What Are Functional Groups?

Functional groups are collections of atoms that have a common pattern of chemical reactivity



Propene trans-2-butene cis-2-butene (E)-3,5-dimethylhex-2-ene [or (E)-2-butene] [or (Z)-2-butene]

Characteristics: nonpolar. Molecule cannot rotate along double bond. Geometry: trigonal planar (sp² hybridized) Reactivity: undergo addition reactions, as well as oxidative cleavage Stability increases with increasing # of carbons attached



Suffix: "-yne". As a substituent: "alkynyl"

Examples:

H₃C-CEC-H

2-butyne 3-heptyne a terminal alkyne

Alkynes with a C-H bond are called "terminal" alkynes Geometry: linear (sp hybridized)

Characteristics: non polar

Propyne

Reactivity: addition reactions oxidative cleavage reactions acid-base reactions (terminal alkynes are unusually acidic)



Suffix: "benzene". As a substituent: "phenvl"

Examples:



(toluene)

Benzene

,4-dimethylbenzene (para-dimethylbenzene)

six-membered ring containing

Reactivity: substitution reactions (e.g. electrophilic aromatic substitution or nucleophilic aromatic substitution) Less reactive than normal alkenes due to aromatic stability

Summary Sheet - Functional Groups (1)

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August 2012 Version 1.1 $\delta^{-} \delta^{-}$ The OH group is an <u>alcohol</u> [unless OH is attached to C=O, Alcohol R-Ö-H in which case it's a carboxylic acid (below)] Suffix: "-ol". As a substituent: "hydroxy" ОН Examples ОН н₃с́^{ОН} `он 2-propanol ("Isopropanol") Methanol Ethanol 2-methyl-2-propanol a primary alcohol a secondary alcohol (t-butanol) a tertiary alcohol Characteristics: polar (O-H group participates in hydrogen bonding) acid-base reactions (can act as acids or bases) Reactivity: substitution reactions (can act as nucleophiles) oxidation reactions (primary and secondary alcohols (and methanol) can be oxidized to aldehydes, ketones, or carboxylic acids, depending on structure and reagent used) $\delta^{-} \delta^{+}$ An oxygen flanked by two carbons is an ether Ether R-Ö-R As a substituent: "alkoxy' Examples: H₃C^OCH₃ <u>`</u>∩' Dimethyl ether Ethyl methyl ether Methyl phenyl ether Tetrahydrofuran (THF) (or "methoxyethane") (or "methoxybenzene", a cyclic ether or "anisole") Characteristics: borderline between nonpolar and polar (due to dipole-dipole) Reactivity: acid-base reactions (oxygen can act as a very weak base $\delta^+ \delta$ $\delta^+ \delta^ \delta^+ \delta^ \delta^+ \delta^-$ An alkyl group attached to Alkyl halide R-F R-CI: R-Br: R-I a halogen is an alkyl halide Suffix: "-ane". As a substituent: "haloalkyl" Examples: B H₃C^{∕I} Iodomethane Fluoroethane 2-chloropropane 2-methyl-2-bromopropane (methyl iodide) (ethyl fluoride) (isopropyl chloride) (t-butyl bromide) a primary alkyl a secondary alkyl halide a tertiary alkyl halide halide Characteristics: generally considered non polar (but more polar than alkanes) substitution reactions (Cl. Br. I can be good leaving groups) Reactivity: elimination reactions (CI, Br, I can be good leaving groups) A nitrogen attached to simple carbon or Amine R--н hvdrogen atoms is an amine Suffix: "-ine". As a substituent: "amino" Examples: $H_3C^{-NH_2}$ NH2 Methylamine Ethylamine Dimethylamine Triethylamine a primary amine a secondary amine a tertiary amine

Characteristics: polar (N-H group participates in hydrogen bonding, although not as much as a hydroxy group

Reactivity: acid-base reactions (tend to act as bases) substitution reactions (can act as nucleophiles) Note - this sheet is not meant to be comprehensive. Your course may provide additional material or may not cover some of the reactions shown here. Your course instructor is the final authorit



Suffix: "-oate

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Examples: C OCH

Methyl methanoate Methyl ethanoate Ethvl butanoate Methyl benzoate acyl substitution reactions (can replace OR with other functional Reactivity:

groups under acidic conditions) addition reactions (the carbonyl carbon reacts easily with nucleophiles)

Omissions, Mistakes, Suggestions?

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