer the double or triple bond.

A.



2-pentene

B.



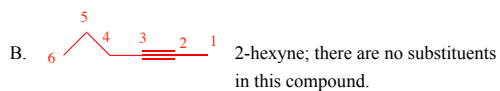
2-hexyne

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Solution

STEP 3 Give the location and name of each substituent (alphabetical order) as a prefix to the alkene or alkyne name.



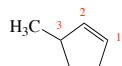
Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Naming Cycloalkenes

Cycloalkenes have a double bond within a ring structure and

- are named by assigning the double bond to be between carbon 1 and carbon 2 when a substituent is on the ring
- do not need to include the numbers for the double bond



3-methylcyclopentene (It is understood the double bond is between carbon 1 and carbon 2.)

The carbon atoms in the ring are numbered to give the double bond numbers 1 and 2, then the lowest possible number to any substituents present.

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Study Check

Name the following alkenes and alkynes:



Chemistry: An Introduction to General, Organic, and Biological Chemistry, Twelfth Edition

© 2015 Pearson Education, Inc.

Solution

Name the following alkenes and alkynes:



cyclohexene



3,3-dimethylcyclopentene

Chemistry: An Introduction to General, Organic, and Biological Chemistry, Tenth Edition

© 2015 Pearson Education, Inc.
