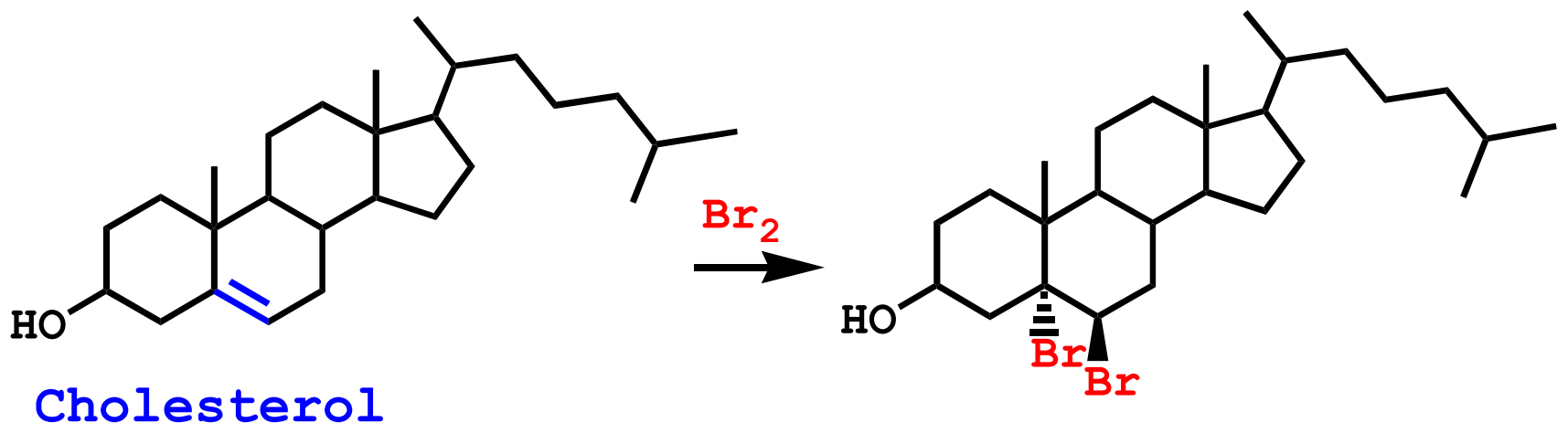
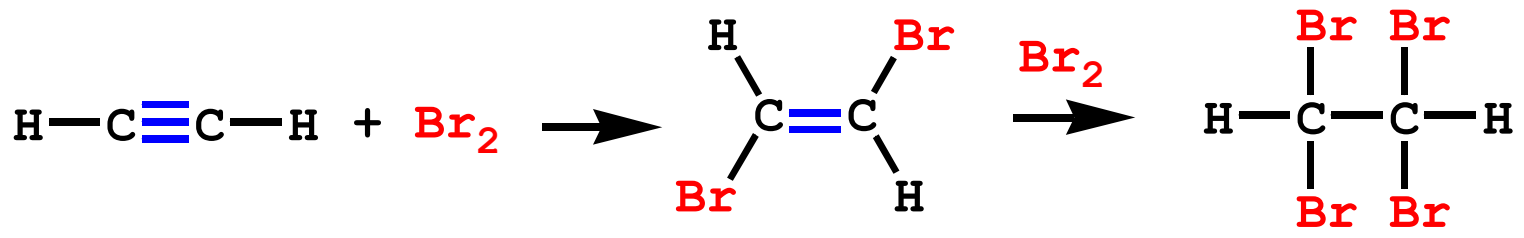
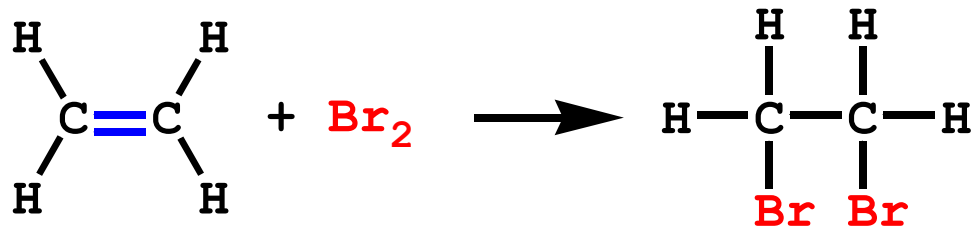


