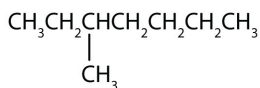


12.E: Unsaturated and Aromatic Hydrocarbons (Exercises)

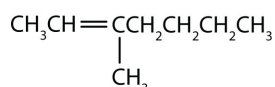
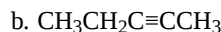
13.1: Alkenes- Structures and Names

Concept Review Exercises

- Briefly identify the important distinctions between a saturated hydrocarbon and an unsaturated hydrocarbon.
- Briefly identify the important distinctions between an alkene and an alkane.
- Classify each compound as saturated or unsaturated. Identify each as an alkane, an alkene, or an alkyne.



a.



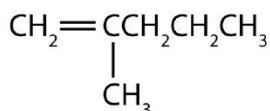
c.

Answers

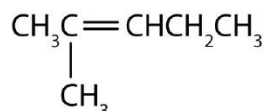
- Unsaturated hydrocarbons have double or triple bonds and are quite reactive; saturated hydrocarbons have only single bonds and are rather unreactive.
- An alkene has a double bond; an alkane has single bonds only.
- saturated; alkane
 - unsaturated; alkyne
 - unsaturated; alkene

Exercises

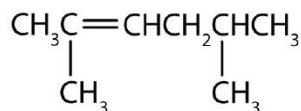
- Draw the structure for each compound.
 - 2-methyl-2-pentene
 - 2,3-dimethyl-1-butene
 - cyclohexene
- Draw the structure for each compound.
 - 5-methyl-1-hexene
 - 3-ethyl-2-pentene
 - 4-methyl-2-hexene
- Name each compound according to the IUPAC system.



a.

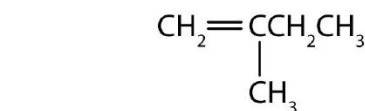


b.

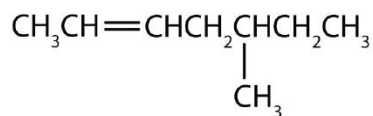


c.

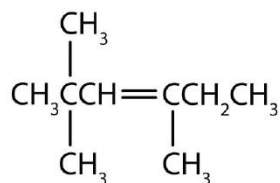
- Name each compound according to the IUPAC system.



a.

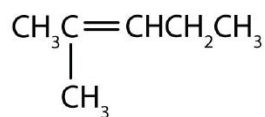


b.

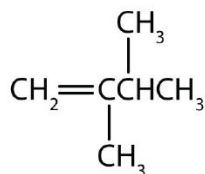


c.

Answers



1. a.



b.



c.

3. a. 2-methyl-1-pentene

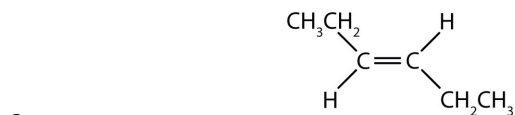
b. 2-methyl-2-pentene

c. 2,5-dimethyl-2-hexene

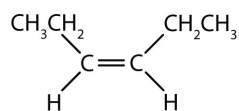
13.2: Cis-Trans Isomers (Geometric Isomers)

Concept Review Exercises

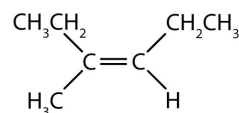
- What are cis-trans (geometric) isomers? What two types of compounds can exhibit cis-trans isomerism?
- Classify each compound as a cis isomer, a trans isomer, or neither.



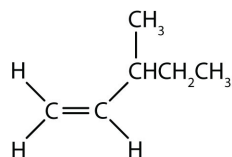
a.



b.



c.



d.

