

HART/CRAIGNE/HART/HADAD

Organic Chemistry  
A SPECTRI. COURSE

Twelfth Edition

## CHAPTER TWO

### Alkanes and Cycloalkanes; Conformational and Geometric Isomerism

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## Warning!!

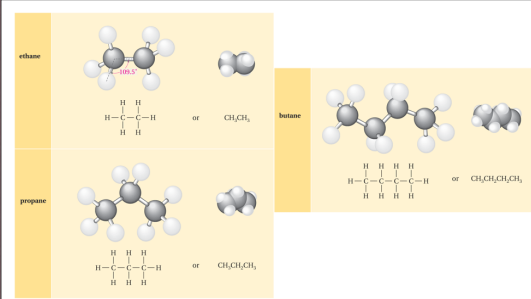
- These slides contains visual aids for learning BUT they are NOT the actual lecture notes!
- Failure to attend to lectures most probably result in failing the lecture!
- So I strongly recommend that you attend to the classes. Take a pen, a notebook and WRITE!

## Alkane bonds

$$\text{CH}_3(\text{CH}_2)_n\text{CH}_3$$

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## Three-dimensional models of ethane, propane, and butane.



ethane:  $\text{CH}_3\text{CH}_3$  or  $\text{CH}_3\text{CH}_3$

propane:  $\text{CH}_3\text{CH}_2\text{CH}_3$  or  $\text{CH}_3\text{CH}_2\text{CH}_3$

butane:  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$  or  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

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## Names and Formulas of the First Ten Unbranched Alkanes

Name	Number of carbons	Molecular formula	Structural formula	Number of structural isomers
methane	1	$\text{CH}_4$	$\text{CH}_4$	1
ethane	2	$\text{C}_2\text{H}_6$	$\text{CH}_3\text{CH}_3$	1
propane	3	$\text{C}_3\text{H}_8$	$\text{CH}_3\text{CH}_2\text{CH}_3$	1
butane	4	$\text{C}_4\text{H}_{10}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	2
pentane	5	$\text{C}_5\text{H}_{12}$	$\text{CH}_3(\text{CH}_2)_3\text{CH}_3$	3
hexane	6	$\text{C}_6\text{H}_{14}$	$\text{CH}_3(\text{CH}_2)_4\text{CH}_3$	5
heptane	7	$\text{C}_7\text{H}_{16}$	$\text{CH}_3(\text{CH}_2)_5\text{CH}_3$	9
octane	8	$\text{C}_8\text{H}_{18}$	$\text{CH}_3(\text{CH}_2)_6\text{CH}_3$	18
nonane	9	$\text{C}_9\text{H}_{20}$	$\text{CH}_3(\text{CH}_2)_7\text{CH}_3$	35
decane	10	$\text{C}_{10}\text{H}_{22}$	$\text{CH}_3(\text{CH}_2)_8\text{CH}_3$	75

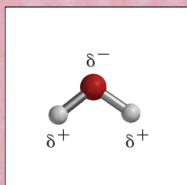
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## Examples of Use of the IUPAC Rules

$\begin{array}{c} 1 & 2 & 3 \\ \text{CH}_3 & \text{CH}_2 & \text{CH}_2 & \text{CH}_2 & \text{CH}_3 \\   & & & & \\ \text{CH}_3 & & & & \end{array}$ 2-methylpentane (not 4-methylpentane)	The ending -ane tells us that all the carbon-carbon bonds are single; pent- indicates five carbons in the longest chain. We number them from right to left, starting closest to the branch point.
$\begin{array}{c} 3 & 4 & 5 & 6 \\ \text{CH}_3 & \text{CH}_2 & \text{CH}_2 & \text{CH}_2 & \text{CH}_3 \\   & & & & \\ \text{CH}_3 & & & & \end{array}$ 3-methylhexane (not 2-ethylpentane or 4-methylhexane)	This is a six-carbon saturated chain with a methyl group on the third carbon. We would usually write the structure as $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$ .
$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3 - \text{C} - \text{CH}_2\text{CH}_3 \\   \\ \text{CH}_3 \end{array}$ 2,2-dimethylbutane (not 2,2-methylbutane or 2-dimethylbutane)	There must be a number for each substituent, and the prefix di- says that there are two methyl substituents.
$\begin{array}{c} 1 & 2 & 3 & 4 \\ \text{CH}_3 & \text{CH}_2 & \text{CH} & \text{CH}_3 \\   & &   & \\ \text{Cl} & & \text{Br} & \end{array}$ 3-bromo-2-chlorobutane (not 1-chloro-3-bromobutane or 2-bromo-4-chlorobutane)	First, we number the butane chain from the end closest to the first substituent. Then we name the substituents in alphabetical order, regardless of position number.

