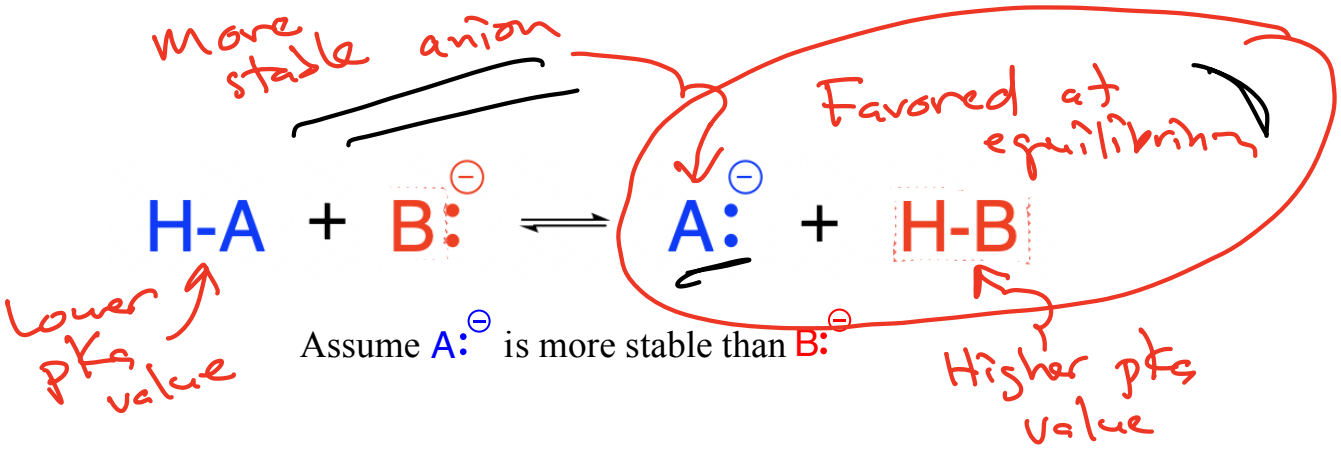
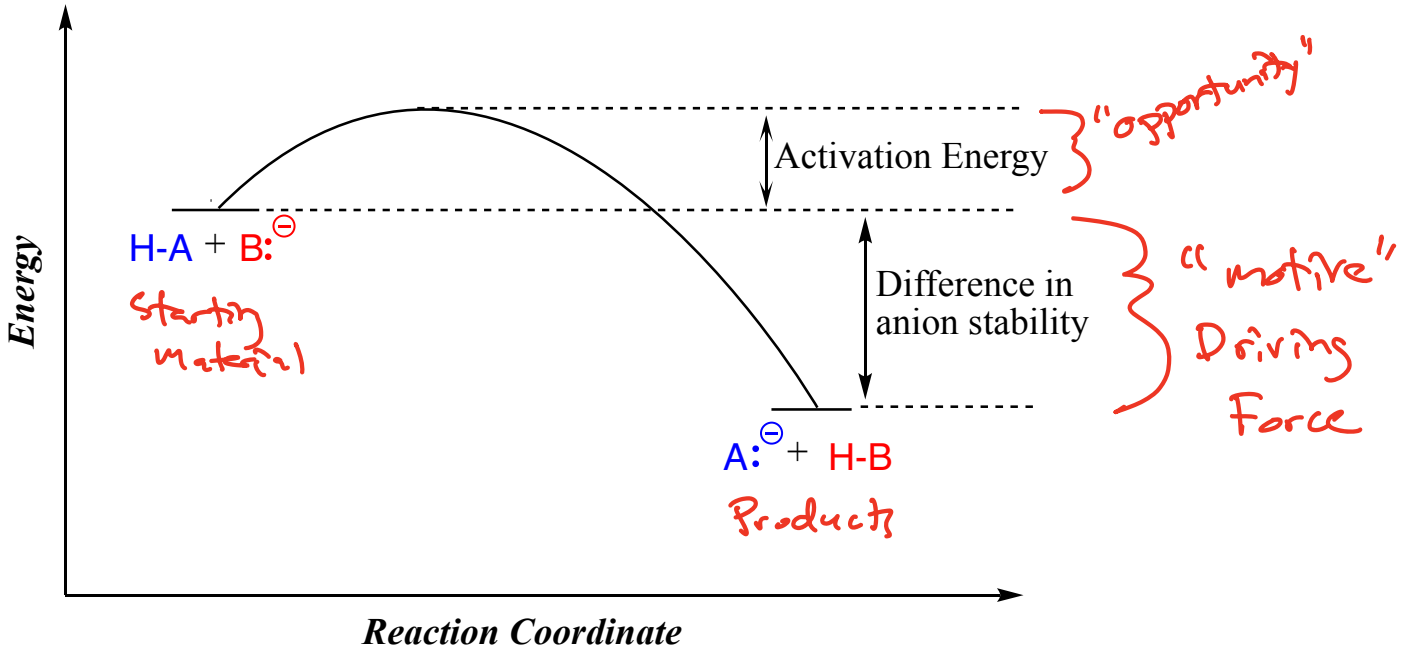
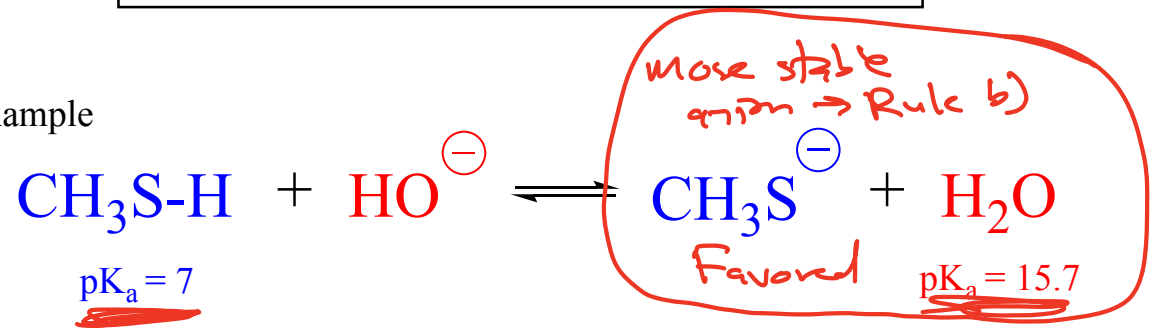