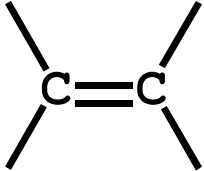

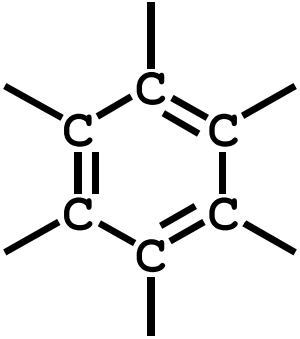
## Chapter 3 - Nature of Organic Compounds: Alkanes and Cycloalkanes\*

Chemistry of a molecule -> determined by the functional groups it contains

Functional group = a small structural fragment that has characteristic properties/reactivity



\*Common **functional** groups (Table 3.1)...

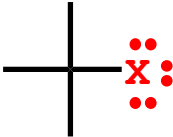
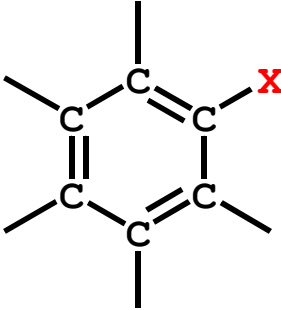
<b>alkene</b>	
<b>alkyne</b>	
<b>arene (aromatic ring)</b>	

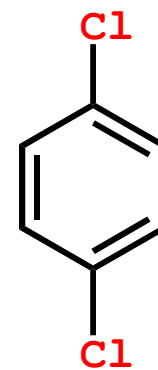


ethylene

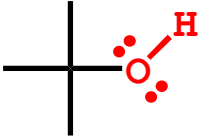
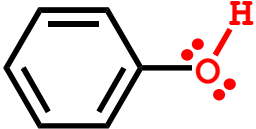


acetylene

<p>alkyl halide</p>	 <p>X = F, Cl, Br, I</p>
<p>aryl halide</p>	

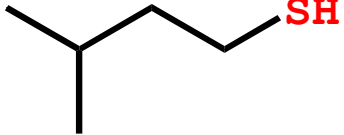



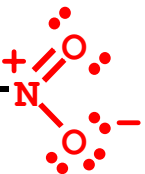
mothballs

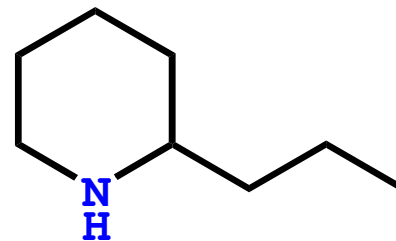
alcohol	
phenol	
ether	$\text{Ar}_1, \text{R}_1 \text{---} \ddot{\text{O}} \text{---} \text{R}_2, \text{Ar}_2$
thiol	$\text{Ar}, \text{R} \text{---} \ddot{\text{S}} \text{---} \text{H}$
sulfide	$\text{Ar}_1, \text{R}_1 \text{---} \ddot{\text{S}} \text{---} \text{R}_2, \text{Ar}_2$

$\text{CH}_3\text{CH}_2\text{---OH}$   
ethyl alcohol

$\text{CH}_3\text{CH}_2\text{---O---CH}_2\text{CH}_3$   
"ether"

  
skunk perfume

amine	$\text{Ar, R, H-N:}$ 
nitrile	$\text{Ar, R-C}\equiv\text{N:}$
nitro	$\text{Ar, R-N}^+\begin{matrix} \diagup \text{O} \\ \diagdown \text{O}^- \end{matrix}$ 

