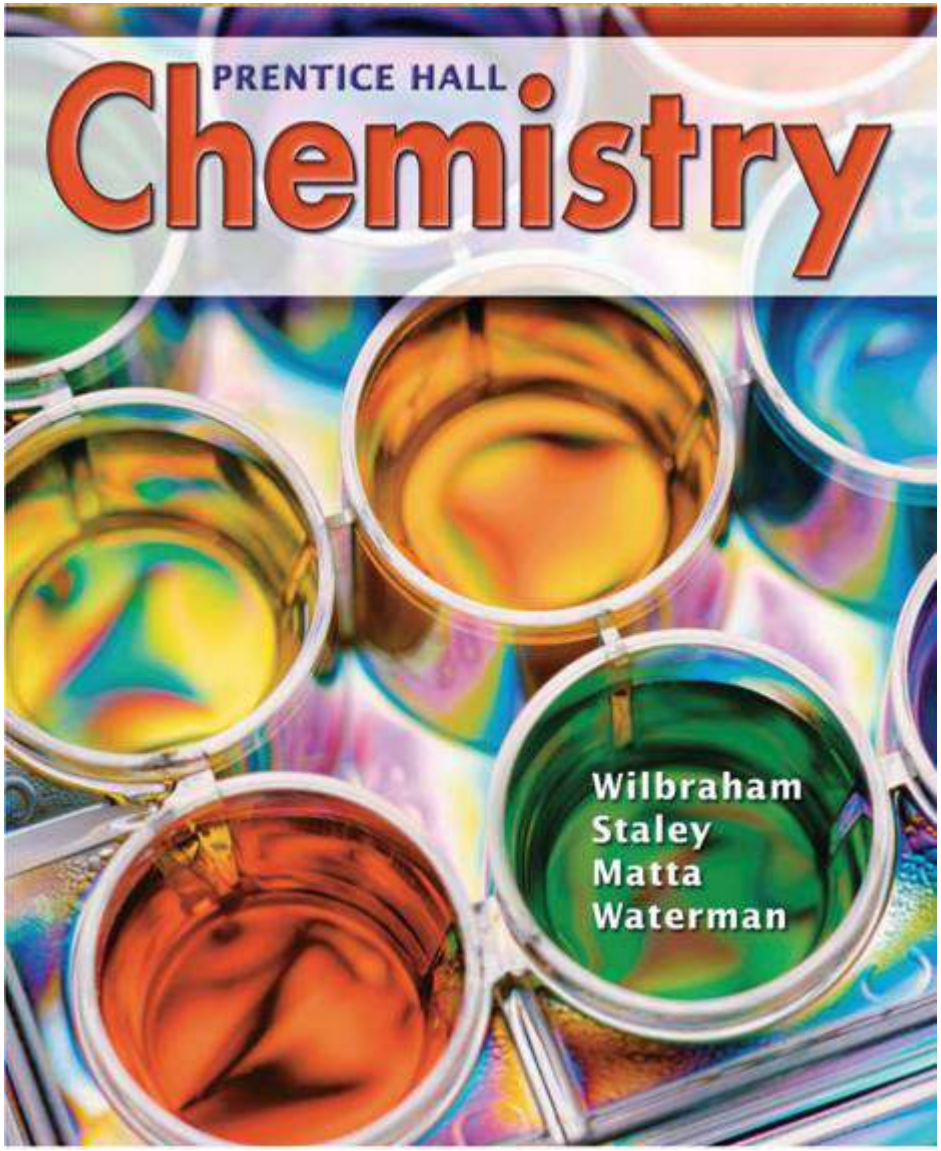

PRENTICE HALL
Chemistry
Wilbraham
Staley
Matta
Waterman

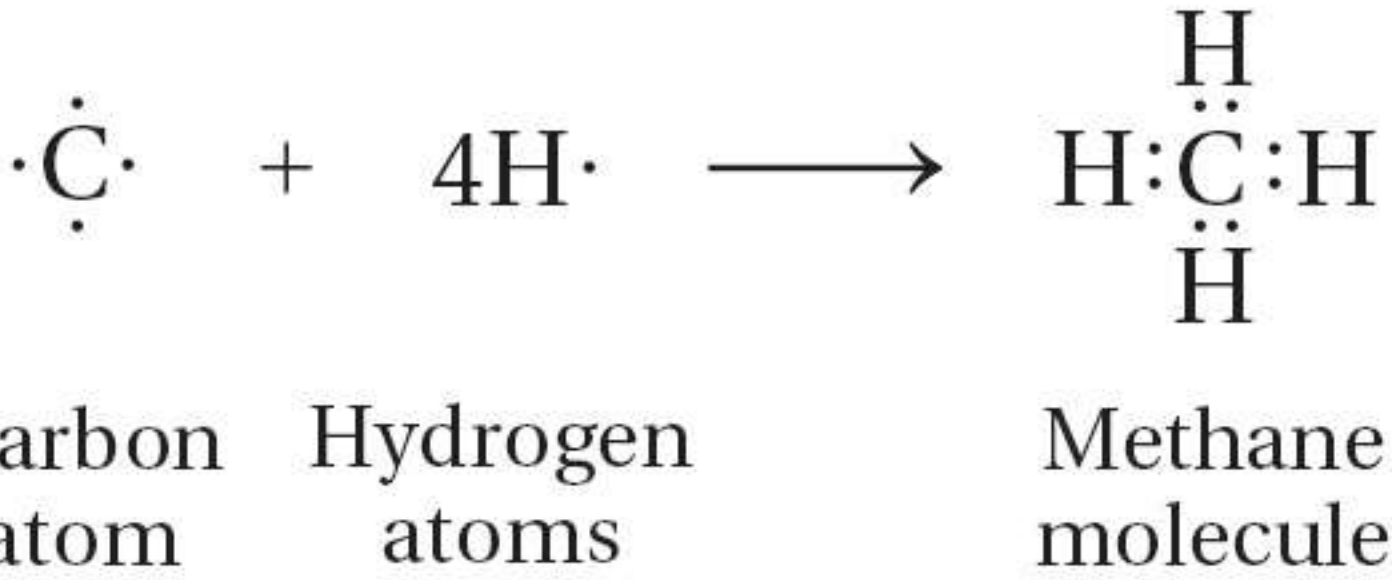
Bell Work

–How is the number of valence electrons in carbon atoms related to the bonds that carbon atoms form?

Because carbon has four valence electrons, a carbon atom always forms four covalent bonds.

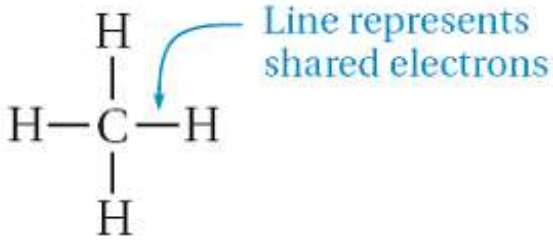