Answers

- Cis-trans isomers are compounds that have different configurations (groups permanently in different places in space) because of the presence of a rigid structure in their molecule. Alkenes and cyclic compounds can exhibit cis-trans isomerism.
- trans (the two hydrogen atoms are on opposite sides)
 - cis (the two hydrogen atoms are on the same side, as are the two ethyl groups)
 - cis (the two ethyl groups are on the same side)
 - neither (flipping the bond does not change the molecule. There are no isomers for this molecule)

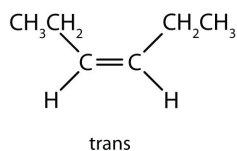
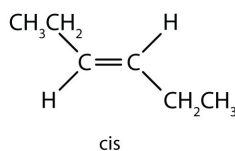
Exercises

- Draw the structures of the cis-trans isomers for each compound. Label them cis and trans. If no cis-trans isomers exist, write none.
 - 2-bromo-2-pentene
 - 3-hexene
 - 4-methyl-2-pentene
 - 1,1-dibromo-1-butene
 - 2-butenic acid ($\text{CH}_3\text{CH}=\text{CHCOOH}$)
- Draw the structures of the cis-trans isomers for each compound. Label them cis and trans. If no cis-trans isomers exist, write none.
 - 2,3-dimethyl-2-pentene
 - 1,1-dimethyl-2-ethylcyclopropane
 - 1,2-dimethylcyclohexane
 - 5-methyl-2-hexene
 - 1,2,3-trimethylcyclopropane

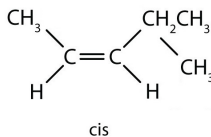
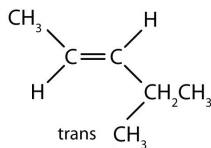
Answer

- none. There are two distinct geometric isomers, but since there are there are four different groups off the double bond, these are both cis/trans isomers (they are technically E/Z isomers discussed elsewhere).

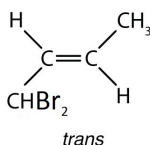
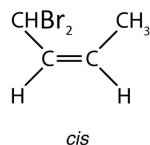
b:

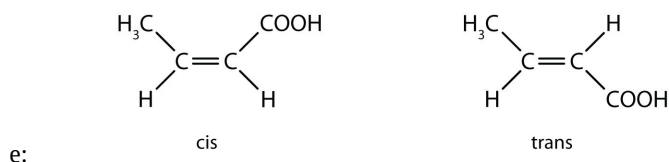


c:



d:





13.3: Physical Properties of Alkenes

Concept Review Exercises

- Briefly describe the physical properties of alkenes. How do these properties compare to those of the alkanes?
- Without consulting tables, arrange the following alkenes in order of increasing boiling point: 1-butene, ethene, 1-hexene, and propene.

Answers

- Alkenes have physical properties (low boiling points, insoluble in water) quite similar to those of their corresponding alkanes.
- ethene < propene < 1-butene < 1-hexene

Exercises

- Without referring to a table or other reference, predict which member of each pair has the higher boiling point.
 - 1-pentene or 1-butene
 - 3-heptene or 3-nonene
- Which is a good solvent for cyclohexene, pentane or water?

Answer

- 1-pentene
 - 3-nonene

13.4: Chemical Properties of Alkenes

Concept Review Exercises

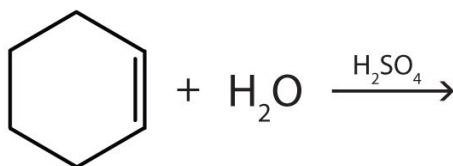
- What is the principal difference in properties between alkenes and alkanes? How are they alike?
- If $\text{C}_{12}\text{H}_{24}$ reacts with HBr in an addition reaction, what is the molecular formula of the product?

Answers

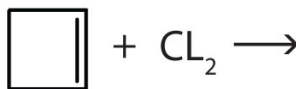
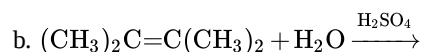
- Alkenes undergo addition reactions; alkanes do not. Both burn.
- $\text{C}_{12}\text{H}_{24}\text{Br}_2$

Exercises

- Complete each equation.
 - $(\text{CH}_3)_2\text{C}=\text{CH}_2 + \text{Br}_2 \rightarrow$
 - $\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_3 + \text{H}_2 \xrightarrow{\text{Ni}}$



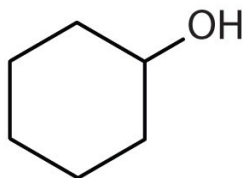
-
- Complete each equation.
 - $\text{CH}_2=\text{CHCH}=\text{CH}_2 + 2\text{H}_2 \xrightarrow{\text{Ni}}$



c.