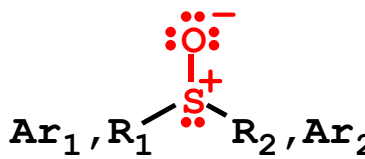
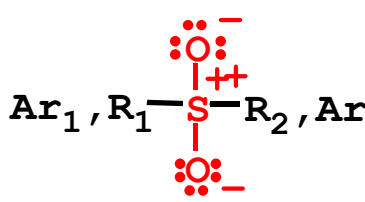


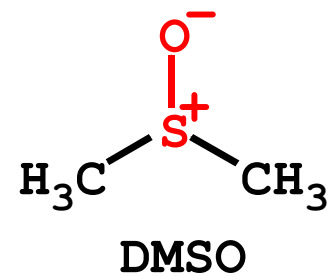
coniine  $\rightarrow$  poison

aldehyde	$\begin{array}{c} \text{:O:} \\ \parallel \\ \text{H, Ar, R} \text{---} \text{C} \text{---} \text{H} \end{array}$
ketone	$\begin{array}{c} \text{:O:} \\ \parallel \\ \text{Ar}_1, \text{R}_1 \text{---} \text{C} \text{---} \text{R}_2, \text{Ar}_2 \end{array}$
carboxylic acid	$\begin{array}{c} \text{:O:} \\ \parallel \\ \text{H, Ar, R} \text{---} \text{C} \text{---} \text{O} \text{H} \\ \text{:} \end{array}$
ester	$\begin{array}{c} \text{:O:} \\ \parallel \\ \text{H, Ar}_1, \text{R}_1 \text{---} \text{C} \text{---} \text{O} \text{---} \text{R}_2, \text{Ar}_2 \\ \text{:} \end{array}$
acid chloride	$\begin{array}{c} \text{:O:} \\ \parallel \\ \text{Ar, R, H} \text{---} \text{C} \text{---} \text{Cl} \\ \text{:} \end{array}$
acid anhydride	$\begin{array}{c} \text{:O:} \quad \text{:O:} \\ \parallel \quad \parallel \\ \text{Ar}_1, \text{R}_1, \text{H} \text{---} \text{C} \text{---} \text{O} \text{---} \text{C} \text{---} \text{R}_2, \text{Ar}_2, \text{H} \\ \text{:} \end{array}$
amide	$\begin{array}{c} \text{:O:} \\ \parallel \\ \text{H, Ar}_1, \text{R}_1 \text{---} \text{C} \text{---} \text{N} \text{---} \text{R}_2, \text{Ar}_2, \text{H} \\ \text{:} \\ \text{R}_3, \text{Ar}_3, \text{H} \end{array}$

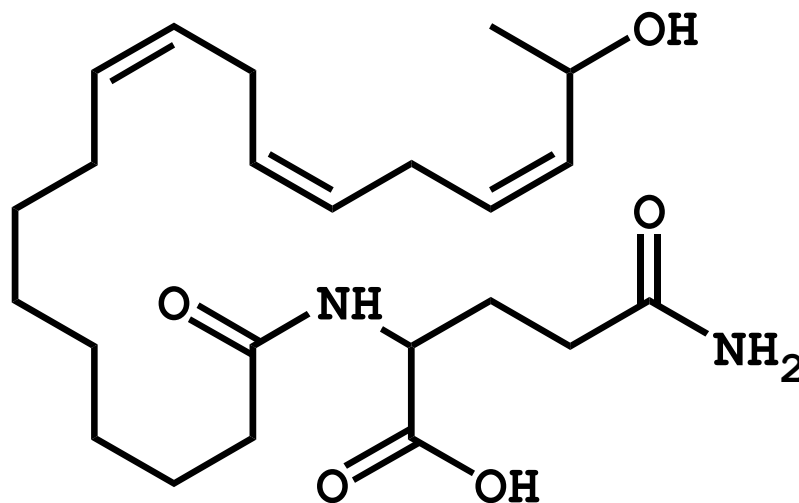
acetone

acetic acid

<p><b>sulfoxide</b></p>	
<p><b>sulfone</b></p>	



**Question:** Identify the functional groups...



**volicitin**

Some plants respond to attack from chewing caterpillars by producing volatile terpenoids. Volicitin attracts parasitic wasps which come to the defense of the plants by parasitizing the caterpillars.

