Chapter 20 – Carbon and Hydrocarbons

20-1 Abundance and Importance of Carbon

I. Structure and Bonding of Carbon

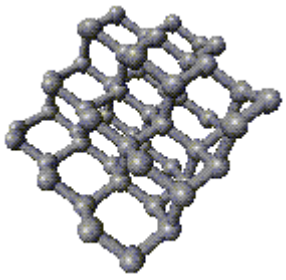
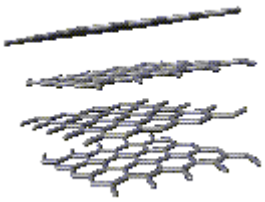
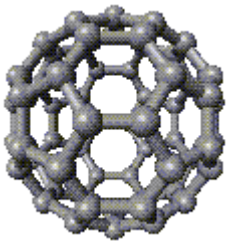
Electron configuration	$1s^2 2s^2 2p^2$
Hybridization (four single bonds)	sp^3
Hybridization (double bonds)	sp^2
Hybridization (triple bonds)	sp

II. Allotropes of Carbon

A. Diamond
   1. Hardest substance known
   2. Extremely high melting point
   3. Excellent conductor of heat, nonconductor of electricity

B. Graphite
   1. Strong bonds within layers of carbon atoms
   2. No bonding between layers of carbon atoms

C. Fullerenes
   1.

Form	Facts	Structure
Diamond	• Hardest substance known • Extremely high melting point • Excellent conductor of heat, nonconductor of electricity	
Graphite	• Strong bonds within layers of carbon atoms • No bonding between layers of carbon atoms	
Fullerenes	• Formed when carbon-containing materials are burned with limited oxygen C_{60} "Buckyball" →	

20-2 Organic Compounds

Organic Compounds: Covalently bonded compounds containing carbon, excluding carbonates and oxides

I. Carbon Bonding and the Diversity of Organic Compounds

A. Carbon-Carbon Bonding

1. Catenation – the covalent bonding of an element to itself to form chains or rings

B. Carbon Bonding to Other Elements

1. Carbon readily bonds to H, O, N, S, and the halogens
2. Hydrocarbons – the simplest organic compounds composed of only carbon and hydrogen

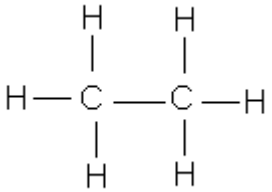
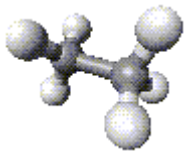
C. Arrangement of Atoms

1. Isomers – Compounds that have the same molecular formula but different structures

II. Structural Formulas

A. Structural Formulas

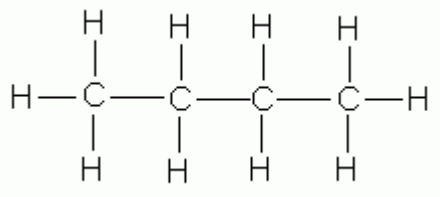
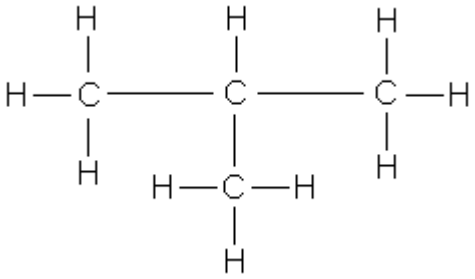
1. Formulas that indicate the number and types of atoms present in a molecule and also shows the bonding arrangement of the atoms
2.

Structural Formula	Ball and Stick Model	Space-filling Model
		

III. Isomers

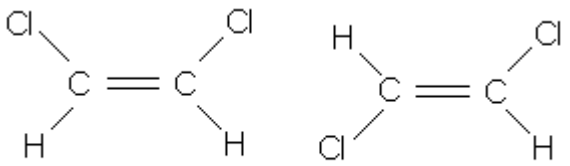
A. Structural Isomers

1. Same formula, but the atoms are bonded together in a different order

C_4H_{10} **Butane**	C_4H_{10} **2-methylpropane**
	

B. Geometric Isomers
   1. Isomers in which the order of atom bonding is the same but the arrangement of atoms in space is different
   2. In order for an isomer to exist, there must be a rigid structure in the molecule to prevent free rotation around a bond
   3. A molecule can have a geometric isomer only if two carbon atoms in a rigid structure each have two different groups attached

Cis 1,2-dichloroethane *Trans* 1,2-dichloroethane



cis trans

   4. In some isomer pairs, one isomer is biologically active, while the other is not (specificity of enzymes is the cause)

20-3 Saturated Hydrocarbons

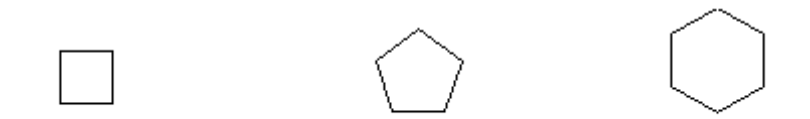
Saturated Hydrocarbons – Hydrocarbons in which each atom in the molecule forms four single covalent bonds with other atoms

I. <u>Alkanes</u>

A. Alkanes – Hydrocarbons that contain only single bonds
   1. Simple alkanes have the formula C_nH_{2n+2}

The First 10 Alkanes		
# of Carbons	*Name*	*Formula* (C_nH_{2n+2})
1	Methane	CH_4
2	Ethane	C_2H_6
3	Propane	C_3H_8
4	Butane	C_4H_{10}
5	Pentane	C_5H_{12}
6	Hexane	C_6H_{14}
7	Heptane	C_7H_{16}
8	Octane	C_8H_{18}
9	Nonane	C_9H_{20}
10	Decane	$C_{10}H_{22}$

B. Cycloalkanes – Alkanes in which the carbon atoms are arranged in a ring, or cyclic, structures

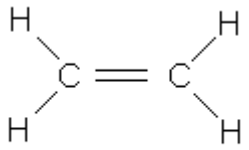


Cyclobutane Cyclopentane Cyclohexane

20-4 Unsaturated Hydrocarbons

Unsaturated Hydrocarbons – Hydrocarbons in which not all carbon atoms have four single covalent bonds

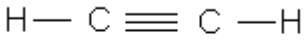
A. Alkenes
    1. Hydrocarbons that contain double bonds
        a. The simplest alkene is ethene, or ethylene (C_2H_4)



Ethene

        b. Alkenes are nonpolar molecules

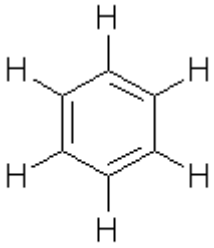
B. Alkynes
    1. Hydrocarbons with triple covalent bonds
        a. The simplest alkyne is ethyne, or acetylene (C_2H_2)



Ethyne

        b. Alkynes are nonpolar molecules

C. Aromatic Hydrocarbons
    1. Hydrocarbons with six-membered carbon rings and delocalized electrons
        a. The simplest aromatic hydrocarbon is benzene (C_6H_6)



Benzene

        b. Aromatic hydrocarbons are nonpolar molecules