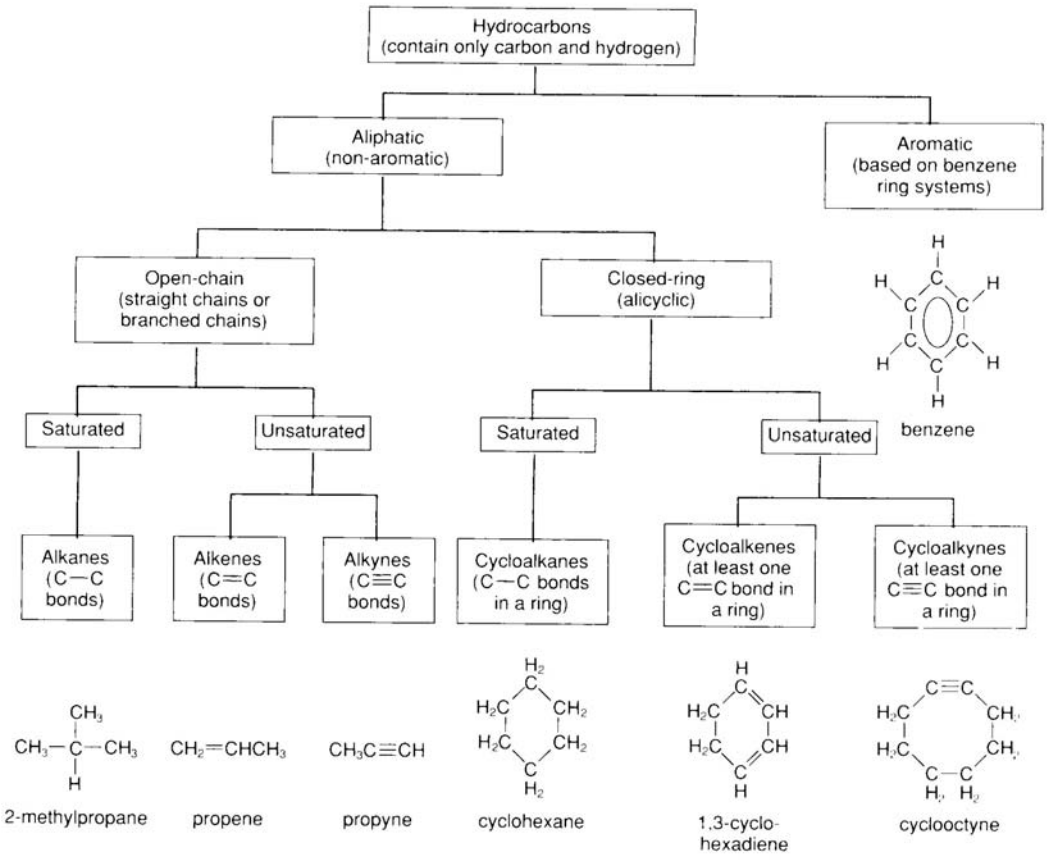
1.2 Hydrocarbons

- Hydrocarbons are compounds that contain only carbon and hydrogen. They are classified into aliphatics and aromatics.

Aliphatics

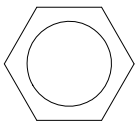
- Aliphatic hydrocarbons can contain single, double, and triple bonds between the carbons. (aliphatic = Greek word for oil)



- A saturated hydrocarbon contains only C – C bonds.
- An unsaturated hydrocarbon contains C = C and C ≡ C bonds.

Aromatics

- Aromatics are usually based on a benzene ring, C_6H_6 and it is a resonance structure shaped like a ring. (they tend to have a strong odour)



Structural *Simplified Structural*

Representing Hydrocarbons

- Chemists frequently represent organic compounds by molecular and structural formulas. However, due to the high number of isomers, structural formulas are normally used.
  E.g. Structural formulas for butane and isobutane (C_4H_{10}).

butane

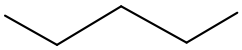
isobutane
(2-methylpropane)

- Structural formulas can be rewritten as "condensed formula" (often seen on tests) where the lines are left out and branches are written in parentheses. Ex. 3-methylpentane.

