What Is Organic Chemistry?

EQ: What is Organic Chemistry?

- **Read: pages 1-3**
- **Answer the questions in your packet**

Basics of Organic Chem

Chapter 1: Structure and Bonding

- **Key terms**
- **Organic Chemistry**
- **Inorganic Chemistry**

EQ: **What is Organic Chemistry and why should you study it?**

Chapter 1: Structure and Bonding

- **CARBON: The Hero... Why?**

Periodic Table

Chapter 1: Structure and Bonding

- **Atomic Structure:**
- **Atom**
- **Nucleus**
- **Neutrons**
- **Protons**
- **Electrons**
- **Atomic number**
- **Mass number**
- **Quantum Mechanical model**
- **Orbitals (s, p, d, f)**
- **Shell**
- **Octet**
- **Duet/ duplet**
- **Energy levels**
- **Ground state electron configuration**

Chapter 1: Structure and Bonding

- **Electron Configuration Of Atoms:**
  - Ground-state electron configuration (g-sec): the lowest energy arrangement
  - 3 rules to predict g-sec:
  - Rule 1: The lowest energy levels are filled first. Use the Aufbau system.
  - Rule 2: Only two electrons can occupy an orbital, and they must be of opposite spin.
  - Rule 3: If two or more empty orbitals of equal energy are available, one electron is placed in each with their spins parallel until all are half-full.
- **Give the ground state electron configuration of Carbon.**

Summary

- Read: pages 3-6
- Do: Problem #s 1.1, 1.2 on page 6

Development Of Chemical Bonds Theory (Sections 1.3)

- **Kekule and Couper** proposed that carbon has four "affinity units"- carbon is tetravalent.
- **Van't Hoff** proposed that the 4 atoms to which carbon forms bonds sit at the corners of a regular tetrahedron.

Development Of Chemical Bonds Theory (Sections 1.3)

- **Other scientists suggested that carbon can form double bonds, triple bonds and rings.**
- **In a drawing of tetrahedral carbon, a wedged line represents a bond pointing toward the viewer, and a dashed line points behind the plane of the page.**

Molecular Model Kits

- **Do: Problem # s 1.3, 1.4 on page 6. Use the molecular model kits to construct the models.**

EQ: Why do atoms bond together?

- Why do atoms bond together?

EQ: Why do atoms bond together?

- Atoms bond together because ...

the resulting compound is more stable than the individual atoms.

- i. Atoms tend to achieve the electron configuration of the nearest noble gas
.
- ii. Atoms either lose electrons (groups 1A, 2A) or gain electrons (group 7A) to form ionic compounds.
- iii. Atoms in the middle of the periodic table share electrons by forming covalent bonds

Nature Of Chemical Bonds (Section 1.4)

- **The number of covalent bonds formed by an atom depends on the number of valence electrons it has and on the number it needs to achieve an octet.**
- **(Example: Cl, O, N, C)**

- Energy flows ***out*** of the system when a Bond is formed. Making bond releases energy.
- Energy must be put into the system when a Bond is **broken**. Breaking bond absorbs energy.

Nature Of Chemical Bonds (Section 1.4)

- Covalent bonds can be represented two ways.
- i. In ***Lewis structures***, bonds are represented as pairs of dots.
- ii. In ***line-bond structures***, bonds are represented as lines drawn between two atoms. Also called ***Kekule structures***.
- Valence electrons not used for bonding are called **lone-pair electrons** or *non-bonding electron pair*.
- Lone-pair electrons are represented as dots.

- *Formation of covalent bonds (Section 1.5)*
  - 1. Covalent bonds are formed by the overlap of two atomic orbitals, each of which contains one electron. The two electrons have opposite spins.
  - 2. ***Bond strength*** is the measure of the amount of energy needed to break a bond.
  - 3. ***Bond length*** is the optimum distance between nuclei.
  - 4. Every bond has a characteristic bond length and bond strength.

Nature Of Chemical Bonds (Section 1.4

- Read sections 1.3, 1.4
- Do problems 1.5 - 1.7

Summary

- Read: pages 1-10
- Do: Problem #s 1.30 - 1.32, 1.34 - 1.35 on page 30
- Model kit

- *Bond length and Bond strength*

Bond	Bond length (in picometer)	Bond Strength (in kJ/mol)
H - H	74 pm	436
H - C	110 pm	438 in CH4 420 in C2H6
C - C	154 pm	376

Review…

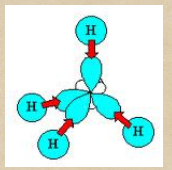
- ***Ionic Bond***
- ***Covalent Bond***
- ***Lewis structures***
- ***Kekule structures***
- **lone-pair of electrons**
- ***Bond strength***
- ***Bond length***
- Arrange these with increasing bond lengths:
  C-C H-H H-C

Hybridization

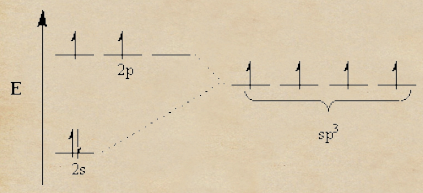
- The concept involves the "cross breeding" of atomic orbitals to create "new" orbitals.