–The simplest organic compounds contain only carbon and hydrogen and are called **hydrocarbons.**

One carbon atom can form a single covalent bond with four hydrogen atoms.



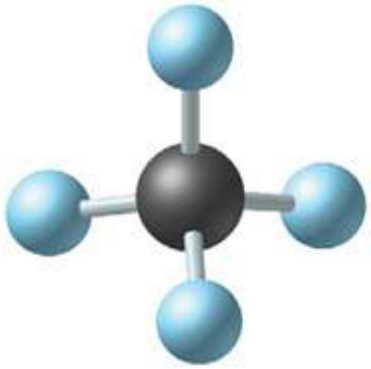
Formulas and Models for Methane and Ethane

Structural formula

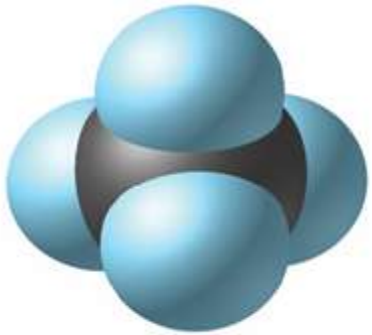


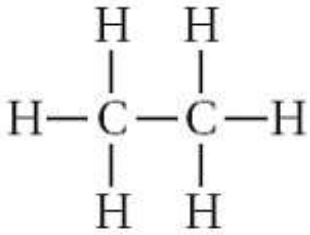
Methane (CH_4)