Answer

1. a. $(\text{CH}_3)_2\text{CBrCH}_2\text{Br}$
b. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$



c.

13.5: Polymers

Concept Review Exercises

1. What is a monomer? What is a polymer? How do polymer molecules differ from the molecules we have discussed in earlier sections of this chapter?
2. What is addition polymerization? What structural feature usually characterizes molecules used as monomers in addition polymerization?
3. What is the molecular formula of a polymer molecule formed by the addition polymerization of 175 molecules of vinyl chloride ($\text{CH}_2=\text{CHCl}$)?

Answers

1. Monomers are small molecules that can be assembled into giant molecules referred to as polymers, which are much larger than the molecules we discussed earlier in this chapter.
2. In addition polymerization, the monomers add to one another in such a way that the polymer contains all the atoms of the starting monomers.
3. $\text{C}_{350}\text{H}_{525}\text{Cl}_{175}$

Exercises

1. Write the condensed structural formula of the monomer from which Saran is formed. A segment of the Saran molecule has the following structure: $\text{CH}_2\text{CCl}_2\text{CH}_2\text{CCl}_2\text{CH}_2\text{CCl}_2\text{CH}_2\text{CCl}_2$.
2. Write the condensed structural formula for the section of a molecule formed from four units of the monomer $\text{CH}_2=\text{CHF}$.

Answer

1. $\text{H}_2\text{C}=\text{CCl}_2$

13.6: Alkynes

Concept Review Exercises

1. Briefly identify the important differences between an alkene and an alkyne. How are they similar?
2. The alkene $(\text{CH}_3)_2\text{CHCH}_2\text{CH}=\text{CH}_2$ is named 4-methyl-1-pentene. What is the name of $(\text{CH}_3)_2\text{CHCH}_2\text{C}\equiv\text{CH}$?
3. Do alkynes show cis-trans isomerism? Explain.

Answers

1. Alkenes have double bonds; alkynes have triple bonds. Both undergo addition reactions.
2. 4-methyl-1-pentyne

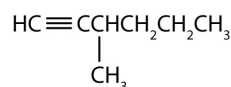
3. No; a triply bonded carbon atom can form only one other bond. It would have to have two groups attached to show cis-trans isomerism.

Exercises

- Draw the structure for each compound.
 - acetylene
 - 3-methyl-1-hexyne
- Draw the structure for each compound.
 - 4-methyl-2-hexyne
 - 3-octyne
- Name each alkyne.
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\equiv\text{CH}$
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\equiv\text{CCH}_3$

Answers

1. a. $\text{H}-\text{C}\equiv\text{C}-\text{H}$



b.

3. a. 1-pentyne
b. 2-hexyne

13.7: Aromatic Compounds- Benzene

Concept Review Exercises

- How do the typical reactions of benzene differ from those of the alkenes?
- Briefly describe the bonding in benzene.
- What does the circle mean in the chemist's representation of benzene?

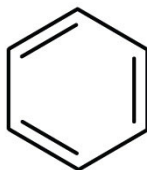
Answers

- Benzene is rather unreactive toward addition reactions compared to an alkene.
- Valence electrons are shared equally by all six carbon atoms (that is, the electrons are delocalized).
- The six electrons are shared equally by all six carbon atoms.

Exercises

- Draw the structure of benzene as if it had alternate single and double bonds.
- Draw the structure of benzene as chemists usually represent it today.

Answer



1.

