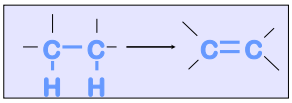
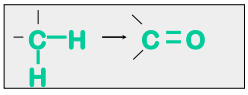
4.4 FUNCTIONAL GROUPS

If one or more hydrogens are replaced by a new bond



or a different atom a Functional Group is created.



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FUNCTIONAL GROUPS

- DEFINE A CLASS OF COMPOUND

Compounds in a class have similar physical properties and chemical reactions.

- ARE A REACTIVE SITE

Define the chemistry (reactions) for the group.

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FUNCTIONAL GROUPS

- PROVIDE A BASE FOR NAMING COMPOUNDS

For instance, all ketones have the ending -ONE in their names.

acetone
methyl ethyl ketone
cyclopropanone

- CONSIST OF UP TO 5 ATOMS

Specific structure

Specific shape

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KNOW YOUR FUNCTIONAL GROUPS

YOU SHOULD MEMORIZE THE NEXT TWO SLIDES (see the handout).

Know how to draw the Lewis Diagrams for these functional groups

YOU SHOULD ALSO MEMORIZE THE TABLE OF COMMON ABBREVIATIONS THAT IS PRESENTED IN THE SECTION THAT FOLLOWS

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COMMON FUNCTIONAL GROUPS

CLASS		FUNCTIONAL GROUP
ALKENES	R can be H	—C=C— double bond
AROMATICS	Any compound which has a benzene ring is "aromatic" or "benzenoid"	benzene ring
ALCOHOLS	H cannot be R, R cannot be H	—O—H hydroxyl
ETHER	R cannot be H	—O—R alkoxy

(R = any group of carbon and hydrogen atoms)
(Take special care where red arrows indicate)

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FUNCTIONAL GROUPS ..... continued

CLASS		FUNCTIONAL GROUP
CARBOXYLIC ACIDS	R can be H	carboxyl
ESTERS	R can be H, R' cannot be H	ester
ALDEHYDES	H cannot be R	aldehyde
KETONES	R cannot be H	carbonyl
AMINES	H can be R	amino
AMIDES	R can be H, H can be R	amide

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GROUPS WITH SPECIAL ABBREVIATIONS (condensed formulas)

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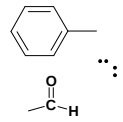
SPECIAL ABBREVIATIONS
(continued)

$-C_6H_5$ benzene ring



-CHO aldehyde
(note H before O,
-C-OH is an alcohol)

(CO) or CO carbonyl group

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SPECIAL ABBREVIATIONS
KNOW THESE - including electron pairs

-COOH
$-CO_2H$ carboxylic acid

-COOR
$-CO_2R$ ester

$-NH_2$ amino group

$-CONH_2$ amide

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MOLECULES WITH MULTIPLE FUNCTIONAL GROUPS

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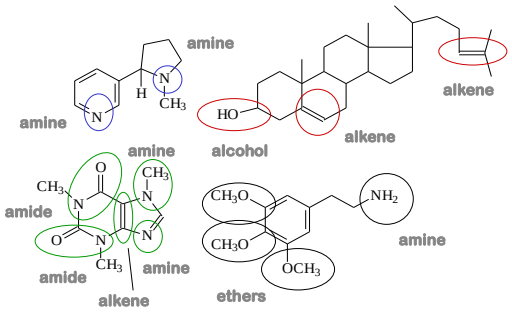
IDENTIFYING FUNCTIONAL GROUPS



Circle and name the functional groups.

