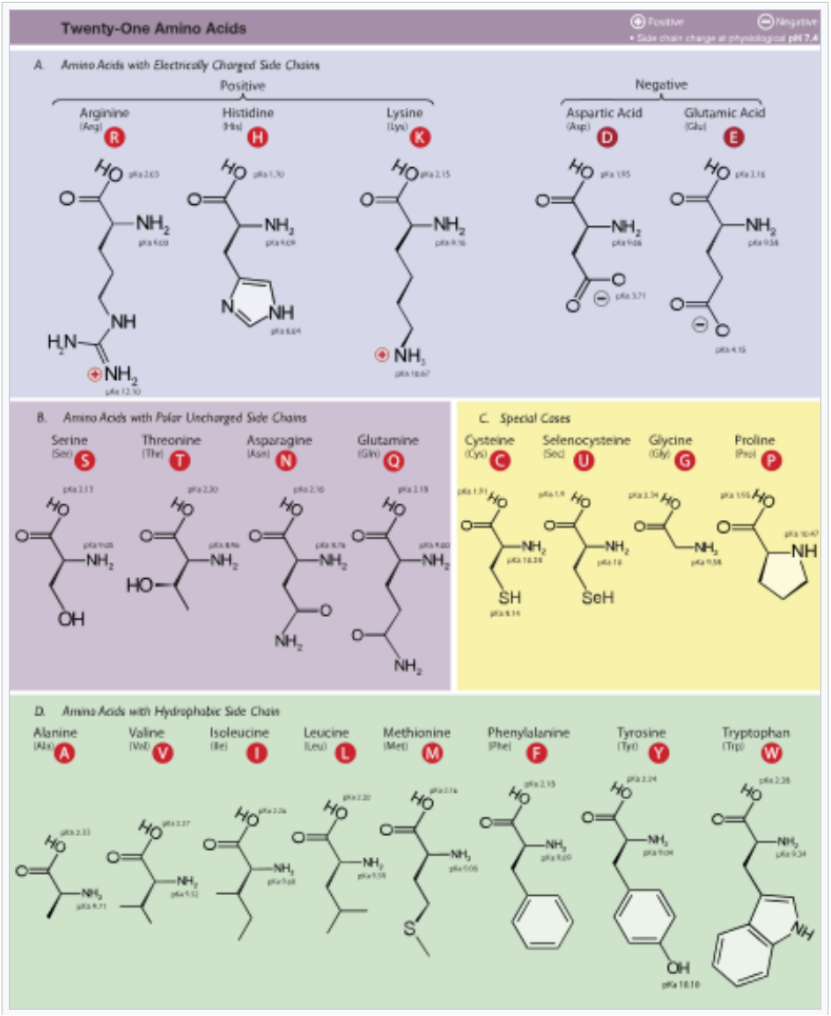
From Wikipedia “Amino Acids” 9-28-2018

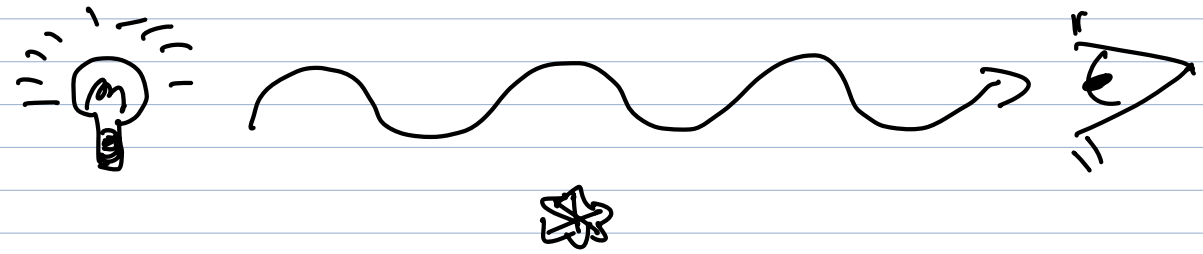
General structure [edit]