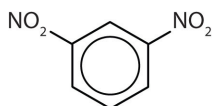
13.8: Structure and Nomenclature of Aromatic Compounds

Concept Review Exercises

- Briefly identify the important characteristics of an aromatic compound.
- What is meant by the prefixes *meta*, *ortho*, or *para*? Give the name and draw the structure for a compound that illustrates each.
- What is a phenyl group? Give the structure for 3-phenyloctane.

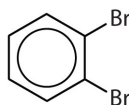
Answers

- An aromatic compound is any compound that contains a benzene ring or has certain benzene-like properties.
- meta = 1,3 disubstitution; (answers will vary)



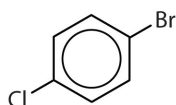
m-dinitrobenzene or 1,3-dinitrobenzene

ortho = 1,2 disubstitution



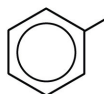
o-dibromobenzene or 1,2-dibromobenzene

para = 1,4 disubstitution or 1-bromo-4-chlorobenzene

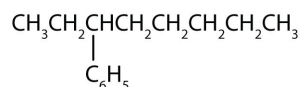


p-bromochlorobenzene or 1-bromo-4-chlorobenzene

- phenyl group: C₆H₅ or

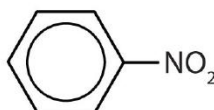


3-phenyloctane:

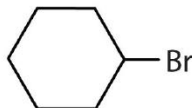


Exercises

- Is each compound aromatic?



a.

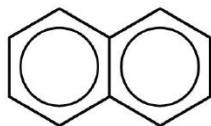


b.

2. Is each compound aromatic?



a.



b.

3. Draw the structure for each compound.

a. toluene

b. *m*-diethylbenzene

c. 3,5-dinitrotoluene

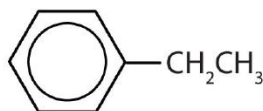
4. Draw the structure for each compound.

a. *p*-dichlorobenzene

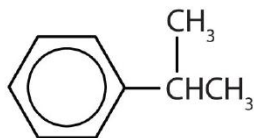
b. naphthalene

c. 1,2,4-trimethylbenzene

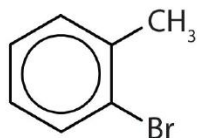
5. Name each compound with its IUPAC name.



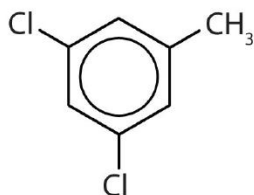
a.



b.

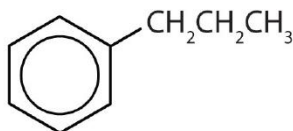


c.



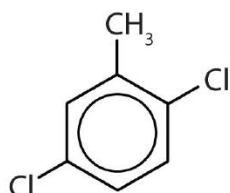
d.

6. Name each compound with its IUPAC name.

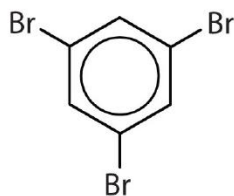


a.

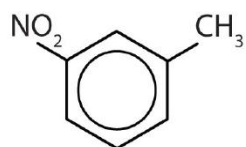
b.



c.



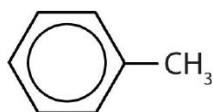
d.



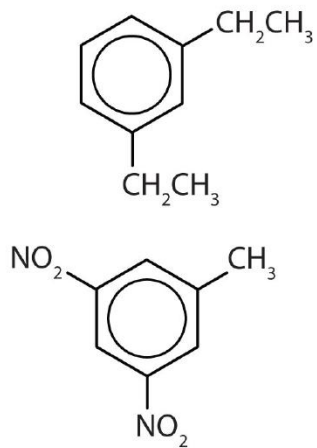
Answers

1. a. yes
b. no

3. a.



b.

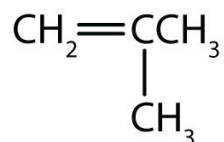


c.