Consider the  $pK_a$ 's of the OH's in alcohols, phenols and carboxylic acids. Why are they so different?

**\*Saturated hydrocarbons = alkanes =**  
**aliphatic hydrocarbons**

**Aliphatic** (from the Greek *aleiphas*, meaning "fat") ->  
contains no  $\pi$ -bonds or rings

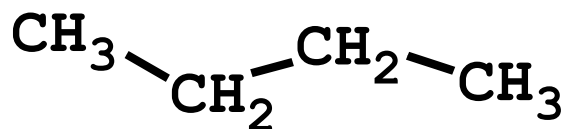
Learn names of  $C_1$  to  $C_{10}$  alkanes (Table 3.3)...



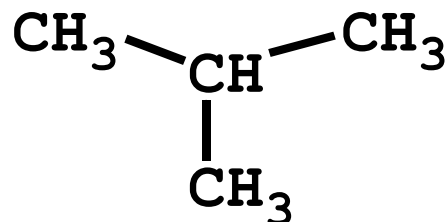
$CH_4$	methane
$CH_3-CH_3$	ethane
$CH_3-CH_2-CH_3$	propane
$CH_3-CH_2-CH_2-CH_3$	butane
$C_5H_{12}$	pentane
etc...	
$C_{10}H_{22}$	decane

## \*Alkane and alkyl group nomenclature

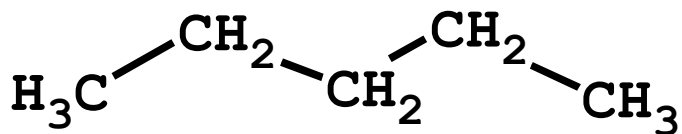
Common names of some butane and pentane isomers...



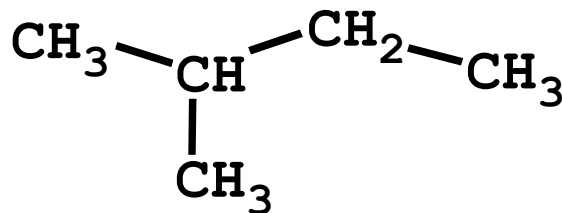
n-butane



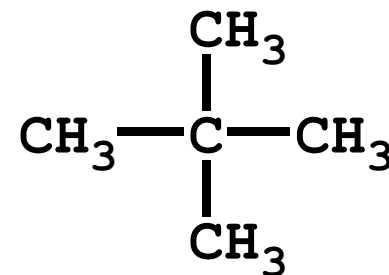
isobutane



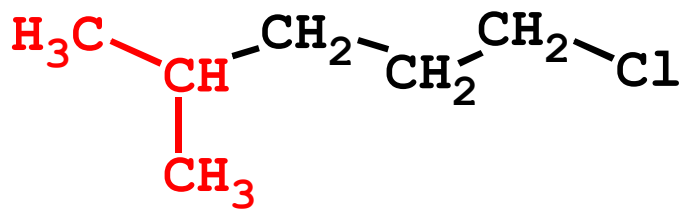
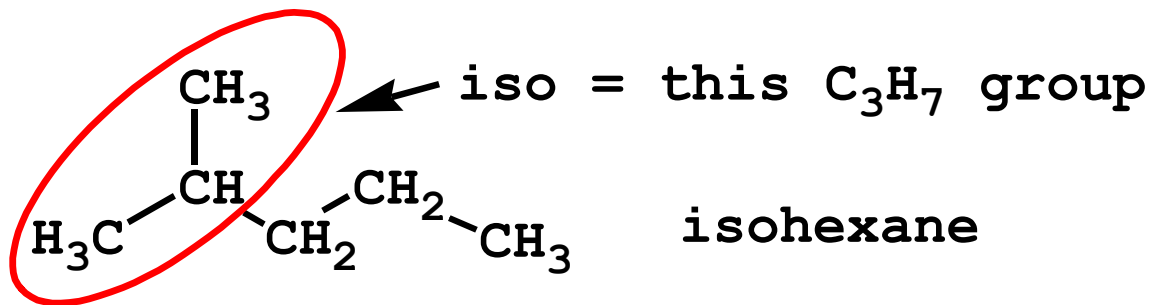
pentane