$$K_{eq} = 10^{(pK_a\ \text{H-B} - pK_a\ \text{H-A})}$$

Example



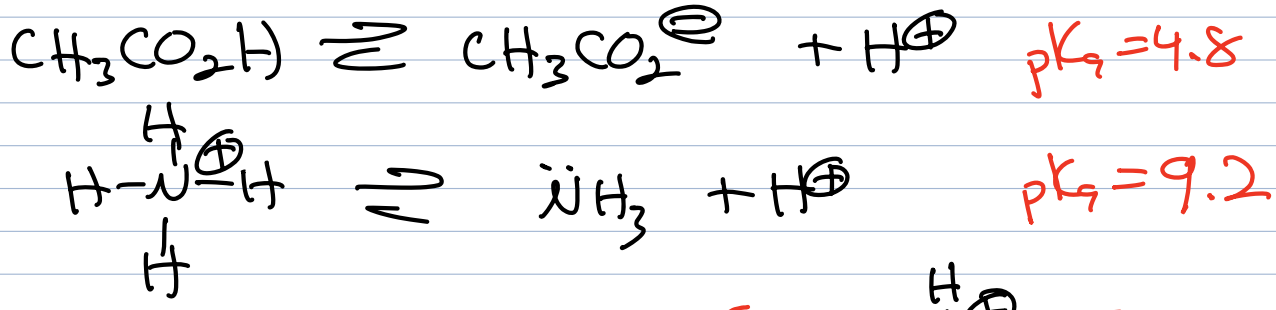
$$K_{eq} = 10^{(15.7 - 7.0)} = 10^{(8.7)}$$

New idea: How do pK_a and pH work together to determine predominant protonation states of acids?

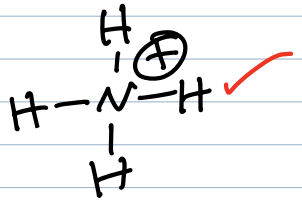
An acid is mostly protonated at a pH that is below its pK_a

An acid is mostly deprotonated at a pH that is above its pK_a

Examples:



Parent Acid → CH_3CO_2H ✓ ($pK_a = 4.8$)


✓ ($pK_a = 9.2$)

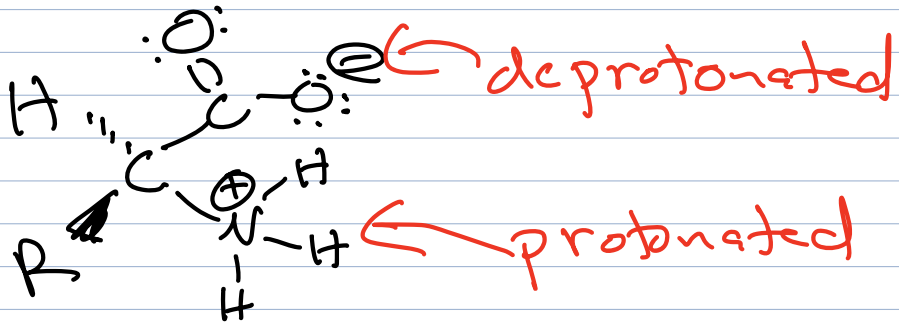
Forms Present at pH = 2.0: CH_3CO_2H ✓ , $NH_4^{\oplus}$