In the structure shown at the top of the page, **R** represents a side chain specific to each amino acid. The carbon atom next to the carboxyl group (which is therefore numbered 2 in the carbon chain starting from that functional group) is called the α–carbon. Amino acids containing an amino group bonded directly to the alpha carbon are referred to as *alpha amino acids*.[34] These include amino acids such as proline which contain secondary amines, which used to be often referred to as "imino acids".[35][36][37]

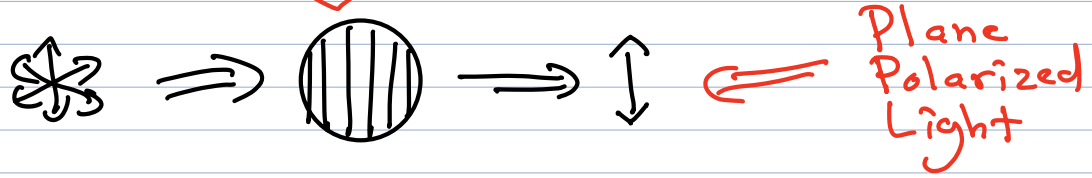


Isomerism [edit]

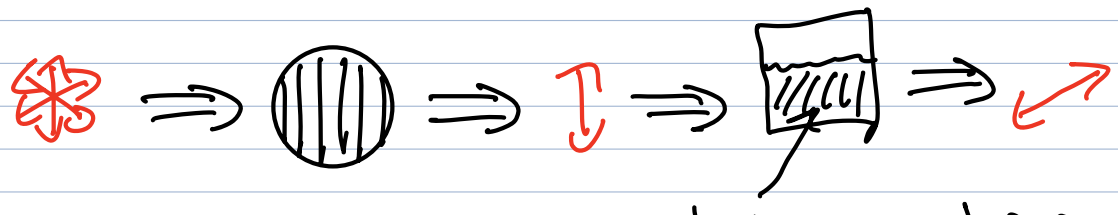
The alpha amino acids are the most common form found in nature, but only when occurring in the L-isomer. The alpha carbon is a chiral carbon atom, with the exception of glycine which has two indistinguishable hydrogen atoms on the alpha carbon.[38] Therefore, all alpha amino acids but glycine can exist in either of two enantiomers, called L or D amino acids, which are mirror images of each other (*see also Chirality*). While L-amino acids represent all of the amino acids found in proteins during translation in the ribosome, D-amino acids are found in some proteins produced by enzyme posttranslational modifications after translation and translocation to the endoplasmic reticulum, as in exotic sea-dwelling organisms such as cone snails.[39] They are also abundant components of the peptidoglycan cell walls of bacteria,[40] and D-serine may act as a neurotransmitter in the brain.[41] D-amino acids are used in racemic crystallography to create centrosymmetric crystals, which (depending on the protein) may allow for easier and more robust protein structure determination.[42]



Polarizing filter → makes it so only light in a single plane gets through

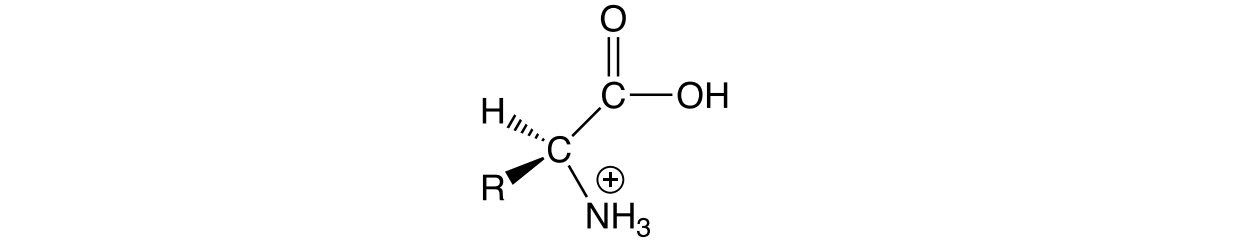


A sample of a chiral molecule will rotate the plane of plane polarized light an amount and direction that is characteristic for that molecule → Its enantiomer will rotate the plane of plane polarized light by the same amount but in the OPPOSITE direction!



