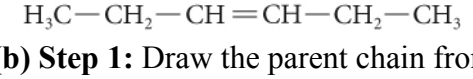
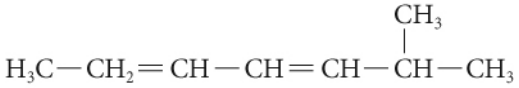
Section 1.2: Alkenes and Alkynes

Tutorial 1 Practice, page 21

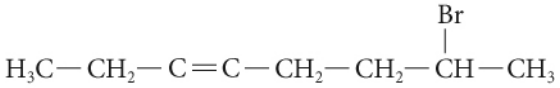
1. (a) Step 1: The longest chain that contains the multiple bond has 4 carbon atoms, so the root name contains *but-*.
Step 2: There is one double bond, so it is a butene.
Step 3: The double bond is between the first and second carbon atoms. So, the compound is but-1-ene.
(b) Step 1: The longest chain that contains the multiple bond has 6 carbon atoms, so the root name contains *hex-*.
Step 2: There is one double bond, so it is a hexene.
Step 3: The double bond is attached to the second carbon atom, so it is a hex-2-ene.
Step 4: The methyl group is bonded to the fourth carbon atom. So, the compound is 4-methylhex-2-ene.
(c) Step 1: The longest chain that contains the multiple bond has 6 carbon atoms, so the root name contains *hex-*.
Step 2: There is one triple bond, so it is a hexyne.
Step 3: The triple bond is attached to the second carbon atom, so it is a hex-2-yne.
Step 4: The methyl group is bonded to the fourth carbon atom. So, the compound is 4-methylhex-2-yne.
(d) Step 1: The ring that contains the multiple bond has 6 carbon atoms, so the root name contains *cyclohex-*.
Step 2: There is one double bond, so it is a cyclohexene.
Step 3: The double bond is between carbon atoms 1 and 2, so it is a cyclohex-1-ene.
Step 4: The methyl group is bonded to carbon atom 3, and the bromine atom is bonded to carbon atom 4. So, the compound is 4-bromo-3-methylcyclohex-1-ene.
2. (a) Step 1: Draw the parent chain from the last part of the compound name. The name hex-3-ene indicates that the longest carbon chain has 6 carbon atoms.
Step 2: The name *-ene* indicates that the compound contains one double bond. The number 3 tells us that the double bond is between the third and fourth carbon atoms.
Step 3: Draw the double bond at the appropriate location. So, the structural formula for hex-3-ene is



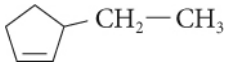
(b) Step 1: Draw the parent chain from the last part of the compound name. The name 6-methylhepta-2,4-diene indicates that the longest carbon chain has 7 carbon atoms.
Step 2: The name *-diene* indicates that the compound contains two double bonds. The number 2,4 indicates that these double bonds are between the second and third and the fourth and fifth carbon atoms. The 6-methyl part of the name indicates that the molecule also contains a methyl group bonded to the sixth carbon atom.
Step 3: Draw the double bonds and methyl group at the appropriate locations. The structural formula for 6-methylhepta-2,4-diene is



(c) Step 1: Draw the parent chain or carbon ring from the last part of the compound name. The name 2-bromooct-5-yne tells us that the longest carbon chain has 8 carbon atoms.
Step 2: The name *-yne* indicates that the compound contains one triple bond. The number 5 tells us that this triple bond is between the fifth and sixth carbon atoms. The *2-bromo* part of the name indicates that the molecule also contains a bromine atom bonded to the second carbon atom.
Step 3: Draw the triple bond and bromine atom at the appropriate locations. So, the structural formula for 2-bromooct-5-yne is



(d) Step 1: Draw the carbon ring from the last part of the compound name. The name 3-ethylcyclopent-1-ene tells us that the carbon ring has 5 carbon atoms.
Step 2: The name *-ene* indicates that the compound contains one double bond. The number 1 tells us that this double bond is between the first and second carbon atoms. The 3-ethyl part of the name indicates that the molecule also contains an ethyl group bonded to the third carbon atom.
Step 3: Draw the double bond and ethyl group at the appropriate locations. So, the structural formula for 3-ethylcyclopent-1-ene is

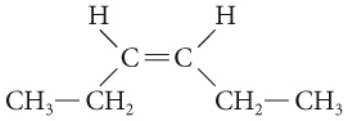


Mini Investigation: Isomers of Pentane, page 21

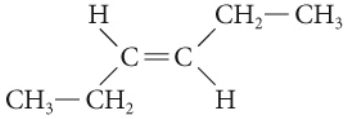
A. There are six isomers of pentene.
B. There are more isomers of pentene than pentane because the carbon–carbon double bond cannot be rotated, giving more non-identical structures. For example, there are two stereoisomers of pent-2-ene (*cis* and *trans*). Different possibilities for the position of the double bond also result in more structures. For example, there are three structural isomers of methylbutene (2-methylbut-1-ene, 2-methylbut-2-ene, and 3-methylbut-1-ene).
C. Answers may vary. Sample answer: I predict that hydrocarbons with one double bond will have twice as many isomers as hydrocarbons of the same length with no multiple bonds. Hydrocarbons with two double bonds will have four times as many isomers as hydrocarbons of the same length with no multiple bonds. This sounds reasonable because for every double bond, there are two ways the atoms on either side can arrange themselves—in the same direction or in opposite directions.