Forms Present at pH = 7.0: $CH_3CO_2^{\ominus}$, $NH_4^{\oplus}$

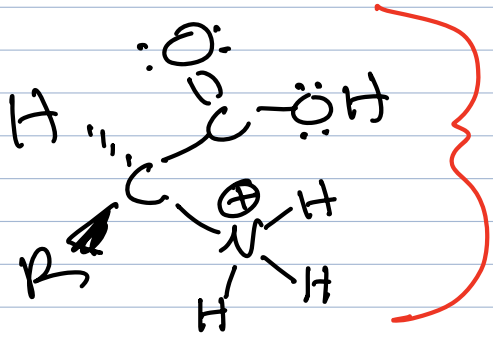
Forms Present at pH = 12.0: $CH_3CO_2^{\ominus}$, $:NH_3$ ✓

Application to important molecules → amino acids → same two groups we just saw

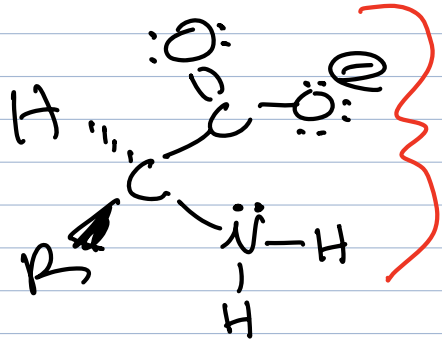
Form present at pH = 7.0

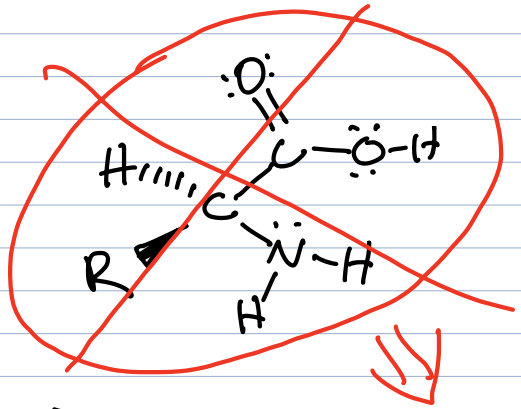


Form present at pH = 2.0



Form present at pH = 12.0





⇒ The $-CO_2H$ and $-\ddot{N}H_2$ forms are NEVER both present at any pH → Not possible!!

Why doesn't anyone get this right?

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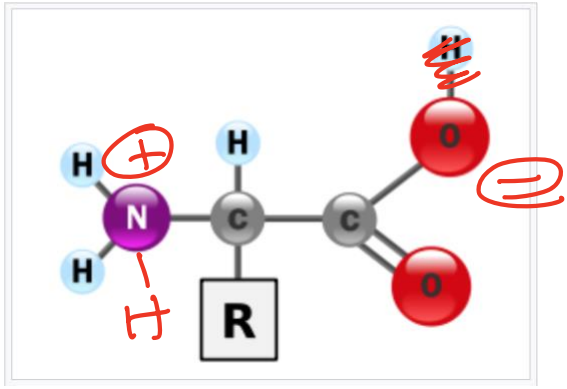
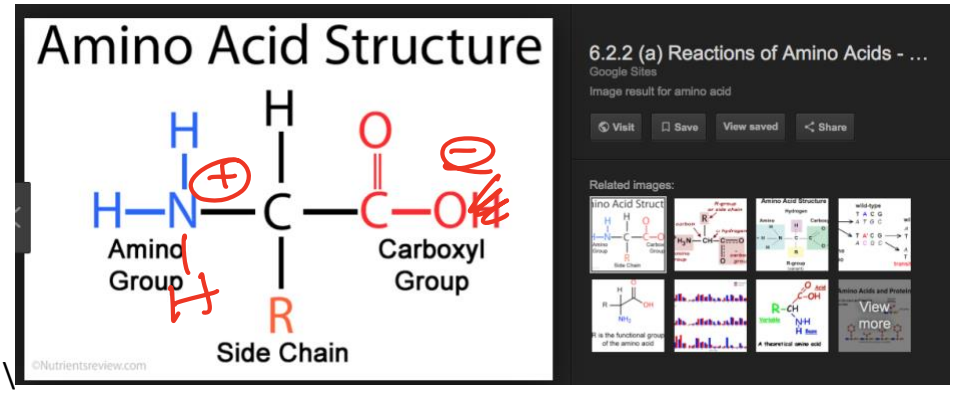
Amino acid

From Wikipedia, the free encyclopedia

This article is about the class of chemicals. For the structures and properties of the standard proteinogenic amino acids, see Proteinogenic amino acid.