Ball-and-stick model

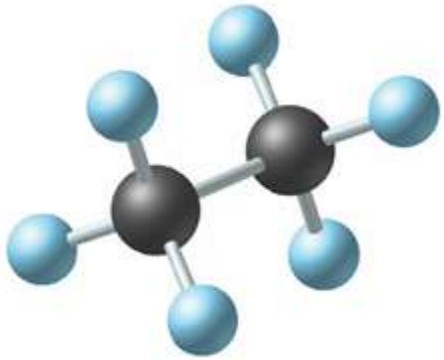


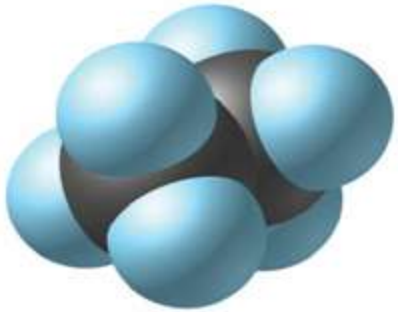
Space-filling model





Ethane (C_2H_6)





An **alkane** is a hydrocarbon in which there are only single covalent bonds.

–The carbon atoms in an alkane can be arranged in a straight chain or in a chain that has branches.

A group of compounds forms a **homologous series** if there is a constant increment of change in molecular structure from one compound in the series to the next.

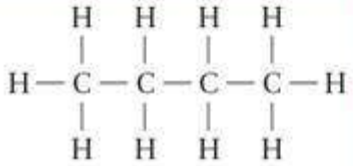
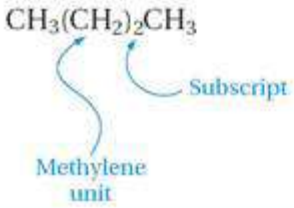
Table 22.1

The First Ten Straight-Chain Alkanes

Name	Molecular formula	Structural formula	Boiling point (°C)
Methane	CH_4	CH_4	−161.0
Ethane	C_2H_6	CH_3CH_3	−88.5
Propane	C_3H_8	$CH_3CH_2CH_3$	−42.0
Butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$	0.5
Pentane	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$	36.0
Hexane	C_6H_{14}	$CH_3CH_2CH_2CH_2CH_2CH_3$	68.7
Heptane	C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	98.5
Octane	C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	125.6
Nonane	C_9H_{20}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	150.7
Decane	$C_{10}H_{22}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	174.1

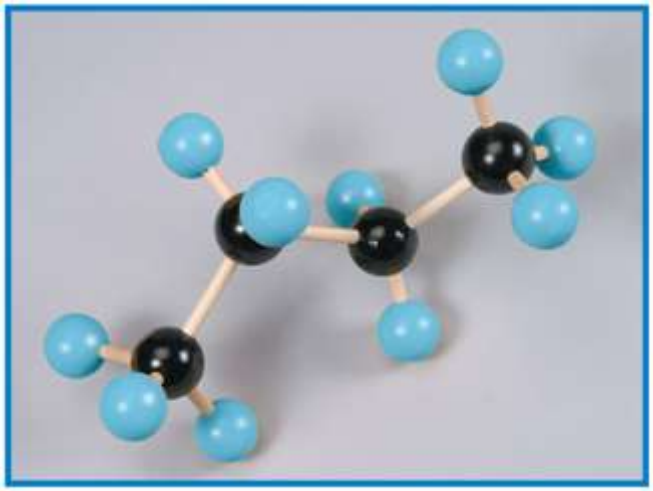
Table 22.2

Formulas for Butane

Formula	Description
C_4H_{10}	Molecular formula
	Complete structural formula
$CH_3 - CH_2 - CH_2 - CH_3$	Condensed structural formula; C — H bonds understood
$CH_3CH_2CH_2CH_3$	Condensed structural formula; C — H and — C — C — bonds understood
	Condensed structural formula; all bonds understood; parentheses indicate CH_2 units are linked together in a continuous chain (the $-CH_2-$ unit is called a methylene group); subscript 2 to the right of parenthesis indicates two methylene groups are linked together
C — C — C — C	Carbon skeleton; all hydrogens and C — H bonds understood
	Line-angle formula; all carbons and hydrogens understood; carbon atoms are located at each intersection and at the ends of lines