Clockwise rotation → "+"

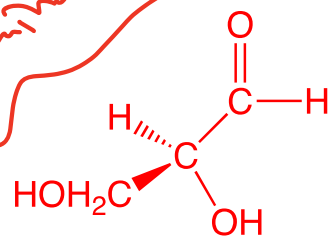
Counterclockwise rotation "−"



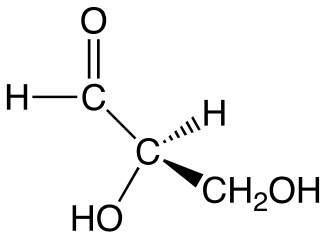
X S S R

IUPAC

Can be used to synthesize all 19 chiral amino acids



(L)-(-)-Glyceraldehyde



(D)-(+)-Glyceraldehyde

Levorotary

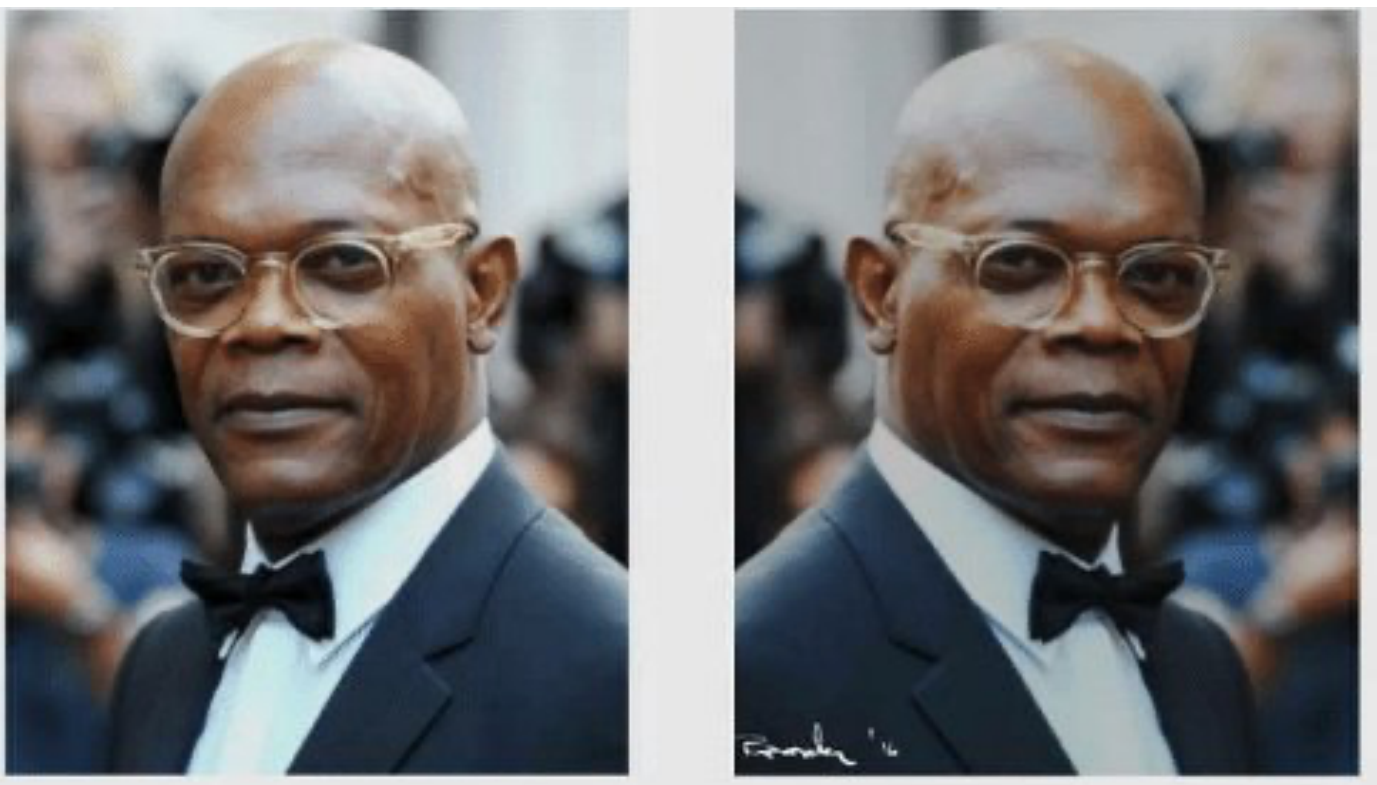
Another word for "−" Rotates the plane of plane polarized light counter-clockwise