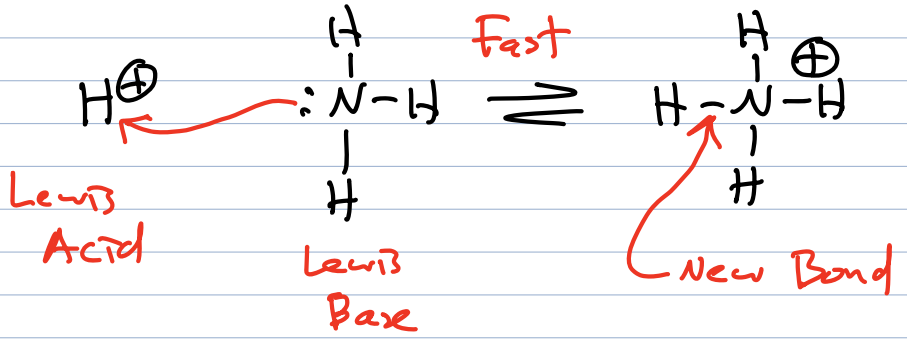
Amino acids are organic compounds containing amine (-NH_2) and carboxyl (-COOH) functional groups, along with a side chain (R group) specific to each amino acid.[1][2][3] The key elements of an amino acid are carbon (C), hydrogen (H), oxygen (O), and nitrogen (N), although other elements are