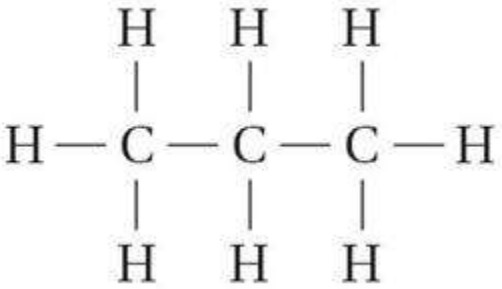
Drawing Structural Formulas for Alkanes

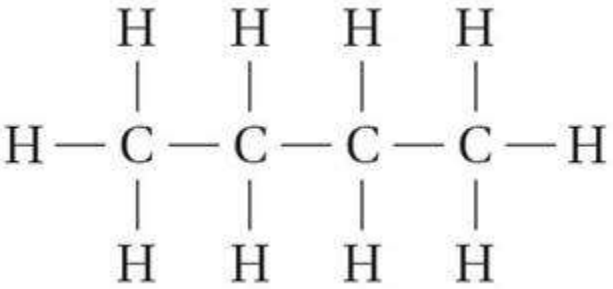
Draw complete structural formulas for the straight-chain alkanes that have three and four carbons.



2 Solve ***Apply concepts to this situation.***

A three-carbon straight-chain alkane has three carbon atoms in a straight line. The center carbon bonds to two hydrogen atoms. Each of the two end carbons bonds to three hydrogen atoms. A four-carbon straight-chain alkane has four carbon atoms in a straight line. Each of the two center carbons bonds to two hydrogen atoms, and each of the two end carbons bond to three hydrogen atoms.



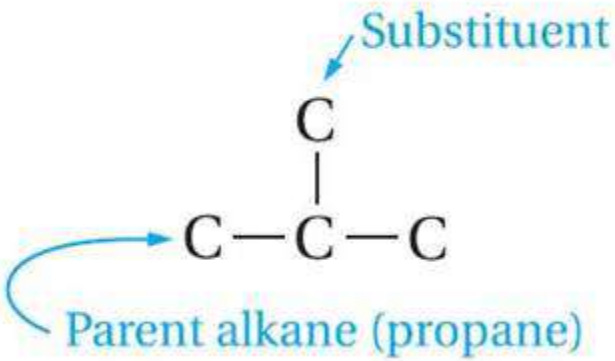


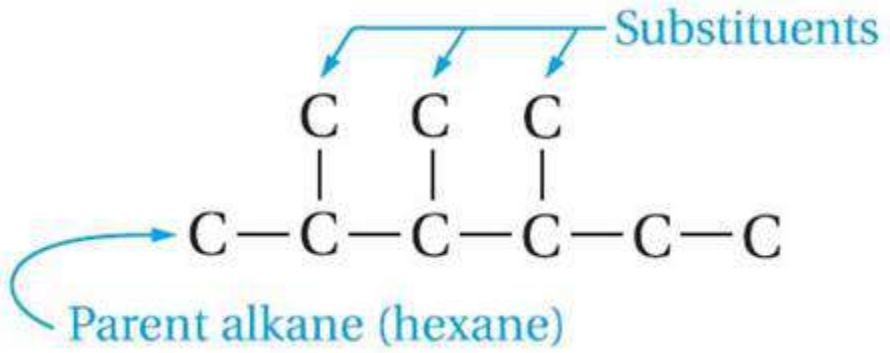
1. Draw complete structural formulas for the straight-chain alkanes with five and six carbons.

Problem Solving 22.1 Solve Problem 1 with the help of an interactive guided tutorial.