Tutorial 2 Practice, page 23

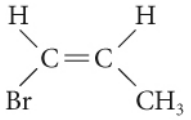
1. (a) Step 1: The name hex-3-ene tells us that the carbon chain has 6 carbon atoms.
Step 2: The double bond is between the third and fourth carbon atoms.
Step 3: There are two hydrogen atoms on the two carbon atoms of the double bond. The *cis* isomer will have the hydrogen atoms on the same side of the double bond; the *trans* isomer will have the hydrogen atoms on opposite sides. So, the structure for *cis*-hex-3-ene is



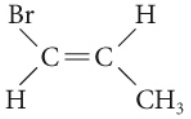
The structure for *trans*-hex-3-ene is



(b) Step 1: The name 1-bromoprop-1-ene tells us that the carbon chain has 3 carbon atoms.
Step 2: The double bond is between the first and second carbon atoms.
Step 3: There are two hydrogen atoms and a bromine atom bonded to the two carbon atoms of the double bond. The *cis* isomer will have the hydrogen atoms on the same side of the double bond; the *trans* isomer will have the hydrogen atoms on opposite sides. So, the structure for *cis*-1-bromoprop-1-ene is

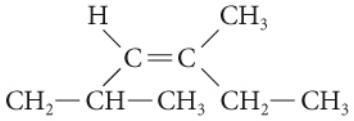


The structure for *trans*-1-bromoprop-1-ene is

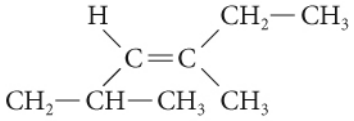


2. (a) Step 1: The longest chain that contains the double bond has 5 carbon atoms, so it is a pentene.
Step 2: The double bond is between the first and second carbon atoms, so the compound is pent-2-ene.
Step 3: Since the hydrogen atoms are on opposite sides of the pair of double-bonded carbon atoms, the name of the compound is *trans*-pent-2-ene.
(b) Step 1: The longest chain that contains the double bond has 5 carbon atoms, so it is a pentene.
Step 2: The double bond is between the first and second carbon atoms, so the compound is pent-2-ene.
Step 3: Since the hydrogen atoms are on the same sides of the pair of double-bonded carbon atoms, the name of the compound is *cis*-pent-2-ene.

3. Step 1: The name 2,4-dimethylhex-3-ene tells us that the carbon chain has 6 carbon atoms.
Step 2: The double bond is between the third and fourth carbon atoms.
Step 3: A hydrogen atom and a methyl group are attached to the two carbon atoms of the double bond. The *cis* isomer will have the hydrogen atom and the methyl group on the same side of the double bond. This isomer is called *cis*-2,4-dimethylhex-3-ene and its structure is

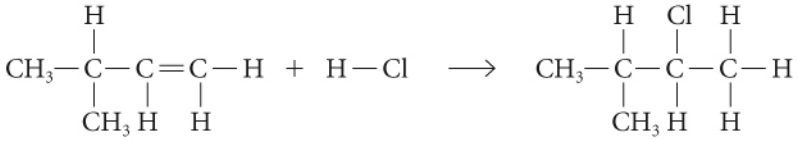


The *trans* isomer will have the hydrogen atom and methyl group on opposite sides of the double bond. This isomer is called *trans*-2,4-dimethylhex-3-ene and its structure is

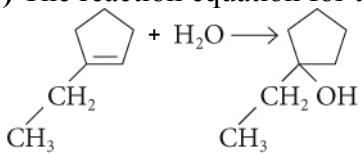


Tutorial 3 Practice, page 26

1. (a) The reaction of 3-methylbut-1-ene and hydrogen chloride is an addition reaction. The reaction equation for the reaction is



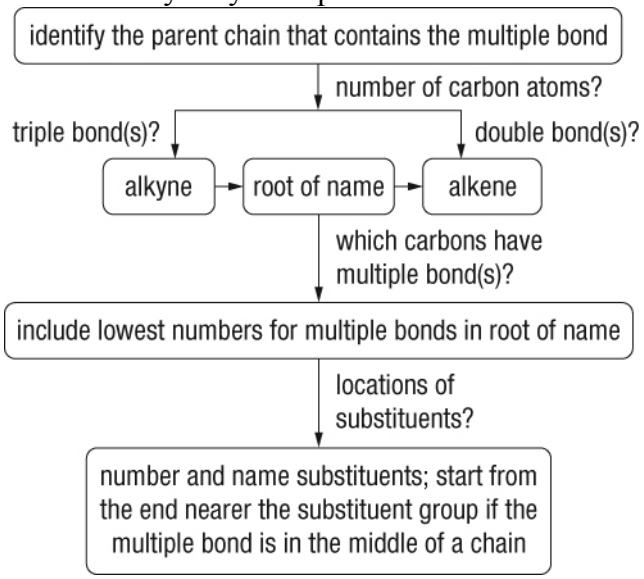
The major product of the reaction is 2-chloro-3-methylbutane.
(b) The reaction equation for the reaction is:



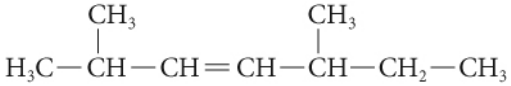
The major product of the reaction is 1-ethyl-1-hydroxycyclopentane.