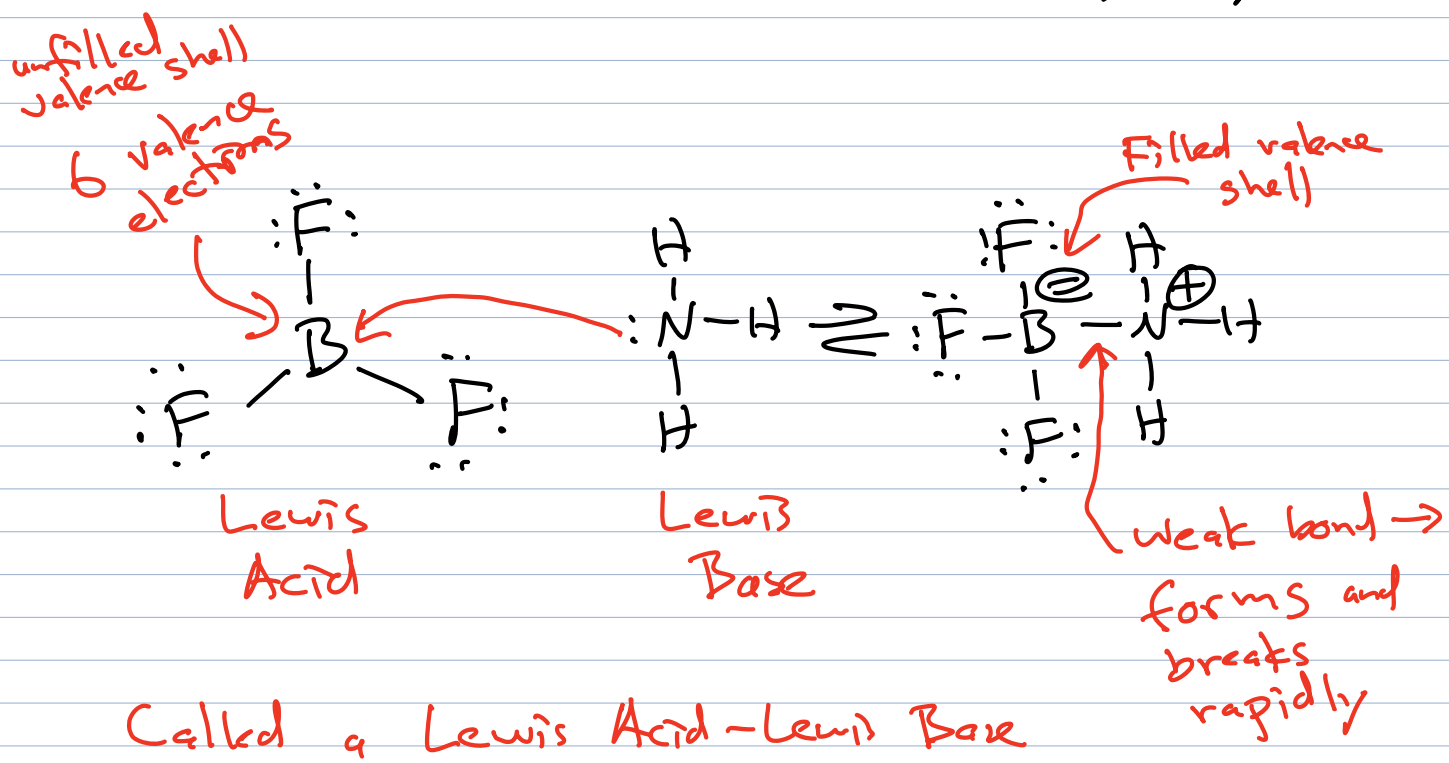


Lewis Acid → accepts an electron pair

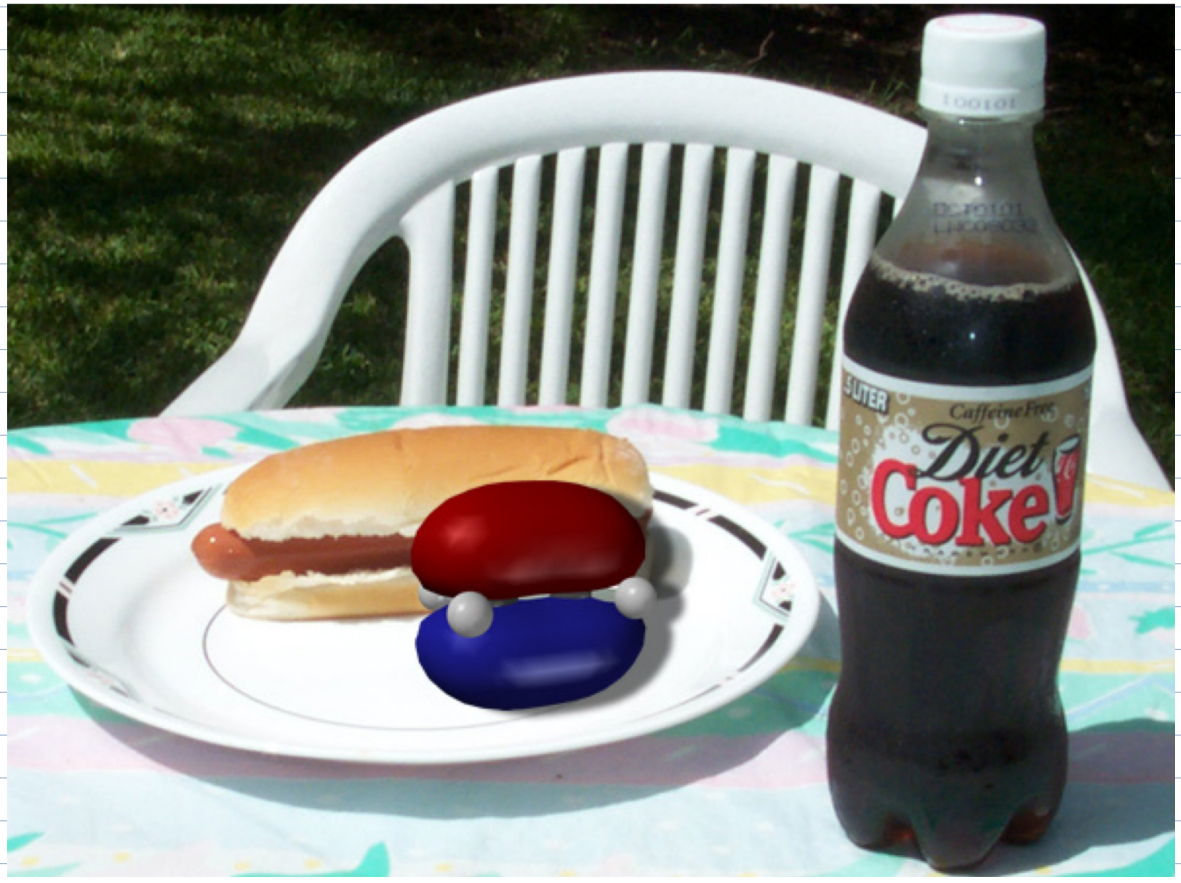
Lewis Base → donates an electron pair



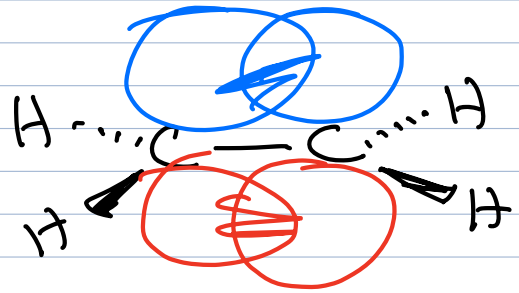
$H^{\oplus}$ can be thought of as a Lewis acid, →
but so can other species → atoms with an incomplete valence shell ⟹ B, Al, Zn, Fe



Called a Lewis Acid-Lewis Base complex or "dative bond" or "coordinate covalent bond"



Electronic Structure of Alkenes



π bond → overlap of 2p orbitals

Consequences of π bonds

1) π bonds cannot rotate

2) Electron density is above and below the bond axis so it is "available" to react with electron deficient atoms/molecules

Like a Lewis base

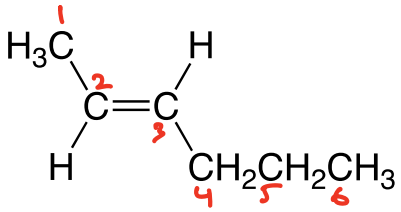
Naming Alkenes

General Directions:

1. Locate longest continuous chain.
2. Number the chain so the double bond gets the lowest possible number.
3. For the parent chain name, use "-ene" not "-ane" as suffix and place a number to indicate the location of the double bond before the main chain name.
4. Make the suffix "-adiene" , "-atriene", etc. if multiple double bonds are present.

***cis/trans* nomenclature** – older chemical nomenclature, but still used commonly in biochemistry – most useful when each sp^2 atom of the double bond has an H atom.