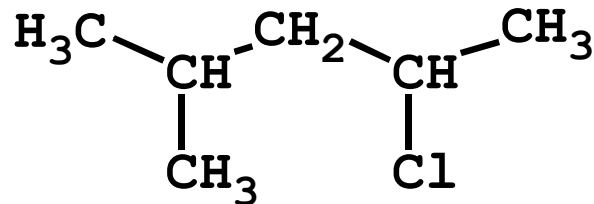
isopentane



neopentane



isohexyl chloride



not isohexyl chloride

IUPAC name = 2-chloro-4-methylpentane

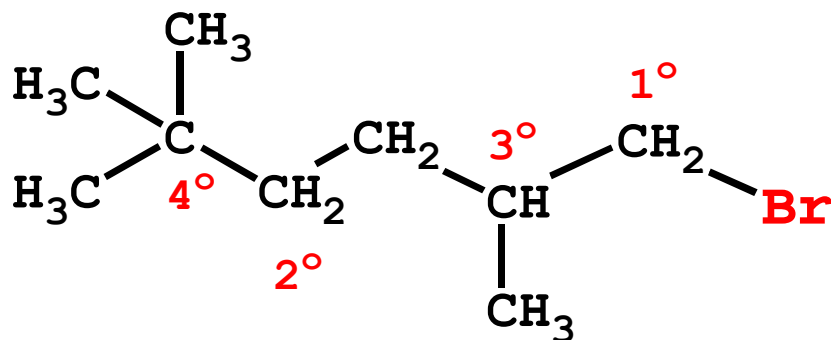
# Common and IUPAC alkyl group names...

alkyl group	common name	IUPAC name
$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-}$	propyl	propyl
$\begin{array}{c} \text{CH}_3 \\ \diagdown \\ \text{CH-} \\ \diagup \\ \text{CH}_3 \end{array}$	isopropyl	1-methylethyl
$\begin{array}{c} \text{CH}_3 \\ \diagdown \\ \text{CH-CH}_2\text{-} \\ \diagup \\ \text{CH}_3 \end{array}$	isobutyl	2-methylpropyl
$\begin{array}{c} \text{CH}_3\text{-CH}_2\text{-CH-} \\   \\ \text{CH}_3 \end{array}$	sec-butyl (s-butyl)	1-methylpropyl
$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3\text{-C-} \\   \\ \text{CH}_3 \end{array}$	tert-butyl (t-butyl)	1,1-dimethylethyl

## Comments about 1°, 2°, 3°...

Primary (1°) C is bonded to one other C atom.