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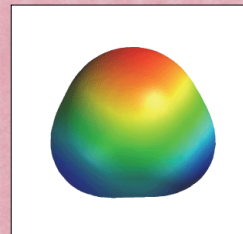
### Hydrogen Bonding: (a) polar water molecule: ball-and-stick model



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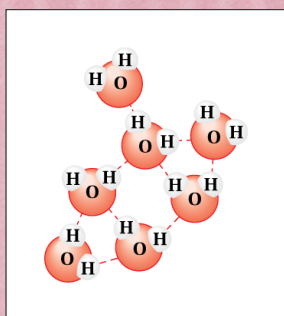
### Hydrogen Bonding: (a) polar water molecule: electrostatic potential map



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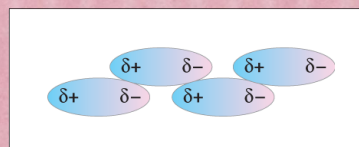
### Hydrogen Bonding: (b) hydrogen bonding between water molecules



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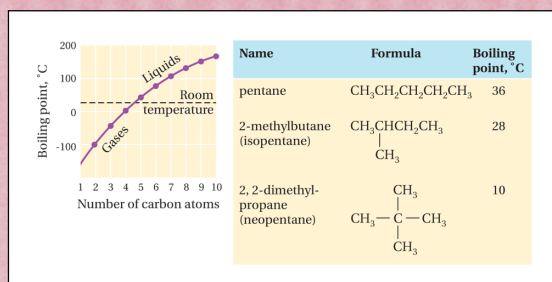
### Molecules with partially positive and partially negative ends



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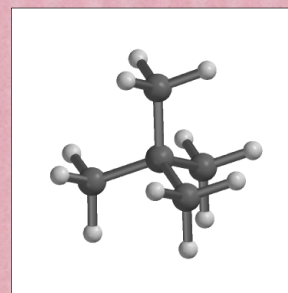
### Boiling points of the normal alkanes



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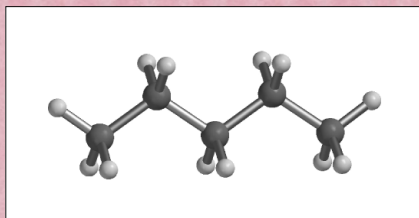
### 2,2-Dimethylpropane ball-and-stick model



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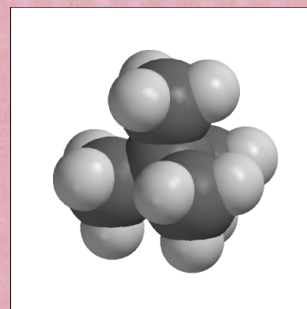
Pentane: ball-and-stick model



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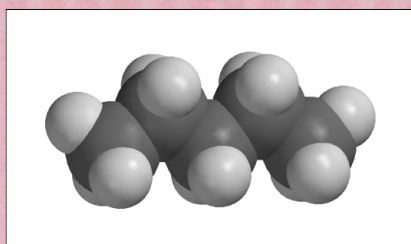
2,2-Dimethylpropane space filling model



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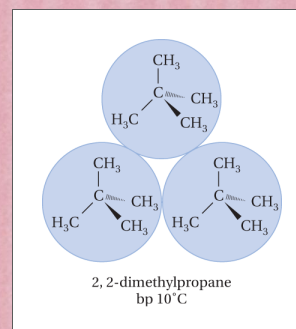
Pentane: space filling model



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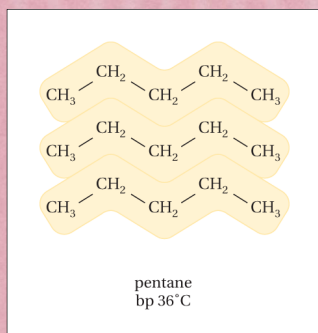
2,2-Dimethylpropane dash-wedge model