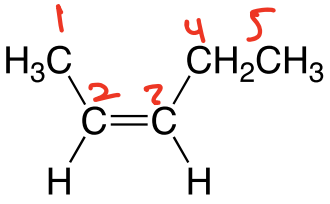
1. Track the longest chain through the double bond
   a. ***cis*** if whole main chain is on the same side of the double bond.
   b. ***trans*** if chain emerges on opposite sides of the double bond.



trans-2-hexene

or

trans-hex-2-ene



cis-2-pentene

or

cis-pent-2-ene

NOT IUPAC but still used by everyone ☹

Naming Alkenes

General Directions:

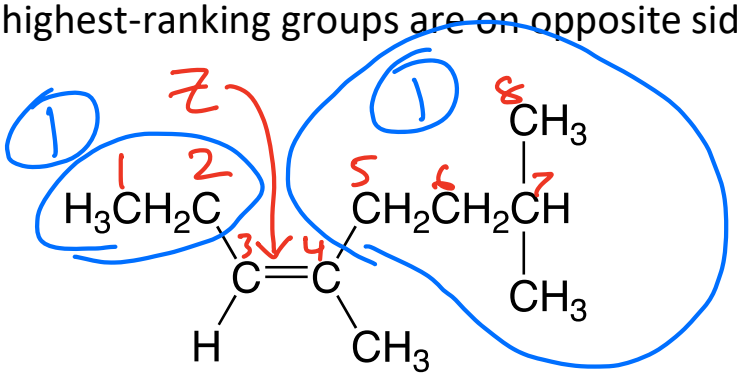
1. Locate longest continuous chain.
2. Number the chain so the double bond gets the lowest possible number.
3. For the parent chain name, use "-ene" not "-ane" as suffix and place a number to indicate the location of the double bond before the main chain name.
4. Make the suffix "-adiene" , "-atriene", etc. if multiple double bonds are present.

***E,Z* nomenclature** - A general IUPAC nomenclature to names alkenes.

Z (zusammen) = *zame zide, zame zide, zame zide*

E (entgegen) = opposite side

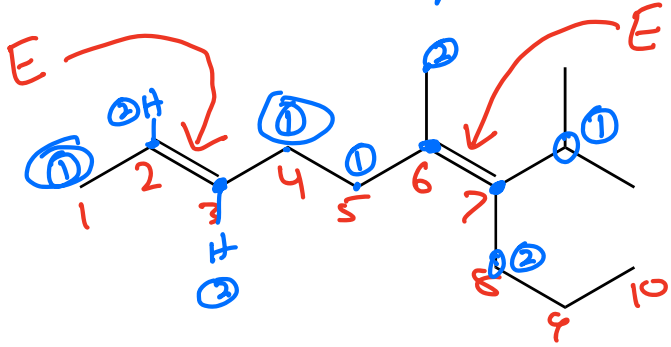
5. On each carbon of the double bond rank the two groups according to the Cahn, Ingold, Prelog priority rules (*R* vs. S rules).
6. If both of the highest-ranking groups are on the zame zide of the double bond it is ***Z***.
7. If both of the highest-ranking groups are on opposite sides of the double bond it is ***E***.



(Z)-4,7-dimethyl-3-octene

or

(Z)-4,7-dimethyloct-3-ene

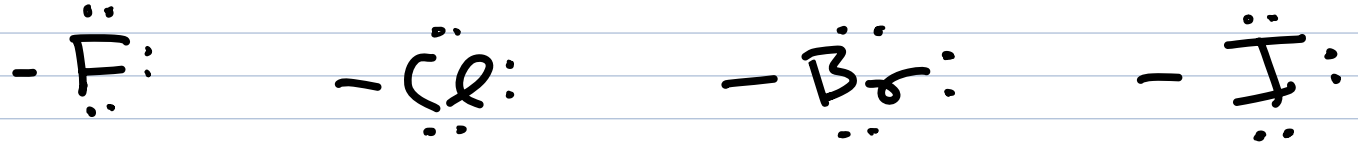


(2E,6E)-7-isopropyl-6-methyl-2,6-decadiene

or

(2E,6E)-7-isopropyl-6-methyldeca-2,6-diene

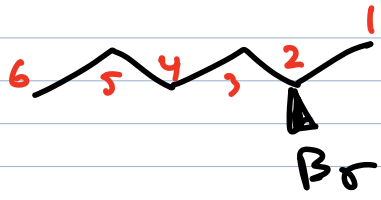
Today's Special Bonus Feature:
Halogen Nomenclature



fluoro- chloro- bromo- iodo-

$-CH_2F$

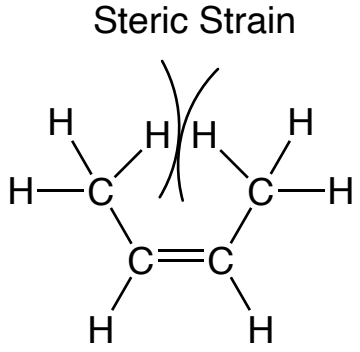
(fluoromethyl) group



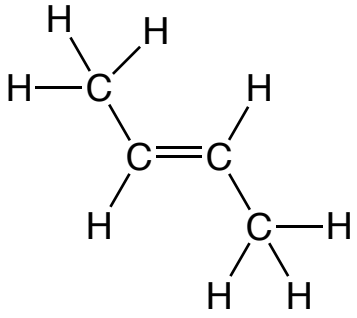
(R)-2-bromohexane

Special Alkene Bonus: Important material you will need to know!