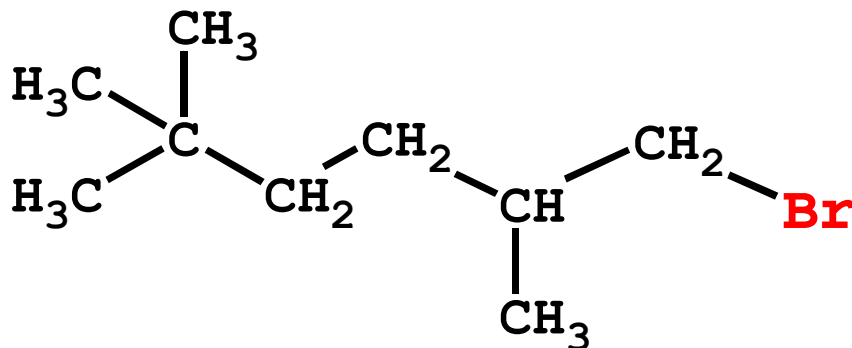
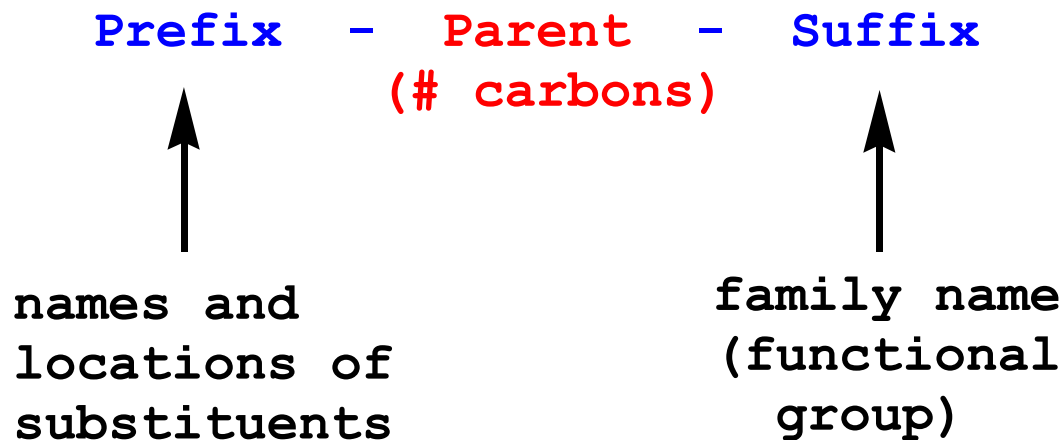
Secondary (2°) C is bonded to two other C's, etc.



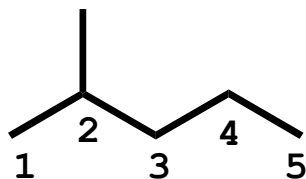
# \*Alkane nomenclature - the IUPAC system..

International Union of Pure and Appplied Chemistry

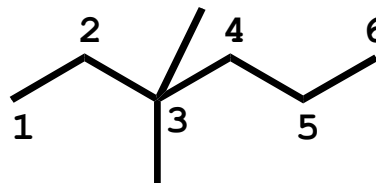
Naming rules in section 3.4; an IUPAC name consists of..



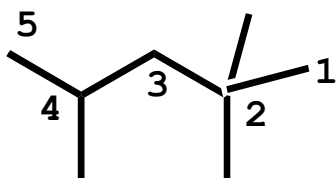
1-bromo-2,5,5-trimethylhexane



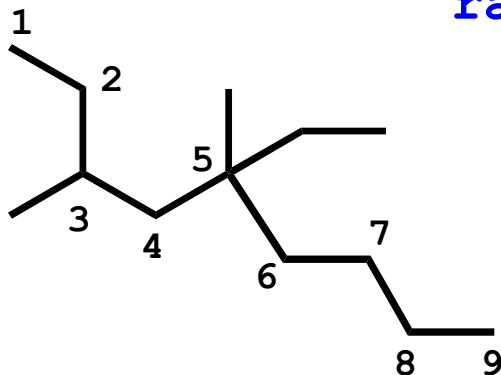
2-methylpentane



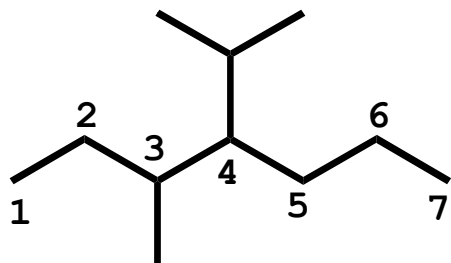
3,3-dimethylhexane



2,2,4-trimethylpentane  
(isooctane; 100 octane  
rating)