Dextrorotary

Another word for "+" Rotates the plane of plane polarized light clockwise

The 19 chiral common amino acids are all "L" amino acids (even cysteine!)

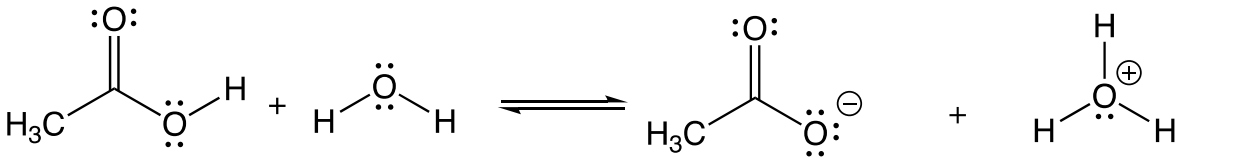
The "L" designation of amino acids is based on the structural relationship to (L)-(-)-glyceraldehyde



Samuel-**L**-Jackson

Samuel-**D**-Jackson

I hope this goes chiral



Acid (H-A) Base (B:) Conjugate Base ($A^{\ominus}$) Conjugate Acid (B-$H^{\oplus}$)

At equilibrium: $K_{equilibrium} = \frac{[Products]}{[Reactants]} = \frac{[CH_3CO_2^{\ominus}]\,[H_3O^{\oplus}]}{[CH_3CO_2H]\,[H_2O]}$

Equilibrium Constant

Assume: $[H_2O] = 55$ M and does not change

Acid Constant

$K_a = K_{equilibrium}\,[H_2O] = K_{equilibrium}\,[55\ M]$

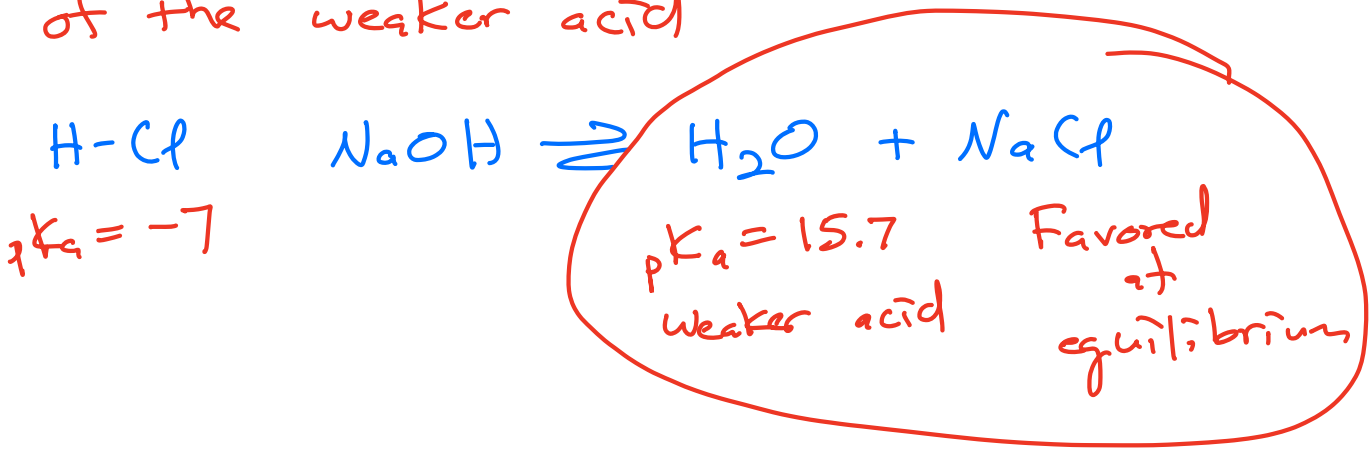
$K_a = \frac{[CH_3CO_2^{\ominus}]\,[H_3O^{\oplus}]}{[CH_3CO_2H]}$ $\qquad pK_a = -\log K_a$