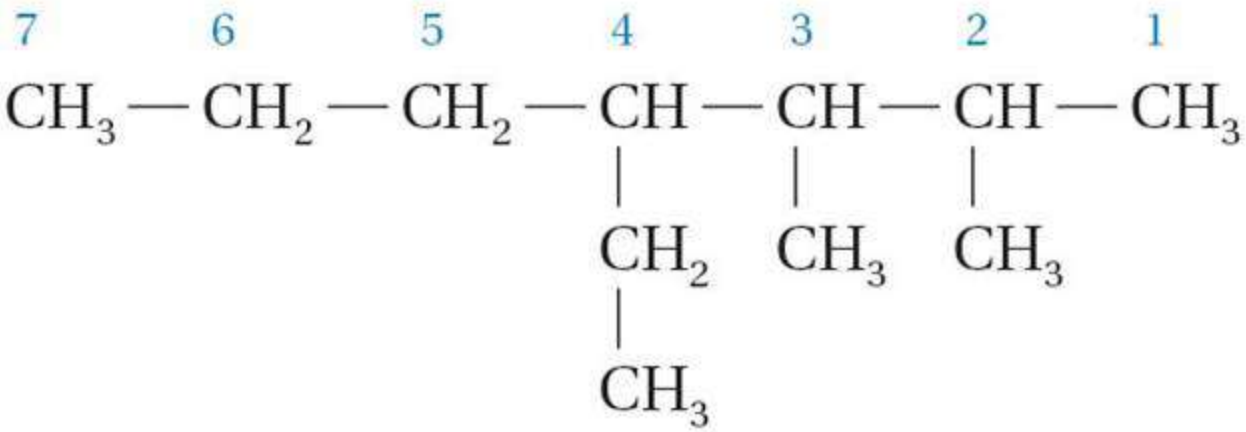
–Branched-Chain Alkanes

An atom or group of atoms that can take the place of a hydrogen atom on a parent hydrocarbon molecule is called a **substituent**.

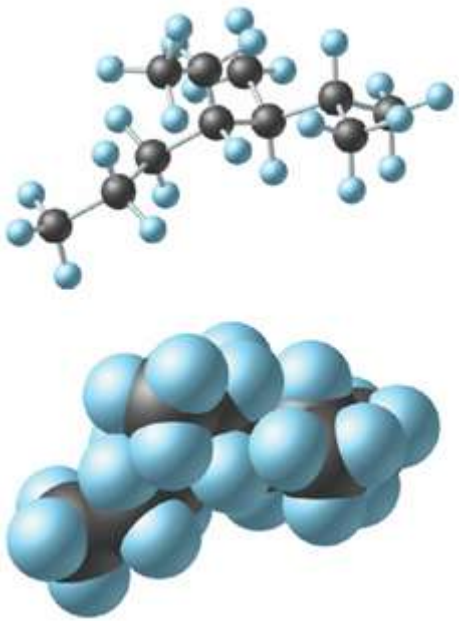




– A hydrocarbon substituent is called an **alkyl group**.
– An alkane with one or more alkyl groups is called a **branched-chain alkane**.

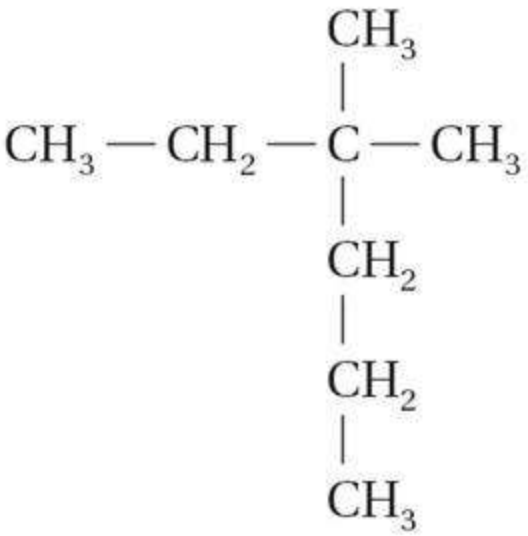


Ball-and-stick and space-filling models show the arrangement of atoms in 4-ethyl-2,3-dimethylheptane.



Naming Branched-Chain Alkanes

Name this compound using the IUPAC system. Notice that the longest chain is not written in a straight line.



1 Analyze ***Identify the relevant concepts.***

The parent structure is the longest chain of carbons. All other groups are substituents. The carbons are numbered to give the first substituent the lowest possible number.