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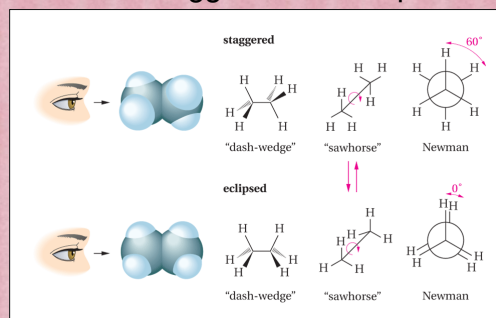
Pentane: dash-wedge model



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Two of the possible conformations for ethane: staggered and eclipsed.

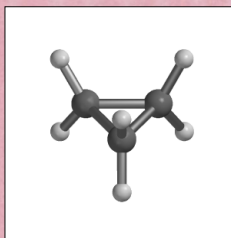


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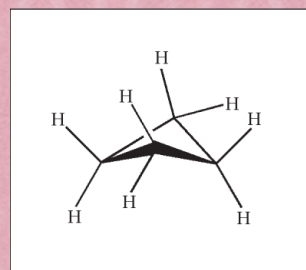
Ball-and-stick model of cyclopropane



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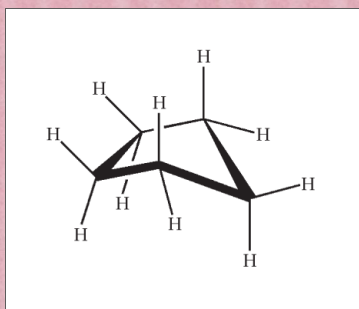
Cyclobutane structure



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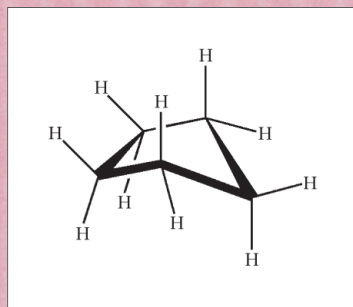
Cyclopentane structure



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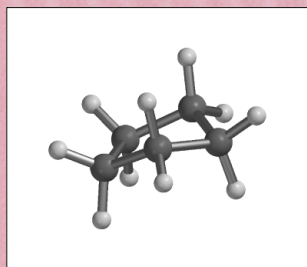
Ball-and-stick model of cyclobutane



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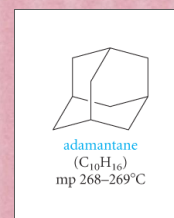
Ball-and-stick model of cyclopentane



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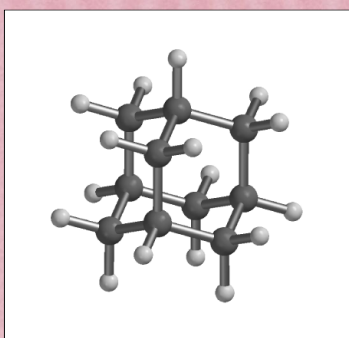
Ball-and-stick of adamantane



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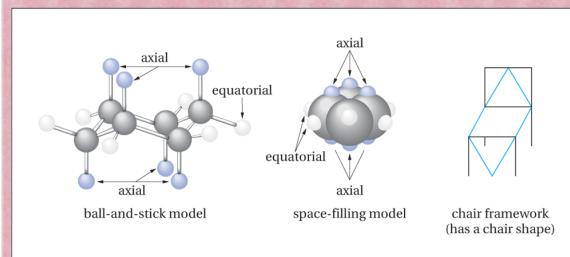
## Ball-and-stick of diamantane



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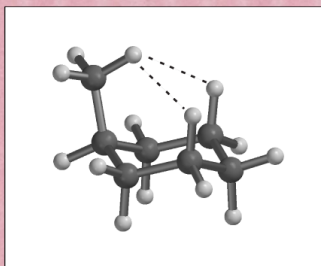
## The chair conformation of cyclohexane, shown in ball-and-stick and space-filling models.