A stronger acid has a lower value of pK_a

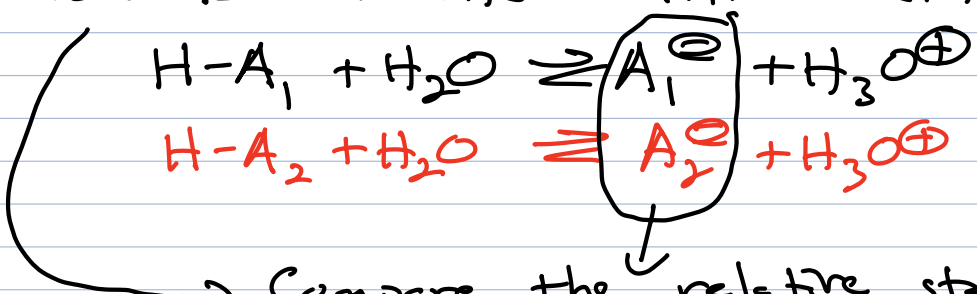
A weaker acid has a higher value of pK_a

General Rule

All acid-base reactions favor formation of the weaker acid



How to estimate relative acid strengths



Compare the relative stabilities of the anions produced upon deprotonation →

How do you predict anion stability?

the more stable anion comes from the stronger acid

2 important principles for predicting anion stability

1) Negative charge (⊖) is neutralized by nuclear ⊕ charge.

2) Delocalizing negative charge (⊖) over a larger area is better. → Golden Rule #5

Rules for anion stability —

The anion is more stable when the negative charge (⊖) is:

a) On a more electronegative element (Principle 1)
→ Periodic Table (across a single row)

b) On a larger atom (Principle 2)
↓ Periodic Table (down a single column)

c) On an atom with more "s" character to its hybridization
($sp > sp^2 > sp^3$)
← anion stability

"s" orbitals are closer to the nucleus (Principle 1)

d) stabilized by resonance delocalization. (Principle 2)

e) Stabilized by the inductive effect (Principles 1 and 2)

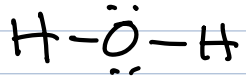
Operates through sigma bonds

nearby electronegative atoms attract ⊖ charge and therefore spread the ⊖ charge onto more atoms

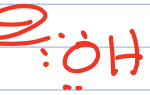
Examples

Rule a)

Ex.

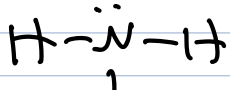


$pK_a = 15.7$

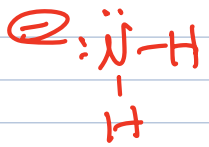


more stable anion

O is more electronegative



$pK_a = 38$



Rule b)

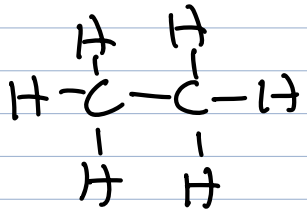
(Only compare atoms in same column of the Periodic Table)

pK_a	3.5	-7	-8	-9
	H-F	H-Cl	H-Br	H-I
	$F^\ominus$	$Cl^\ominus$	$Br^\ominus$	$I^\ominus$