Hybridization

- Structure of Methane

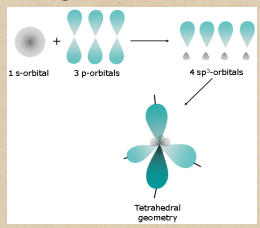


sp^3 Hybridization



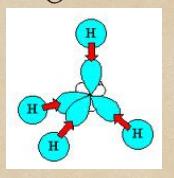
One 2*s* orbital and three 2*p* orbitals combine to form four equivalent atomic orbitals

sp^3 Hybridization



These are Strong bonds called SIGMA bonds

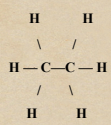
sp^3 Hybridization

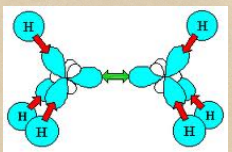


- Orbitals are tetrahedrally oriented and bond angle is 109.5°

sp^3 hybridization in Ethane

Single bond formed between two carbon atoms



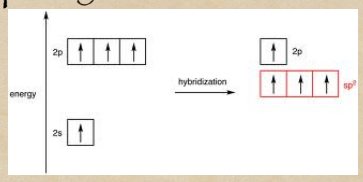


A *sigma* bond is formed between the two carbon atoms.

- *Bond length and Bond strength*

Bond	Bond length (in picometer)	Bond Strength (in kJ/mol)
H - H	74 pm	436
H - C	110 pm	438 in CH_4 420 in C_2H_6
C - C	154 pm	376

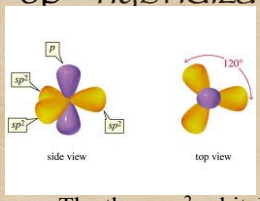
sp^2 hybridization

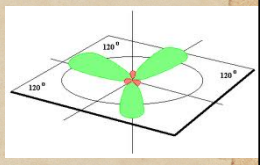


One 2*s* orbital and two 2*p* orbitals combine to form three equivalent atomic orbitals.

One *p* orbital remains unchanged

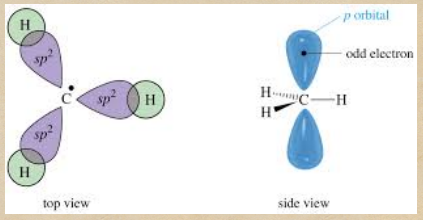
sp^2 hybridization





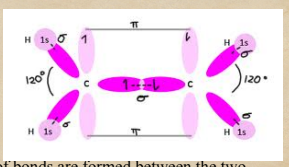
- The three sp^2 orbitals lie in a plane (trigonal planar) at angles of 120^O and the p orbital is perpendicular to them

sp^2 hybridization



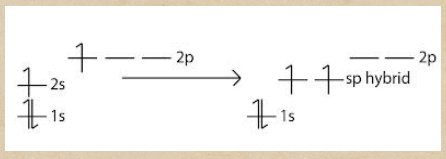
sp^2 hybridization in Ethylene

- Double bond formed between two carbon atoms.
- H H
- \ /
- C = C
- / \
- H H



- Two different types of bonds are formed between the two carbon atoms
- A (sigma) bond from the head-on overlap of two sp^2 orbitals
- One (pi) bond by sideways (lateral) overlap of unhybridized *p* orbital

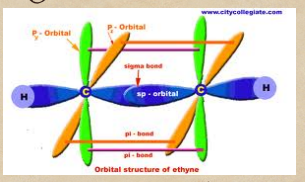
sp hybridization



One 2*s* orbital and one 2*p* orbitals combine to form two equivalent atomic orbitals.

two *p* orbitals remains unchanged.

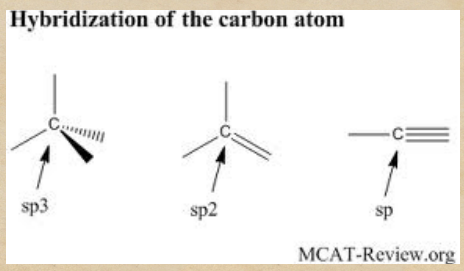
sp hybridization



The two *sp* orbitals lie in a plane (linear) at angles of 180^{O} and the two *p* orbitals are perpendicular to them and to each other.

sp hybridization in Acetylene

- Triple bond formed between two carbon atoms.
- H—C ≡ C—H
- Two different types of bonds are formed between the two carbon atoms
- 1) A (sigma) bond from the head-on overlap of two *sp* orbitals
- 2) Two (pi) bonds by sideways overlap of four *p* orbitals



Hybridization	Sp3	Sp2	sp
# of 2s orbitals involved in hybridization	1	1	1
# of 2s orbitals unhybridized	0	0	0
# of 2p orbitals involved in hybridization	3	2	1
# of 2s orbitals unhybridized	0	1	2

Hybridization	Sp3	Sp2	sp
Type of Carbon-carbon bond	Single	Double	triple
Bond angle	109.5	120	180
# of sigma bonds σ	4	3	2
# of Pi bonds π	0	1	2

- Review practice Problem 1.4 (page 15)
- Complete Problem #s 1.11 - 1.15 (page 15-16)
- Complete Problem #s 1.26 - 1.28 (page 29)

- Quiz - Hybridization
- check problem #s 1.8, 1.9

- X : X
- X : Y
- X+ Y: -

EQ: What is electronegativity?