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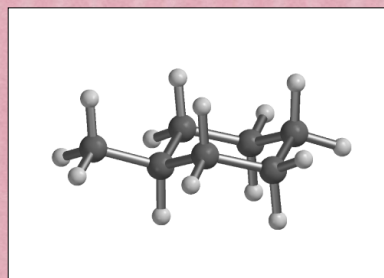
Conformational equilibrium between the axial (left) and equatorial (right) isomers of methylcyclohexane. The steric interactions between the axial methyl and the 1,3-diaxial hydrogens are evident in the left ball and stick structure.



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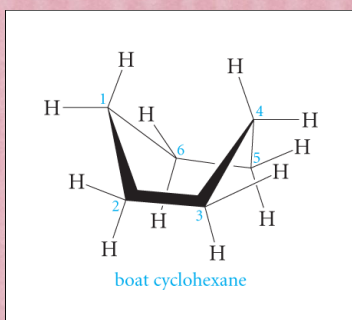
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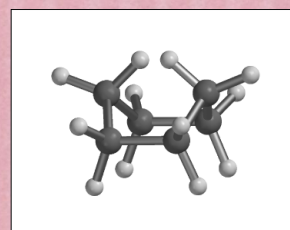
## Boat cyclohexane



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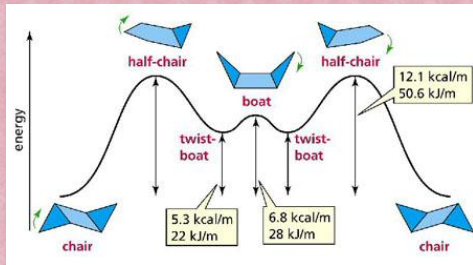
## Ball-and-stick model of boat cyclohexane



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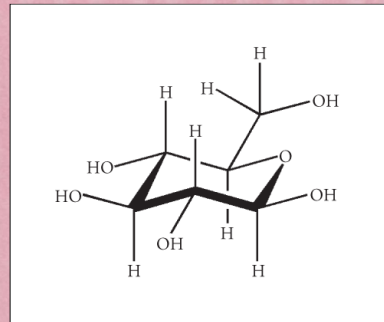
### Conformation Energy



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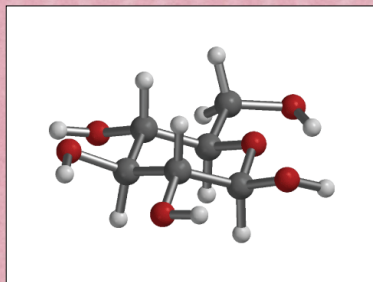
### Line drawing of glucose



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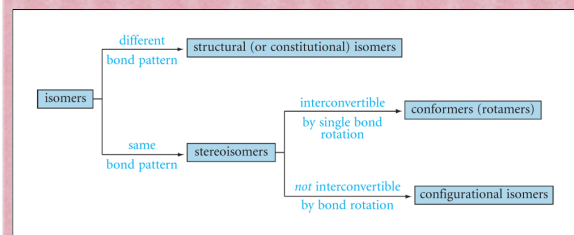
### Ball-and-stick model of glucose



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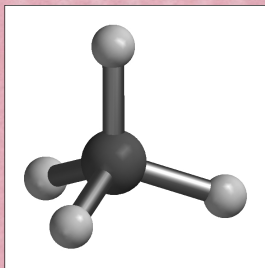
### The relationships of the various types of isomers.



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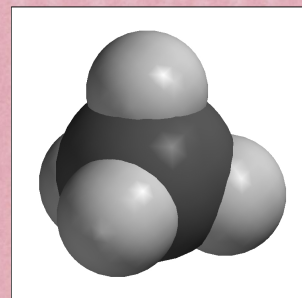
### Methane -- ball-and-stick



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### Methane -- space-filling model

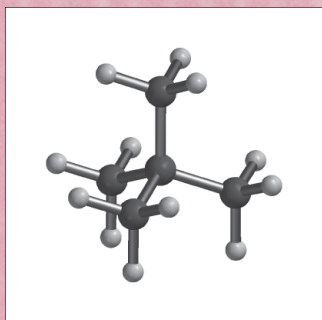


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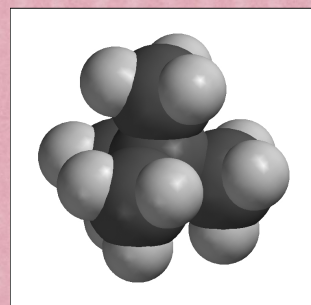
2,2-dimethylpropane -- ball-and-stick