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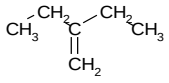
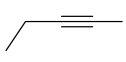
4.4 Unsaturated Hydrocarbons

Hydrocarbons that contain at least one C=C (or C≡C) are called <u>unsaturated</u> hydrocarbons





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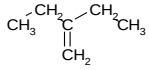
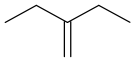
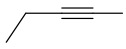
***Unsaturated* hydrocarbons that contain at least one C=C are called alkenes**





***Unsaturated* hydrocarbons that contain at least one C≡C are called alkynes**



***Unsaturated* hydrocarbons that contain are called aromatic**

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4.4 Characteristics of Alkenes and Cycloalkenes

Unsaturated hydrocarbons can be open-chain (linear and branched) or cyclic (cycloalkene)

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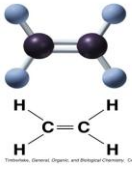
Alkenes are acyclic unsaturated hydrocarbons that contain at least one C=C



C_2H_4

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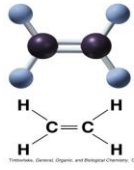
- **Generic formula: Start with C_nH_{2n+2} and minus two for each C=C**
- **one C=C → C_nH_{2n} e.g., C_2H_4, C_3H_6, etc.**



C_2H_4

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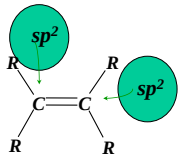
ALKENE GEOMETRY



SHAPE IS TRIGONAL PLANAR

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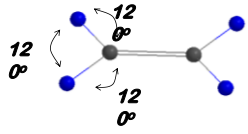
THE BOND ANGLE OF AN ALKENE



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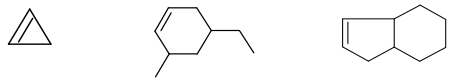
Cycloalkenes are cyclic unsaturated hydrocarbons that contain at least one C=C



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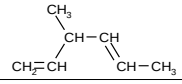
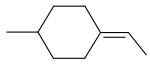
$C_nH_{2n+2-2-2} = C_nH_{2n-2}$

2 C=C 	C_7H_{12}
1 C=C and 1 ring 	C_9H_{16}
2 rings 	C_9H_{16}

Alkenes & cyclic alkanes are constitutional isomers

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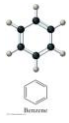
4.4 Families of Organic Compounds—Functional Groups, Continued

Aromatics

- ***Aromatic compounds*** are six-carbon member rings with alternating double and single bonds. The simplest aromatic compound is benzene.



- These compounds get their name, *aromatic*, because the first ones discovered have pleasant aromas. Compounds such as oil of spearmint and peppermint are compounds in the aromatic family.

4.4 Families of Organic Compounds—Functional Groups, Continued

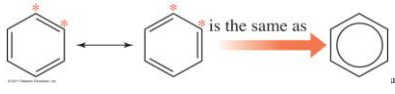
Aromatics

- When the benzene ring is part of a larger molecule it is called a ***phenyl group***.
- The aromatic ring is unreactive and is very stable.
- Benzene contains three double bonds, but it is very stable and is resistant to reactions that would break double bonds.

4.4 Families of Organic Compounds—Functional Groups, Continued

Aromatics

- Unsaturated cyclic compounds like benzene, which are unusually stable, are said to exhibit ***aromaticity***.
- Stability of the double bonds of benzene is due to the fact that the double bonds are not static. That is, the electrons of the double bond can freely move around the ring. This phenomena is known as ***resonance***.



4.4 Families of Organic Compounds—Functional Groups, Continued

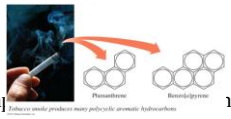
Aromatics

- Because electrons are equally shared with all the bonds of benzene, they are much less reactive.
- Decreased reactivity means more stability of aromatic compounds.
- Many compounds in tobacco smoke contain two or more benzene rings attached to each other.

4.4 Families of Organic Compounds—Functional Groups, Continued

Aromatics

- These compounds are called ***polycyclic aromatic hydrocarbons*** or ***PAHs***. Phenanthrene and benzo[⟨]pyrene are examples. Many have been shown to be carcinogenic (cancer causing).



Tobacco smoke produces many polycyclic aromatic hydrocarbons

- Aromatic com[illegible]ıy plastics and pharmaceuticals.