Section 1.2 Questions, page 27

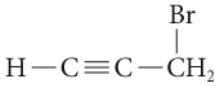
1. Answers may vary. Sample answer:



2. (a) The compound $CH_3CH_2CHCHCH_3$ has a straight carbon chain and the formula C_5H_{10}. This fits the general formula for alkenes, which is C_nH_{2n}. Therefore, the compound is an alkene.
(b) The compound $CH_2CHCH_2CH_3$ has a straight carbon chain and the formula C_4H_8. This fits the general formula for alkenes, which is C_nH_{2n}. Therefore, the compound is an alkene.
(c) The compound $CHCCH_2CCH$ has a straight carbon chain, with the multiple bonds located between the first and second and the fourth and fifth carbon atoms, and a formula of C_5H_4. The general formula for an alkyne is C_nH_{2n-2}. Since this compound has fewer than $2n - 2$ hydrogen atoms, it must have more than one triple bond. The compound is an alkyne with two triple bonds.
3. (a) The name of the alkene is but-1-ene.
(b) The name of the alkene is 4-methylhex-2-ene.
(c) The name of the alkene is 3-chloro-4-propylcylcopent-1-ene.
4. (a) The structure for 2,5-dimethylhept-3-ene is:

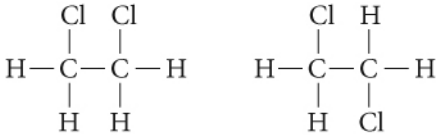


(b) The structure for 3-bromopropyne is:



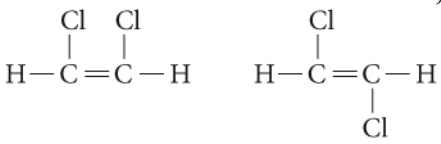
5. (a) The name of the alkyne is 1-bromobut-2-yne.
(b) The name of the alkyne is 4-methylhex-2-yne.
6. *Cis* and *trans* isomers are compounds that are identical except for the position of matching groups on either side of a double bond. In *cis* isomers, the same groups are located on the same side of the double bond. In *trans* isomers, the groups are located on opposite sides of the double bond.

7. (a) The compound is *cis*-hex-2-ene.
(b) The compound is *trans*-1-bromobut-1-ene.
8. Consider two structures drawn for 1,2-dichloroethane:



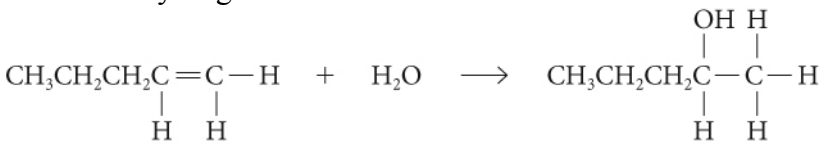
structure 1 structure 2

The carbon atoms around the C–C bond in structure 1 can be rotated to form structure 2. So, there is only one compound that is named 1,2-dichloroethane.
Consider two structures drawn for 1,2-dichloroethene:



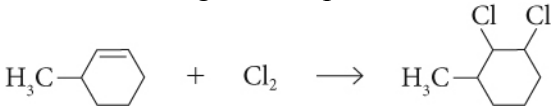
structure 1 structure 2

Since the carbon atoms around the C=C bond cannot be rotated, structure 1 and structure 2 are two distinct compounds that are named 1,2-dichloroethene.
9. (a) $CH_3CH{=}CHCH_3 + Cl_2 \rightarrow CH_3CHClCHClCH_3$
but-2-ene chlorine 2,3-dichlorobutane
(b) $CH_3CH{=}CHCH_2\,CH_2CH_3 + HBr \rightarrow CH_3CH_2CHBrCH_2CH_2CH_3$
hex-3-ene hydrogen bromide 3-bromohexane
10. (a) When pent-1-ene is mixed with water, a hydration reaction will occur. According to Markovnikov's rule, the hydrogen atom will be added to the carbon atom that already has the most hydrogen atoms bonded to it.



pent-1-ene water 2-hydroxypentane

The major product of the reaction is 2-hydroxypentane.
(b) When chlorine gas is bubbled through 3-methylcyclohexene, chlorine will bond to the carbons in the ring that are part of the double bond.



The product of the reaction is 1,2-chloro-3-methylcyclohexane.