Electronegativity

- Polar covalent bonds: (Section 1.10)
- Electronegativity: the intrinsic ability of an atom to attract electrons in a covalent bond.

EQ: What is electronegativity?

Electronegativity

- Polar covalent bonds: (Section 1.10)
- Although some bonds are totally ionic and some are totally covalent, most chemical bonds are polar covalent bonds.
- In these bonds, electrons are attracted to one atom more than to the other atom.

EQ: What is electronegativity?

Electronegativity

- Bond polarity is due to differences in electronegativity (EN).
- Elements on the right side of the periodic table are more electronegative than elements on the left side.

EQ: What is electronegativity?

Electronegativity

The difference in EN between two elements can be used to predict the polarity of a bond.

a. If EN ≤ 0.4, a bond is nonpolar covalent.

b. If EN is between 0.41 and 1.65, a bond is polar covalent.

c. If EN ≥ 1.66, a bond is ionic.

EQ: What is electronegativity?

Electronegativity

d. The symbols +δ and - δ are used to indicate partial charges.

E. A crossed arrow (+→) is used to indicate bond polarity. Tail of the arrow is electron poor and the head of the arrow is electron rich.

EQ: What is electronegativity?

f. *Electrostatic Potential map*: uses color to indicate electron rich (RED) and electron poor (BLUE) regions.

An *inductive effect* is an atom's ability to polarize a bond.

EQ: What is electronegativity?

Classwork

- READ PAGES 17 - 19.
- review problem #s 1.15
- Do problem #s 1.16 - 1.19
- Do: problem #s 1.33, 1.35-1.49, 1.51, 1.59-1.66

- **The Arrhenius Concept: (1884)**
- **ACID: Any substance that increases the H^{+1}**
- **(aq) concentration when dissolved in water.**
- **BASE: Any substance that increases the $(OH)^{-1}$**
- **(aq) concentration when dissolved in water.**

EQ: What is the difference between acids and bases?

Acids and Bases

A. Bronsted-Lowry definition

A Bronsted-Lowry acid *donates* an H^+

A Bronsted-Lowry base *accepts* H^+

The product that results when a base gains H^+ is the conjugate acid of the base; the product that results when an acid loses H+ is the conjugate base of the acid. (example on page 19)

EQ: What is the difference between acids and bases?

Acid and Base strength

a) A strong acid reacts almost completely with water.

b) The strength of an acid in water is indicated by *K_a, the acidity constant*.

c) Strong acids have large acidity constants, and weaker acids have smaller acidity constants.

EQ: What is the difference between acids and bases?

d) The pK_a is normally used to express acid strength.

1. $pK_a = -\log K_a$

2. A strong acid has a small pK_a, and a weak acid has a large pK_a

Look at table 1.3 on page 21

EQ: What is the difference between acids and bases?

***

-A strong acid has a weak conjugate base

-A weak acid has a strong conjugate base

-A strong acid loses H^+ easily - ie CB does not hold proton tightly, hence weak base

EQ: What is the difference between acids and bases?

Predicting acid-base reactions from pK_a

1. An acid with a low pK_a reacts with the conjugate base of an acid with a high pK_a.

2. In other words, the products of an acid-base reaction are more stable than the reactants, and the reaction factors formation of the weaker acid/ base pair.

EQ: What is the difference between acids and bases?

Practice problem 1.6

Practice problem 1.7

- To calculate Ka.....(pKa = - log Ka)
- On your calculator enter the value of pKa
- change the sign using +/- key
- Use INV, then log (or antilog)
- Convert to scientific notation

Try these.....

- Page 24: Problems 1.20

Organic acids and organic bases

There are two main types of organic acids:

- Acids that contain hydrogen bonded to oxygen. (R-C-O-H)

- Acids that have hydrogen bonded to carbon next to a C=O group. (H-C=O)

Organic acids and organic bases

The main type of organic base contains a nitrogen atom with a lone electron pair

Lewis acids and bases

- **A Lewis acid accepts an electron pair.**
- **A Lewis acid may have either a vacant low-energy orbital or a polar bond to hydrogen.**
- **Examples include metal cations, halogen acids, Group 3 compounds and transition-metal compounds**

Lewis acids and bases

- **A Lewis base has a pair of nonbonding electrons.**
- **1. Most oxygen- and nitrogen-containing organic compounds are Lewis bases.**
- **2. Many organic Lewis bases have more than one basic site.**

Lewis acids and bases

- **A curved arrow shows the movement of electrons from a Lewis base to a Lewis acid**

- Thursday (2/3/11) - Review Chapter 1
- Friday (2/4/11) - Chapter 1 TEST

- Review practice problem 1.8 on page 25

try

- 1.23 - 1.25
- 1.29
- 1.50, 1.52- 1.58

Acids & Bases