Alkene stability part 1: Z (cis) groups larger than H atoms will crunch into each other causing steric strain.



Z

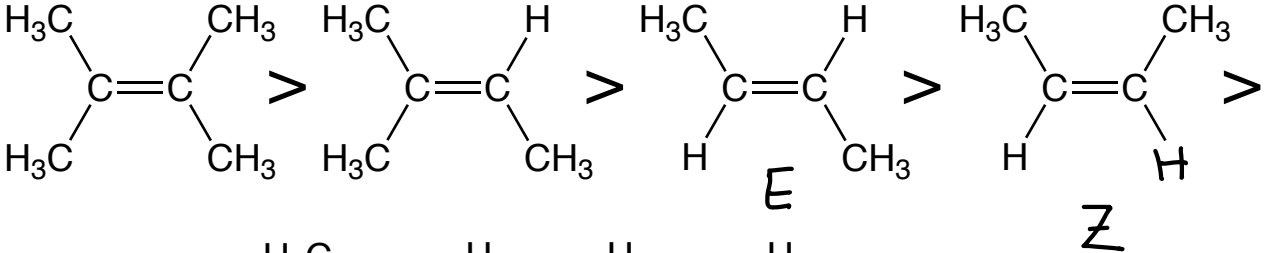


E

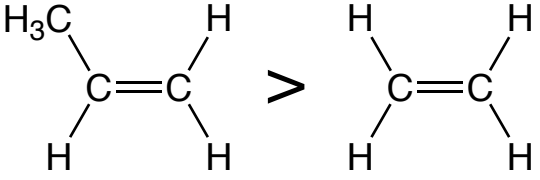
(no steric strain)

Alkene stability part 2: For reasons we are not able to tell you, more substituted alkenes have more stable (stronger) pi bonds than alkenes with more H atoms on their sp^2-hybridized C atoms (despite there being steric strain present in the most substituted alkenes).

