Objective 5: Name alkanes chains and rings – parent and branches.

Quiz Practice problems

Key ideas:

You know how to write chemical formulas and expanded formulas, draw Lewis structures and skeletal structures, and identify functional groups of organic compounds. When you are communicating with another person, you may want to describe an organic compound by its name. There are specific rules for naming organic compounds so a person in one place or country will know exactly what another person is talking about in another place or country.

Organic names are based on the number of carbons.

Prefixes and suffixes mean something.

Start with alkanes (hydrocarbon compounds that contain C and H only with single bonds only).

The –ane suffix means an alkane.

Examples: one carbon alkane = methane (CH_4)

two carbon alkane = ethane (C_2H_6)

three carbon alkane = propane (C_3H_8)

For compounds with a functional group:

(i) remove H from alkane to form alkyl group.

The –yl suffix means alkyl group.

Examples: methane becomes methyl (CH_3-). Note the carbon in CH_3 only has 6 electrons around it and does not fit the octet rule.

Ethane becomes ethyl (C_2H_5-).

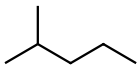
(ii) attach functional group where H was.

Examples: attach alcohol group to methyl group ==> methyl alcohol = CH_3OH

Attach Br group to ethyl group ==> ethyl bromide = C_2H_5Br

For big alkanes:

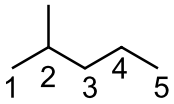
Example: Name this compound.

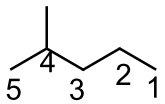


Identify the longest continuous carbon chain in the compound – this is the “parent” chain = 5 carbons = pentane

Identify the branches on the parent chain – these are alkyl groups = one carbon branch = methyl

Number the carbons on the parent chain from one end to the other from 1 to the # of carbons.





For this compound, the carbons are numbered from left to right or right to left.

Name of compound using left to right numbering: 2-methyl pentane

Name of compound using right to left numbering: 4-methyl pentane

Name of compound should have the lowest numbers so 2-methyl pentane is the correct name.

Note: a dash goes between a number and letter, a comma goes between 2 numbers.

For an alkane ring, use the cyclo- prefix.

Example:

Cyclopropane

The hydrogen deficiency index (HDI) tells you how many pi bonds or rings are in a compound. It can help you determine whether two compounds are the same compound, different, or isomers.

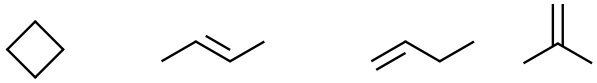
For hydrocarbons: HDI = 0.5 (# of H’s in fully saturated hydrocarbon - # of H’s in compound)

# of H’s in fully saturated hydrocarbon = 2 (# of carbons in compound) + 2

Example: C_4H_8 has a HDI = 0.5 (10 – 8) = 1

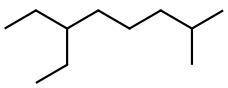
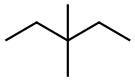
So this compound has 1 pi bond or 1 ring.

Possible structures of C_4H_8:

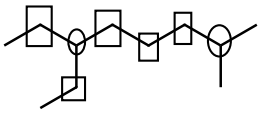
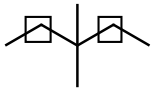


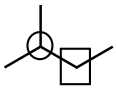
Skills:
Know the names of the one carbon alkane (methane) to the 10 carbon alkane.
Given a Lewis or skeletal structure, name the compound.
Given a compound name, draw Lewis or skeletal structure.
Given a chemical formula, determine hydrogen deficiency index (HDI).
Draw possible structures based on HDI.

1. a. Name the following hydrocarbons:

$CH_3CHCH_3CH_2CH_3$  

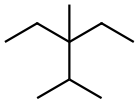
b. A 1^o C is a C with 0 or 1 C bonded to it, a 2^o is a C with 2 C bonded to it, 3^o C is a C with 3 C bonded to it.
In each compound, box the 2^o C and circle the 3^o C.
Answers:
a. parent chain = 4 carbons = butane, branch = methyl group on C-2. Name = 2-methylbutane
parent chain = 8 carbons = octane, branch = methyl group and ethyl group. Name = 6-ethyl-2-methyloctane (3-ethyl-7-methyloctane is incorrect because the sum of the numbers (3+7=10) is greater than 2+6=8).
parent chain = 5 carbons = pentane, branch = two methyl groups on C-3. Name = 3.3-dimethylpentane
b. In 3rd compound, the C with four C's bonded to it is called a quaternary carbon.

$CH_3CHCH_3CH_2CH_3$  

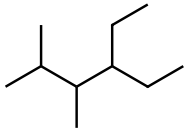


2. Draw the structure of the following compounds:
a. 2-methylpropane
b. 3-isopropyl-3-methylpentane
c. 4-ethyl-2,3-dimethylhexane. Why is it not correct to name this compound 2,3-dimethyl-4-ethylhexane?
Answers:
a.

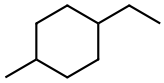
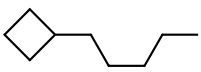
b.



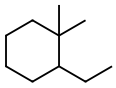
c. Branches are listed in alphabetical order so ethyl before methyl.



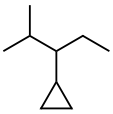
3. a. Name the following compounds.

b. Draw the structure of the following compounds.
(i) 2-ethyl-1,1-dimethylcyclohexane
(ii) 2-methyl-3-cyclopropylpentane
Answers:
a. 1-ethyl-4-methylcylcohexane
1-Cyclobutylpentane. The parent is the chain – 5 carbon chain vs. 4 carbon ring.
b.