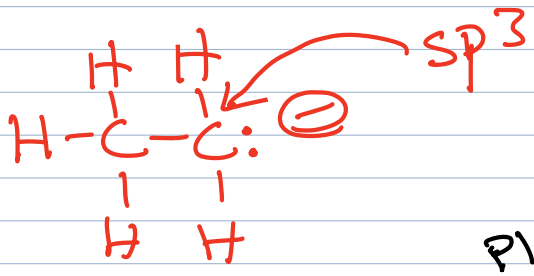
larger ion →

acid strength →

Rule c)



$pK_a \cong 50$

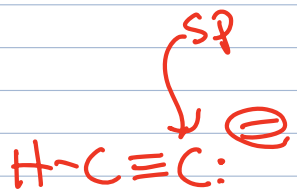


$sp^3 \rightarrow 25\%\ s$

$75\%\ p$

H-C≡C-H

$pK_a = 25$



Places more ⊖ closer to nucleus

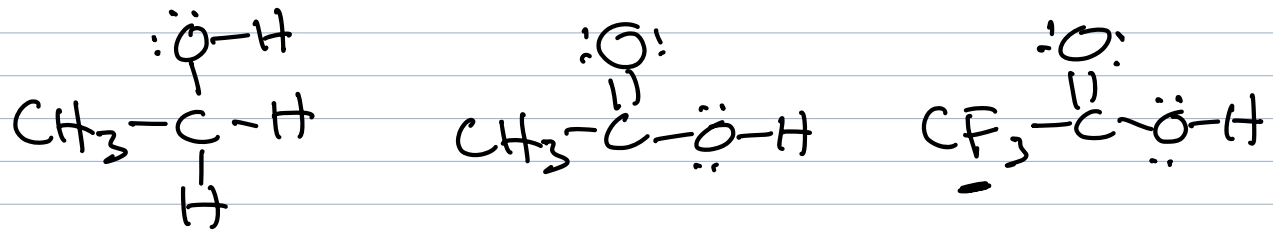
More "s" →

$sp \rightarrow 50\%\ s$

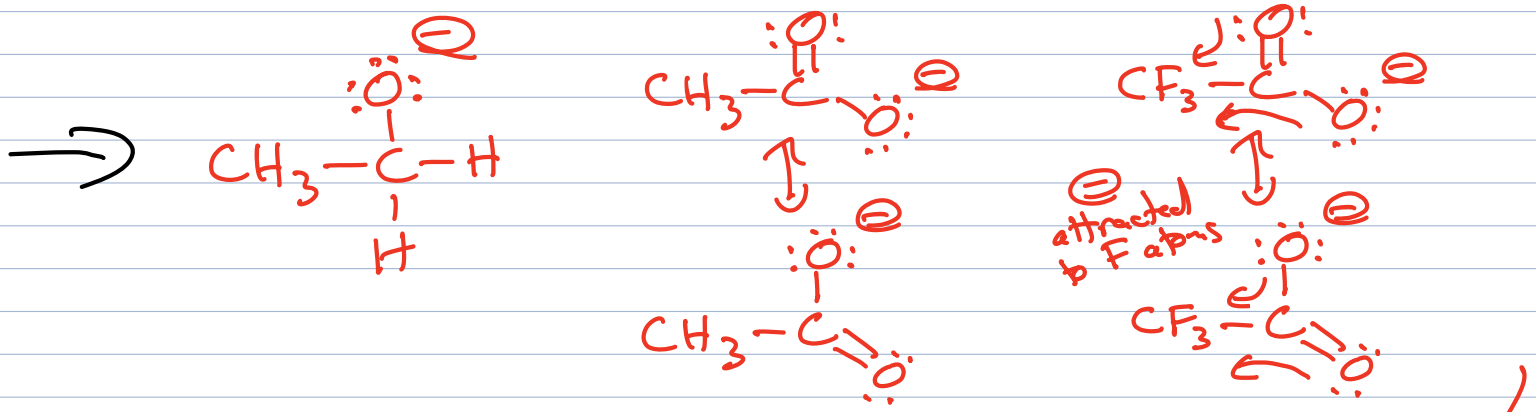
$50\%\ p$

More stable anion

Rules d) and e)