5-ethyl-3,5-dimethylnonane



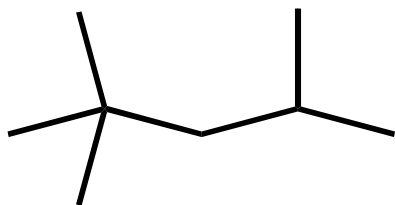
4-isopropyl-3-methylheptane

**\*Properties of alkanes:** Read and study section 3.5

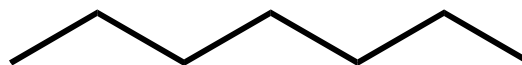
~~~~~

**An aside on gasoline, octane, petroleum..**

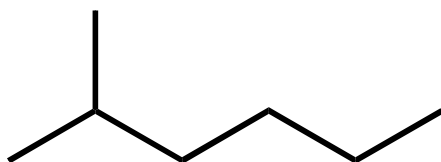
1929, procedure developed for establishing anti-knock quality of gasoline



isooctane  
octane # 100



heptane  
octane # 0



2-methylhexane  
octane # 42

{ has same knocking properties as mixture of...  
42% isooctane &  
58% heptane



octane # -20

1930, anti-knock properties of tetraethyl lead discovered by Thomas Midgley.

3 g Et<sub>4</sub>Pb per gal increases octane # 15-20.

2.4-3.2 g/gal in regular; 4.2 g/gal in premium.

Et<sub>4</sub>Pb usage peaked in 1970's; used in ~99% of all U. S. gasoline

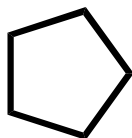
### Components of petroleum...

| Bp (°C)  | # C's | Fraction/Use                            |
|----------|-------|-----------------------------------------|
| < 30     | 2-4   | petroleum gas, heating, propane, butane |
| 30-180   | 4-9   | gasoline                                |
| 160-230  | 8-16  | kerosene, heating, jet fuel             |
| 200-320  | 10-18 | diesel, fuel                            |
| 300-450  | 16-30 | heavy oil, heating, lubrication         |
| > 300    | > 25  | petroleum jelly, parafin wax            |
| (vacuum) | > 35  | asphalt                                 |

## \*Cycloalkanes...

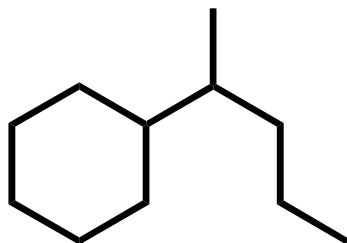


Cyclopropane

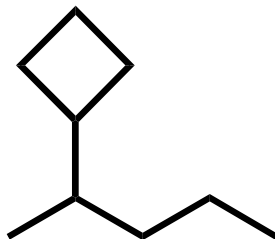


Cyclopentane

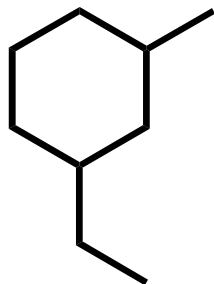
If the # ring C's  $\geq$   
the C's in largest  
substituent, name as a  
cycloalkane.



1-methylbutylcyclohexane  
(is sec-pentylcyclohexane OK?)



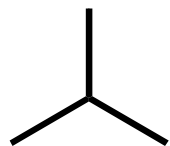
2-cyclobutylpentane



1-ethyl-3-methylcyclohexane

# \*Stereoisomers and cycloalkanes...

Constitutional isomers (different connections)...

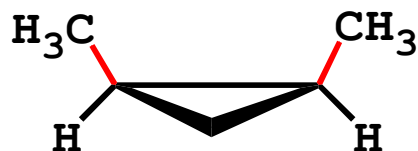


and

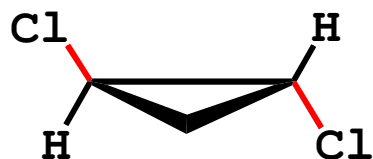


Hmmm...what is an isomer?

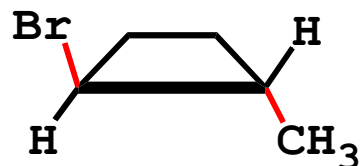
Stereoisomers (same connections, different 3D structures)...



cis-1,2-dimethylcyclopropane



trans-1,2-dichlorocyclopropane



trans-1-bromo-3-methylcyclobutane