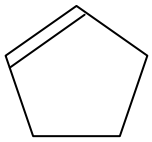
$CH_3CH_2CH(CH_3)CH_2CH_3$
(C_6H_{14} is not very useful)

Structural *Condensed*

- When the molecules become very complex, "stick formula" are used. A carbon will be found at each end and where the line is angled. The hydrogen atoms are usually omitted.



pentane



cyclopentene

Naming Alkanes

- Memorize the first 10 alkanes and alkyls (Table 2 on page 12)

Alkane	Molecular Formula	Number of C's	Alkyl Group	Alkyl Formula
methane	CH_4	1	methyl	$-CH_3$
ethane	C_2H_6	2	ethyl	$-C_2H_5$
propane	C_3H_8	3	propyl	$-C_3H_7$
butane	C_4H_{10}	4	butyl	$-C_4H_9$
pentane	C_5H_{12}	5	pentyl	$-C_5H_{11}$
hexane	C_6H_{14}	6	hexyl	$-C_6H_{13}$
heptane	C_7H_{16}	7	heptyl	$-C_7H_{15}$
octane	C_8H_{18}	8	octyl	$-C_8H_{17}$
nonane	C_9H_{20}	9	nonyl	$-C_9H_{19}$
decane	$C_{10}H_{22}$	10	decyl	$-C_{10}H_{21}$
general formula	**C_nH_{2n+2}**			**$-C_nH_{2n+1}$**

- Alkyl groups (also known as radicals) are alkanes with one hydrogen atom removed from the parent alkane. They will form bonds where the hydrogen was removed.

Physical & Chemical Properties of Alkanes

- Straight chain alkanes are only held together by Van Der Waal forces. The more atoms in a chain the greater the Van Der Waal forces and the higher the boiling point and melting point.
- Long chain alkanes are known by the common name paraffin. They are relatively stable and will remain unchanged for long periods of time.

Structural Isomers

- Structural isomers are molecules that have the same molecular formula but different spatial arrangements of the atoms.
- Some common terms to remember: *n*-butane is normal butane (4 C chain) and *iso*-butane is the most common isomer of butane (3 C chain with a methyl group on the second C)
- Due to the different shapes, isomers have different characteristics.
- Remember that free rotation is possible on a single bond and what appears to be an isomer, may not be one.

Systematic Naming of Alkanes (IUPAC)

- Systemic naming indicates structure and was introduced by The International Union of Pure and Applied Chemistry (IUPAC) and is used worldwide.
- Alkyl groups have the general formula C_nH_{2n+1} and are often represented as R.

Naming Alkanes with Side Branch(s)

a) find the longest carbon chain as your main chain (backbone)
b) number the carbon atoms, starting at the end that has the branch nearest to it
c) name the main chain and use as the root of the systemic name
d) name the branch based on its position (C#) and alkyl name
e) indicate the number of side branches using the correct prefix
f) put the names of the side branches into alphabetical order

E.g.: 2-methyl-pentane 3-ethyl-2,2-dimethyl-pentane

See pages 13 to 16 for additional information & examples.

Drawing Structural Formulas from IUPAC Names

a) draw the first chain based on the root name (backbone)
b) check the numbers and prefixes to place the branches
c) add the missing hydrogen

E.g.: 2,2,3-trimethyl-4,4-dipropyloctane

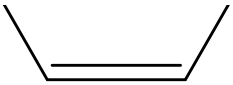
Naming Alkenes and Alkynes

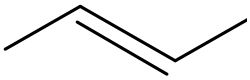
- Alkene general formula: C_nH_{2n} and ends with the suffix –ene.
- Alkyne general formula: C_nH_{2n-2} and ends with the suffix –yne.
- When naming, the double or triple bond must be part of the carbon backbone and be given the lowest possible number.
- E.g. 2,3-pentadiene 3-methyl-1-butyne

Shapes and Geometric Isomerism

- Ethyne is linear and does not rotate. H−C ≡ C−H
- The C = C bond of an alkene is rigid and produces geometric isomers.
- cis = on same side & trans = on opposite sides

E.g. cis-2-butene trans-2-butene





Physical & Chemical Properties of Alkenes & Alkynes

- Boiling points increase with an increase in molecular mass (van der Waal's forces).
- Very reactive compared because of the C = C & C ≡ C bonds.

Aromatic Compounds

- Include benzene (C_6H_6) and those compounds that contain a benzene ring or related structure.

Naming Aromatic Compounds

- The numbering of the carbon atoms of the benzene ring, start with the topmost carbon atom and rotate clockwise.
- e.g. xylenes (IUPAC and trivial names)

1,2-dimethyl-benzene	1,3-dimethyl-benzene	1,4-dimethyl-benzene
(orthoxylene)	(metaxylene)	(paraxylene)
(*o*-xylene)	(*m*-xylene)	(*p*-xylene)

- When a –H is removed from the aromatic compound, an "aryl" is formed (similar to an alkyl). An aryl of benzene is called phenyl.
- e.g.: 2-phenyl-2-butene

Physical and Chemical Properties of Aromatics

- Unlike cyclic compounds, aromatics are planer (2 dimensional).
- They are not very reactive but are usually considerably toxic.

Homework

- Practice 1,2,3,4,5,6,7,8
- Questions 1,2,3,4