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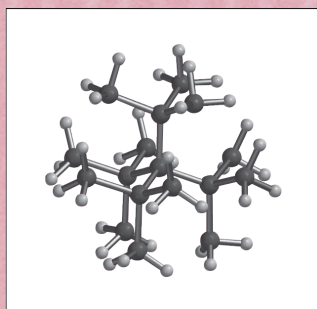
2,2-dimethylpropane -- space filling model



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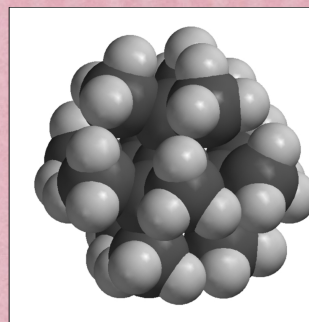
tetra-t-butylmethane -- ball-and-stick



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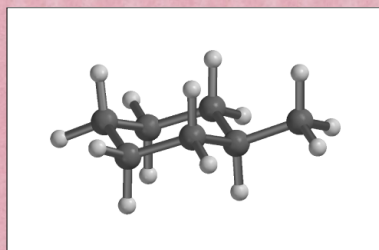
tetra-t-butylmethane -- space-filling model



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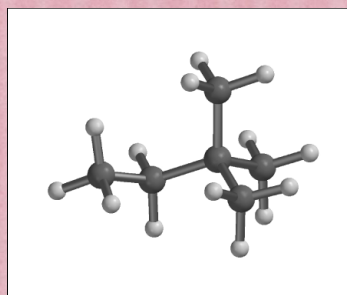
Ball-and-stick model of methylcyclohexane



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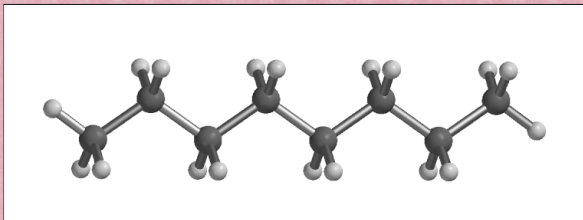
Ball-and-stick model of 2,2-dimethylbutane



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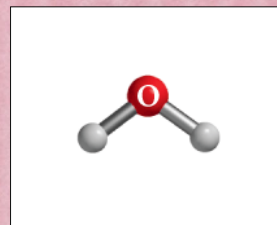
Ball-and-stick model of octane for  
Prob. 2-35



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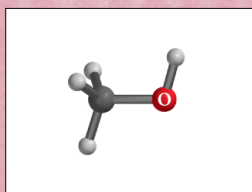
Ball-and-stick model of water Prob. 2-35



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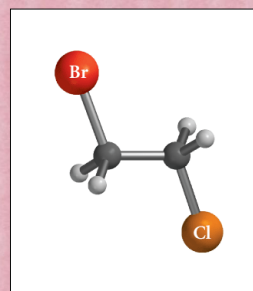
Ball-and-stick model of  $\text{CH}_3\text{OH}$  for  
Prob. 2-35



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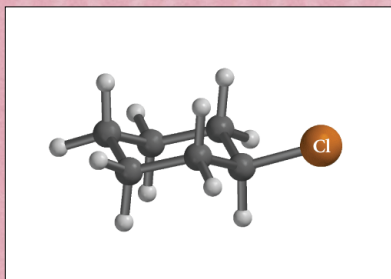
Ball-and-stick model of 1-bromo-2-  
chloroethane for Prob. 2-37



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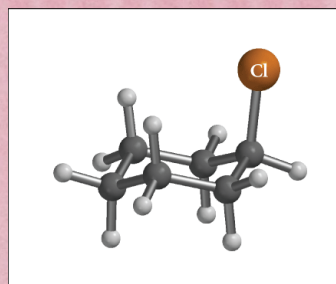
Ball-and-stick model for Problem 2-42b



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Ball-and-stick model for Problem 2-42b



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