5. a. ethylbenzene
b. isopropylbenzene
c. *o*-bromotoluene
d. 3,5-dichlorotoluene

Additional Exercises

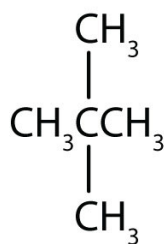
1. Classify each compound as saturated or unsaturated.



a.

b. $\text{CH}_3\text{C}\equiv\text{CCH}_3$

2. Classify each compound as saturated or unsaturated.

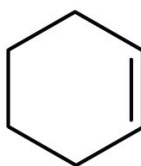


a.

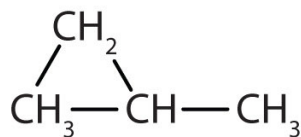


b.

3. Give the molecular formula for each compound.



a.



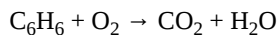
b.

4. When three isomeric pentenes—X, Y, and Z—are hydrogenated, all three form 2-methylbutane. The addition of Cl_2 to Y gives 1,2-dichloro-3-methylbutane, and the addition of Cl_2 to Z gives 1,2-dichloro-2-methylbutane. Draw the original structures for X, Y, and Z.

5. Pentane and 1-pentene are both colorless, low-boiling liquids. Describe a simple test that distinguishes the two compounds. Indicate what you would observe.

6. Draw and name all the alkene cis-trans isomers corresponding to the molecular formula C_5H_{10} . (Hint: there are only two.)

7. The complete combustion of benzene forms carbon dioxide and water:



Balance the equation. What mass, in grams, of carbon dioxide is formed by the complete combustion of 39.0 g of benzene?

8. Describe a physiological effect of some PAHs.

9. What are some of the hazards associated with the use of benzene?

10. What is wrong with each name? Draw the structure and give the correct name for each compound.

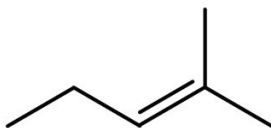
- 2-methyl-4-heptene
- 2-ethyl-2-hexene
- 2,2-dimethyl-3-pentene

11. What is wrong with each name?

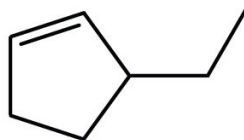
- 2-bromobenzene
- 3,3-dichlorotoluene
- 1,4-dimethylnitrobenzene

12. Following are line-angle formulas for three compounds. Draw the structure and give the name for each.

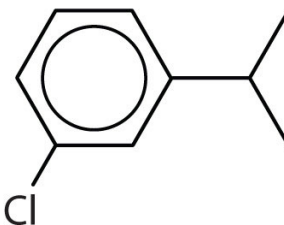
a.



b.

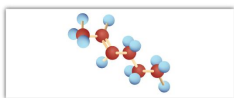


c.

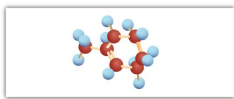


13. Following are ball-and-stick molecular models for three compounds (blue balls represent H atoms; red balls are C atoms). Write the condensed structural formula and give the name for each.

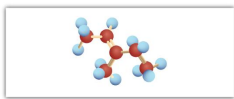
a.



b.



c.



Answers

1.

- a. unsaturated
- b. unsaturated

3.

- a. C_6H_{10}
- b. C_4H_8

5. Add bromine solution (reddish-brown) to each. Pentane will not react, and the reddish-brown color persists; 1-pentene will react, leaving a colorless solution.

7. $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$; 132 g

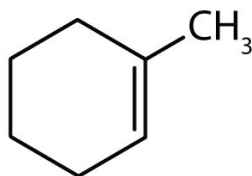
9. carcinogenic, flammable

11.

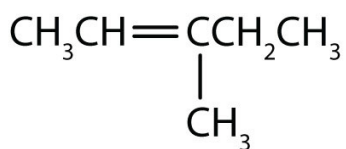
- a. number not needed
- b. can't have two groups on one carbon atom on a benzene ring
- c. can't have a substituent on the same carbon atom as the nitro group

13.

- a. $CH_3CH=CHCH_2CH_2CH_3$; 2-hexene



b.



c.

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