Strongest Pi Bond



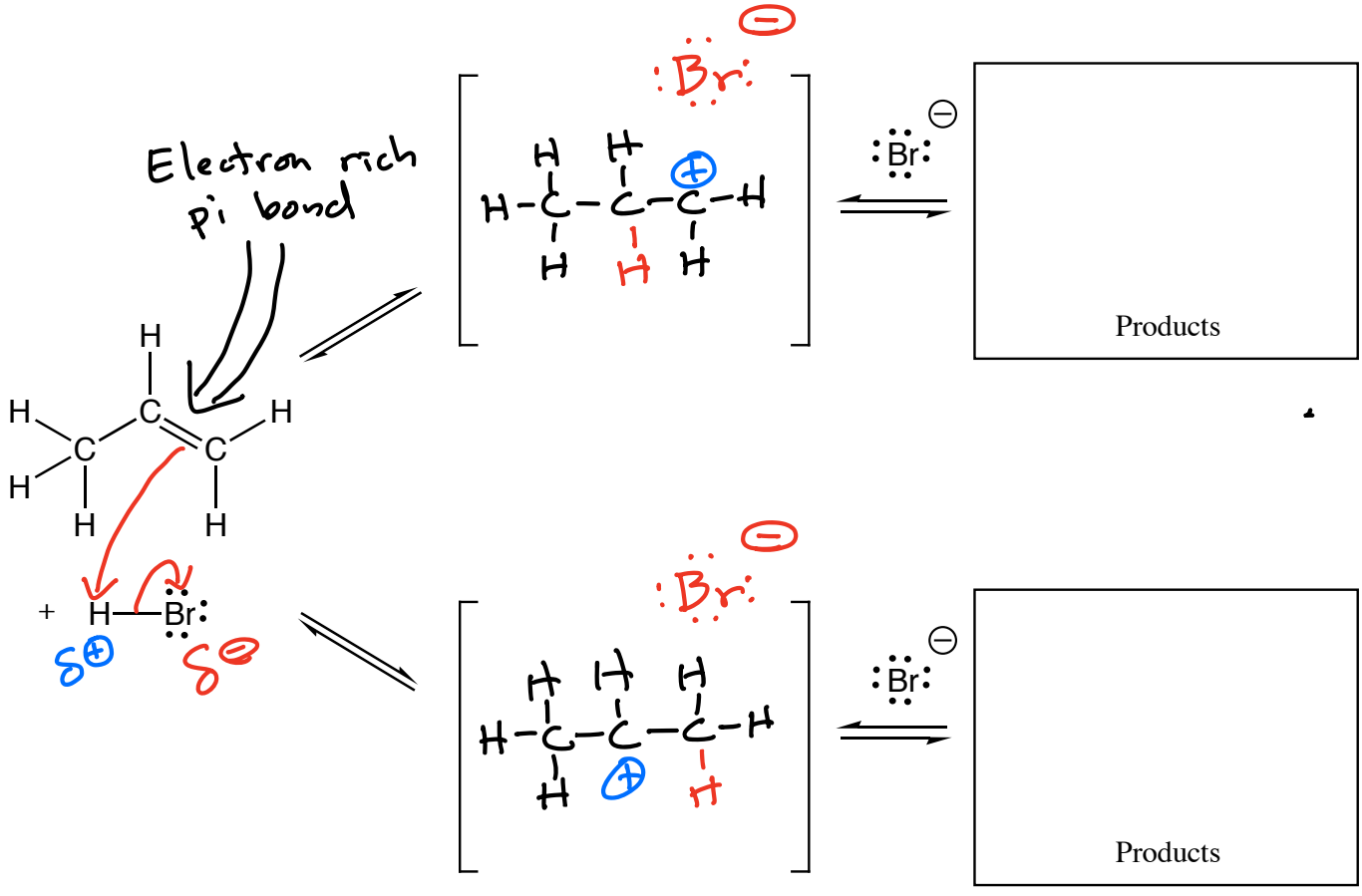
E Z



Weakest Pi Bond

Time Capsule: Zaitsev's rule follows this trend!!

Addition of H-X to an Alkene

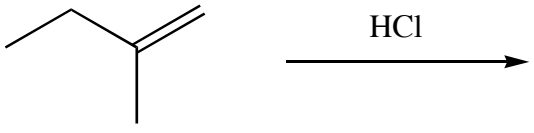


Summary:

Regiochemistry:

Stereochemistry:

Example:



For a reaction to take place, you need both:

Motive → thermodynamic driving force

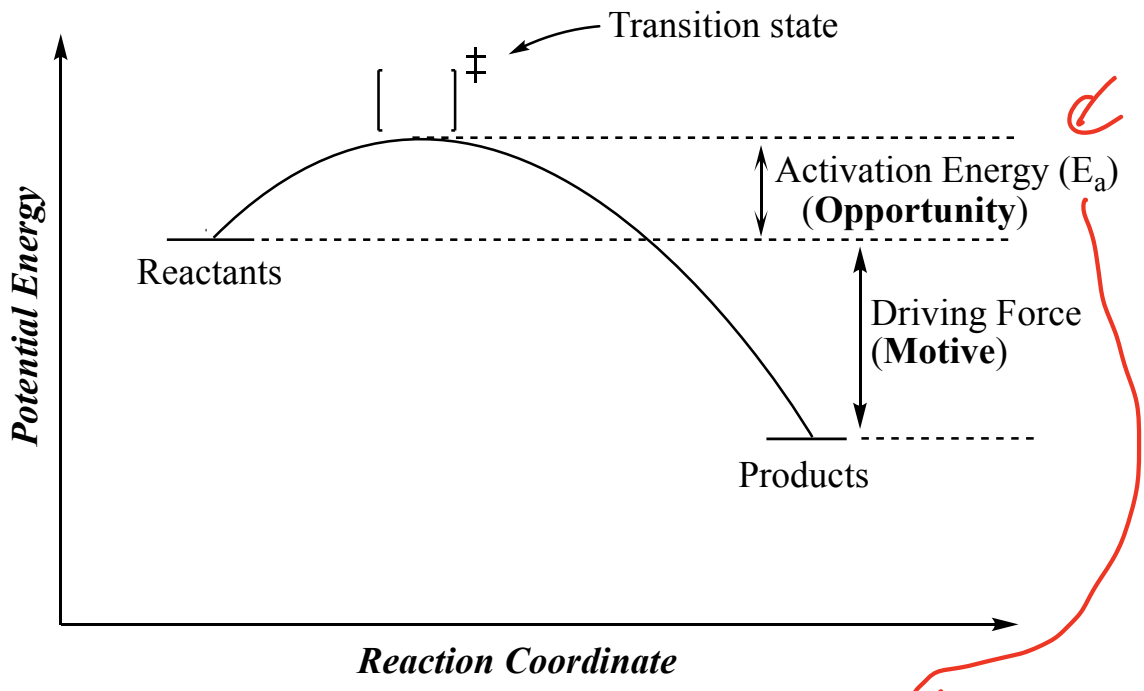
1) Make stronger bonds than you break

2) Formation of a weaker acid (or base)

3) Entropy → if you make a gas molecule (H_2, N_2)

Opportunity → reasonable mechanism so that activation energy is not too high

⟹ movement of electrons



$$k = \text{reaction rate} = Ae^{-E_a/RT}$$

Increasing Temperature → increases the number of molecules with enough energy to react