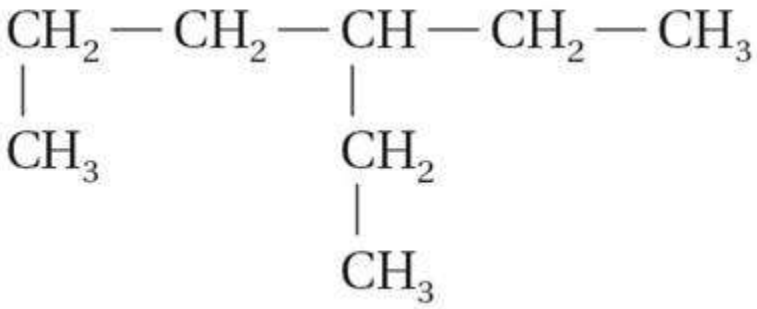
These location numbers become part of the name as prefixes. The names of the substituents are listed in alphabetical order with numbers separated by commas and numbers and words separated by hyphens.

2 Solve ***Apply concepts to this situation.***

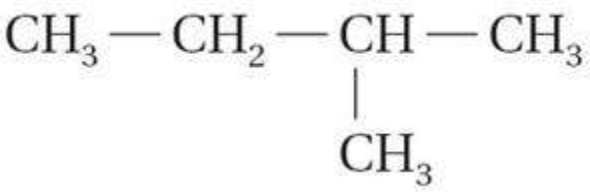
The longest carbon chain in the molecule is hexane (six carbons). There are two methyl substituents on carbon 3, so the prefix is 3,3-dimethyl. The correct IUPAC name is 3,3-dimethylhexane.

3. Name these compounds according to the IUPAC system.

a.



b.



Problem Solving 22.3 Solve Problem 3 with the help of an interactive guided tutorial.

Drawing Structural Formulas for Branched-Chain Alkanes

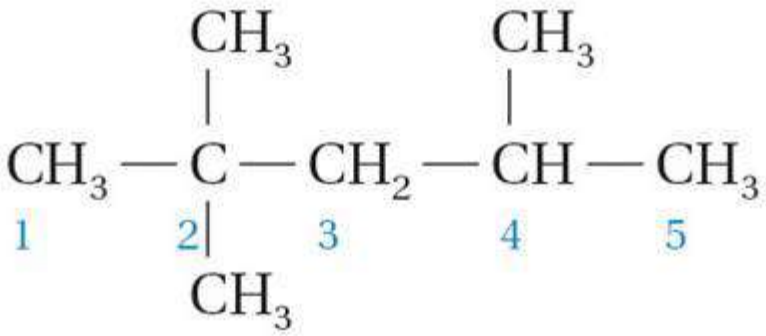
The compound 2,2,4-trimethylpentane (isooctane) is found in gasoline. Draw a complete structural formula for isooctane.

1 Analyze ***Identify the relevant concepts.***

Prefixes indicate the types of substituents, the number of times each appears, and their locations on the parent chain. The part of the name that ends in *-ane* indicates the parent structure. The carbons on the parent chain are numbered so that the carbons to which alkyl substituents are attached have the lowest numbers. Hydrogens are added as needed.

2 Solve ***Apply concepts to this situation.***

The parent structure is pentane, which has five carbon atoms. There are two methyl groups on carbon 2 and one on carbon 4. Nine hydrogens are added to complete the structure.



5. Draw a structural formula for 2,3-dimethylhexane.

Problem Solving 22.5 Solve Problem 5 with the help of an interactive guided tutorial.

Properties of Alkanes

–In terms of their polarity, what type of molecules are alkanes?

–Molecules of hydrocarbons, such as alkanes, are nonpolar molecules.

–The the oil spill are n r water mole

22.1 Section Quiz.

Assess students' understanding of the concepts in Section 22.1.

Continue to:

Section Quiz

-or-

Launch:

ExamView® QuickTake

22.1 Section Quiz.

– 1. Choose the correct words for the spaces. Because carbon has _____ valence electrons, it can form _____ bonds.

- four, four covalent
- four, four ionic
- six, six covalent
- six, four or fewer covalent

22.1 Section Quiz.

2. Alkanes are hydrocarbons that contain only _____ bonds.

- carbon-carbon
- single covalent
- carbon-hydrogen
- ionic

22.1 Section Quiz

3. Choose the correct words for the spaces.
   Hydrocarbons are highly soluble in _____ solvents because they are _____ molecules.

- nonpolar, nonpolar
- nonpolar, polar
- polar, nonpolar
- polar, polar

END OF SHOW