pK_a 15.9 4.8 0.1

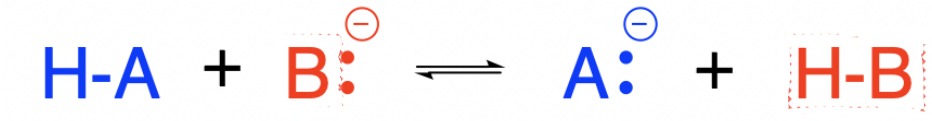


Resonance Delocalization Rule d)

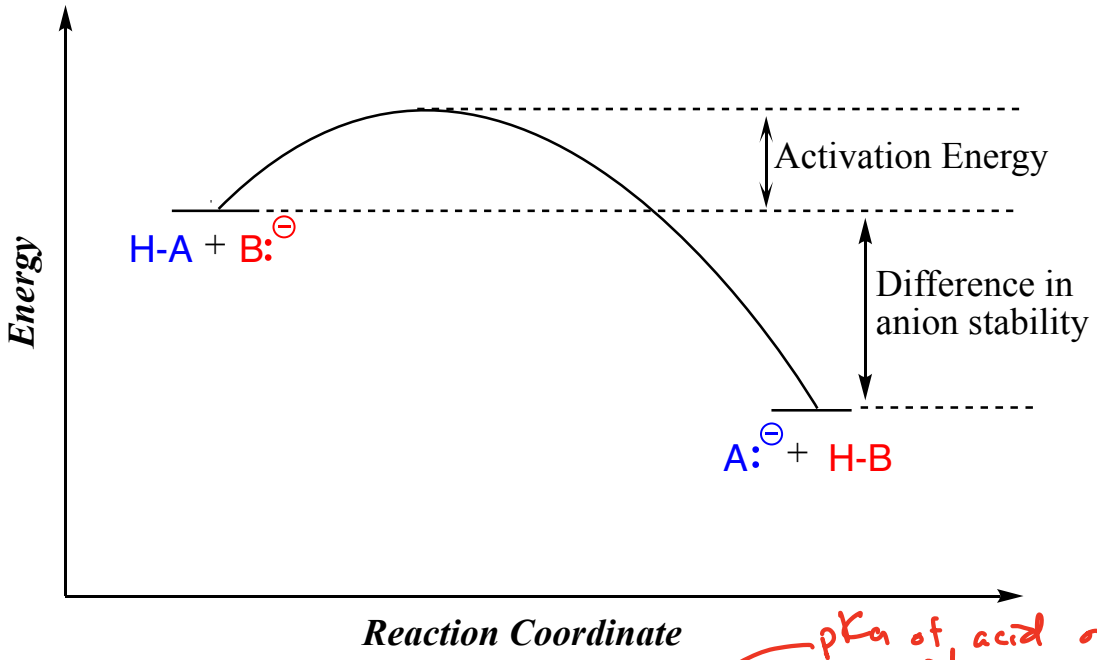
Inductive Effect Rule e)

anion stability

acid strength



Assume $A:^{\ominus}$ is more stable than $B:^{\ominus}$



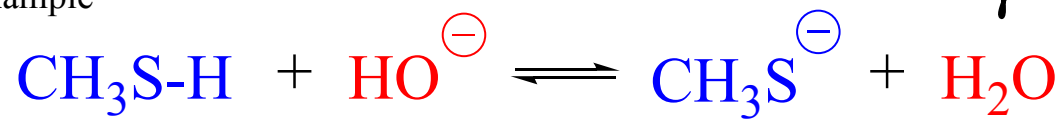
pKa of acid on product side as written

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

pKa of acid on starting material side as written

Favored at equilibrium

Example



$pK_a = 7$ $\qquad$ $pK_a = 15.7$ ← weaker acid

$$K_{eq} = 10^{(15.7 - 7)} = 10^{(8.7)}$$