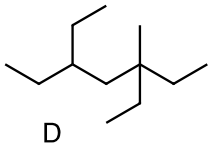


(i)

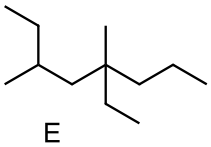


(ii)

4. Identifying 1^o, 2^o, or 3^o C's helps you determine whether two compounds are the same, different, or isomers. Consider Structures D and E.
a. Count the number of carbons.
b. Identify each carbon as a 1^o, 2^o, or 3^o C.
c. Are D and E the same compound, different compounds, or isomers?

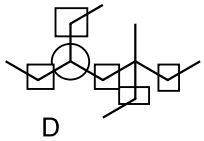


D

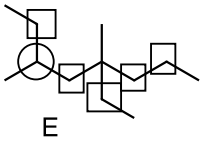


E

Answers:
a. D has 12 carbons. E has 12 carbons.
b. The 2^o C are boxed. Each compound has five 2^o C.
The 3^o C are circled. Each compound has one 3^o C.
The remaining carbons are 1^o C. Each compound has five 3^o C.
One carbon has 4 carbons bonded to it. This C is a quaternary (4^o) C. Each compound has one 4^o C.



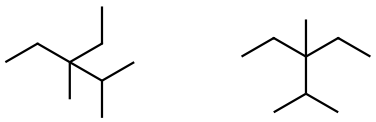
D



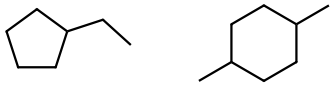
E

c. Each compound has 12 C and 26 H – either same compound or isomers.
Compound D parent chain is 7 carbons. Compound E parent chain is 8 carbons. ==> isomers
Check by naming each compound. D = 3,6-diethyl-3-methylheptane. E = 5-ethyl-3,5-dimethyloctane. ==> isomers

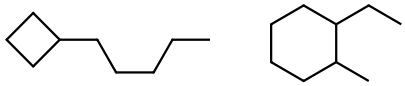
5. Determine whether each pair of compounds are the same compound, different compounds, or isomers. Confirm your answer by naming each compound.
a.



b.



c.



d.

Answers:
a. same compound. 3-isopropyl-3-methylpentane (from Question 2b) or 3-Ethyl-2,3-dimethylpentane.
b. different compounds (different number of carbons). Ethylcyclopentane and 1,4-dimethylcyclohexane.
c. Isomers. 1-Cyclobutylpentane and 1-ethyl-2-methylcylcohexane.
d. same compound. 3-Ethyl-4-methyl-1-hexene

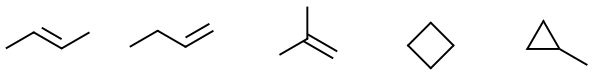
6. The Hydrogen Deficiency Index (HDI) tells you the number of pi bonds or rings or both in a compound. Determining the HDI helps you determine the possible structure of a compound quickly.
The HDI is calculated by comparing the # of H's in the compound of interest to the # of H's if the compound is a saturated hydrocarbon. A saturated hydrocarbon has the maximum # of H's and is an alkane. The formula for an alkane is C_nH_{2n+2}.
HDI = 0.5 (# of H's in saturated compound - # of H's in compound of interest)
If the compound contains O, ignore the O when you calculate HDI.
If the compound contains F, Cl, Br, or I, treat the F, Cl, Br, or I like a H when you calculate HDI.
Example 1: The HDI of C_3H_8 is 0.
3 C's so a saturated hydrocarbon with 3 C's has 8 H's ($C_nH_{2n+2} = C_3H_{2(3)+2} = C_3H_8$.
So HDI = 0.5 (# of H's in saturated compound - # of H's in compound of interest) = 0.5 (8 – 8) = 0.
The HDI tells us the structure of C_3H_8 does not have any pi bonds or rings.
Draw the structure of C_3H_8.

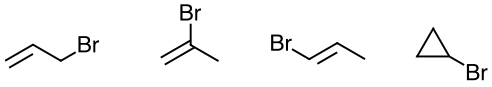
Example 2: The HDI of C_4H_8 is 1.
4 C's so a saturated hydrocarbon with 4 C's has 10 H's ($C_nH_{2n+2} = C_4H_{2(4)+2} = C_4H_{10}$.
So HDI = 0.5 (# of H's in saturated compound - # of H's in compound of interest) = 0.5 (10 – 8) = 1
The HDI tells us the structure of C_4H_8 has 1 pi bond or 1 ring.
Draw a structure of C_4H_8 with a pi bond.
Draw a structure of C_4H_8 with a ring.

Example 3: The HDI of C_3H_5Br is 1.
3 C's so a saturated hydrocarbon with 3 C's has 8 H's ($C_nH_{2n+2} = C_3H_{2(3)+2} = C_3H_8$.
Treat Br as H so treat C_3H_5Br as C_3H_6.
So HDI = 0.5 (# of H's in saturated compound - # of H's in compound of interest) = 0.5 (8 – 6) = 1.
The HDI tells us the structure of C_3H_5Br has 1 pi bond or 1 ring.
Draw a structure of C_3H_5Br with a pi bond.
Draw a structure of C_3H_5Br with a ring.

Example 4: The HDI of C_2H_6O is 0.
2 C's so a saturated hydrocarbon with 2 C's has 6 H's ($C_nH_{2n+2} = C_2H_{2(2)+2} = C_2H_6$.
Ignore O so treat C_2H_6O as C_2H_6.
So HDI = 0.5 (# of H's in saturated compound - # of H's in compound of interest) = 0.5 (6 – 6) = 0.
The HDI tells us the structure of C_2H_6O has no pi bonds or rings.
C_2H_6O has two isomers. Draw the structure of each isomer.
Answers:

C_3H_8 

C_4H_8 

C_3H_5Br 

C_2H_6O