Pre-Health Post-Baccalaureate Program
CHM2210 Study Guide & Practice Problems

Topics Covered:

Brønsted-Lowry Acids & Bases
Relative Strengths of Acids
Equilibrium in Acid-Base Reactions
Molecular Structure and Acidity
Lewis Acids and Bases

Created by Isaac Loy

B/L Acids and Bases

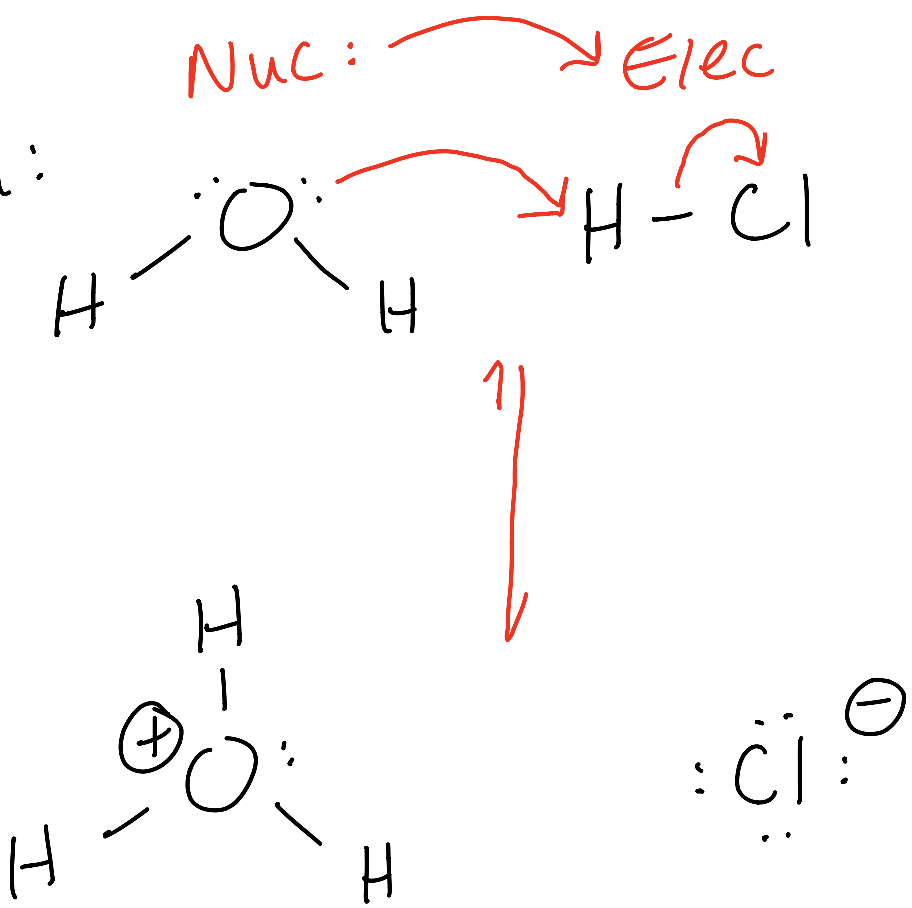
- → Acid is proton donor
- → Base is proton acceptor
- → Conjugate acid is protonated base
- → Conjugate base is deprotonated acid
- → Remember our rules!
  - → 1: "Neutrality rules the day"
  - → 2: "Proton-transfer is #1"

Example A

Rxn: $HCl + H_2O \rightleftharpoons Cl^{\ominus} + H_3O^{\oplus}$

acid — base — CB — CA

Mech:

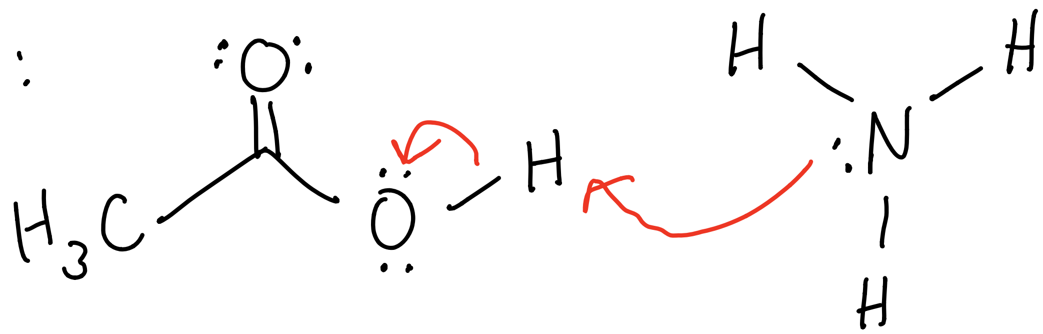


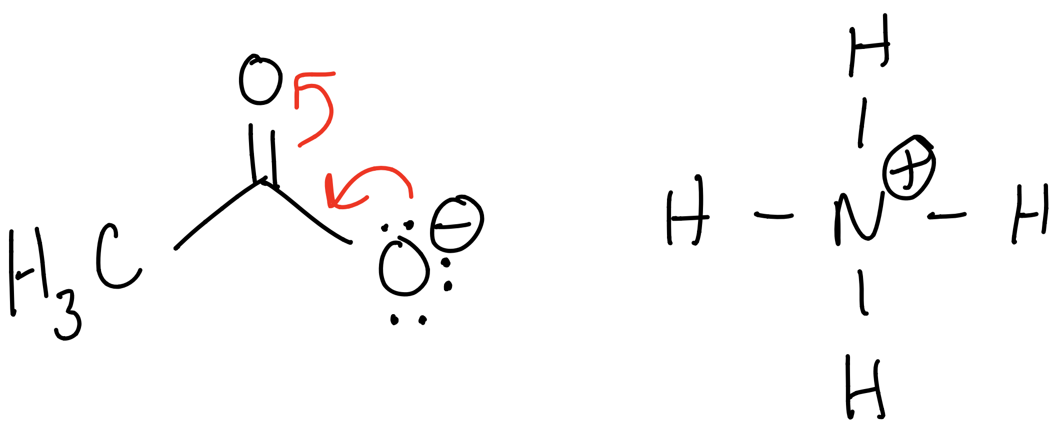
Example B

Rxn: $CH_3COOH + NH_3 \rightleftharpoons CH_3COO^{\ominus} + {}^{\oplus}NH_4$

acid — base — CB — CA

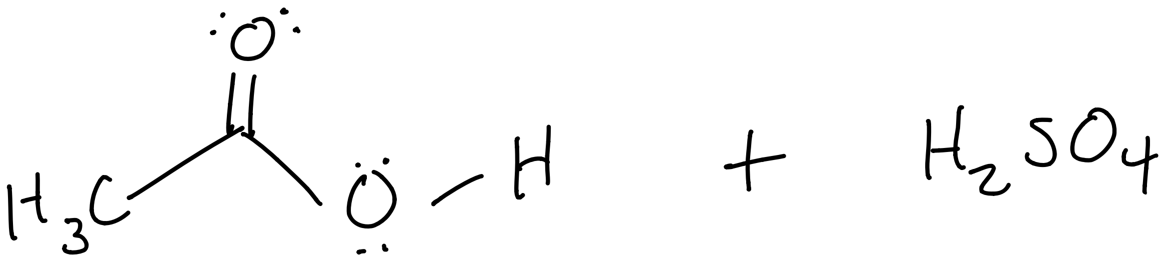
Mech:



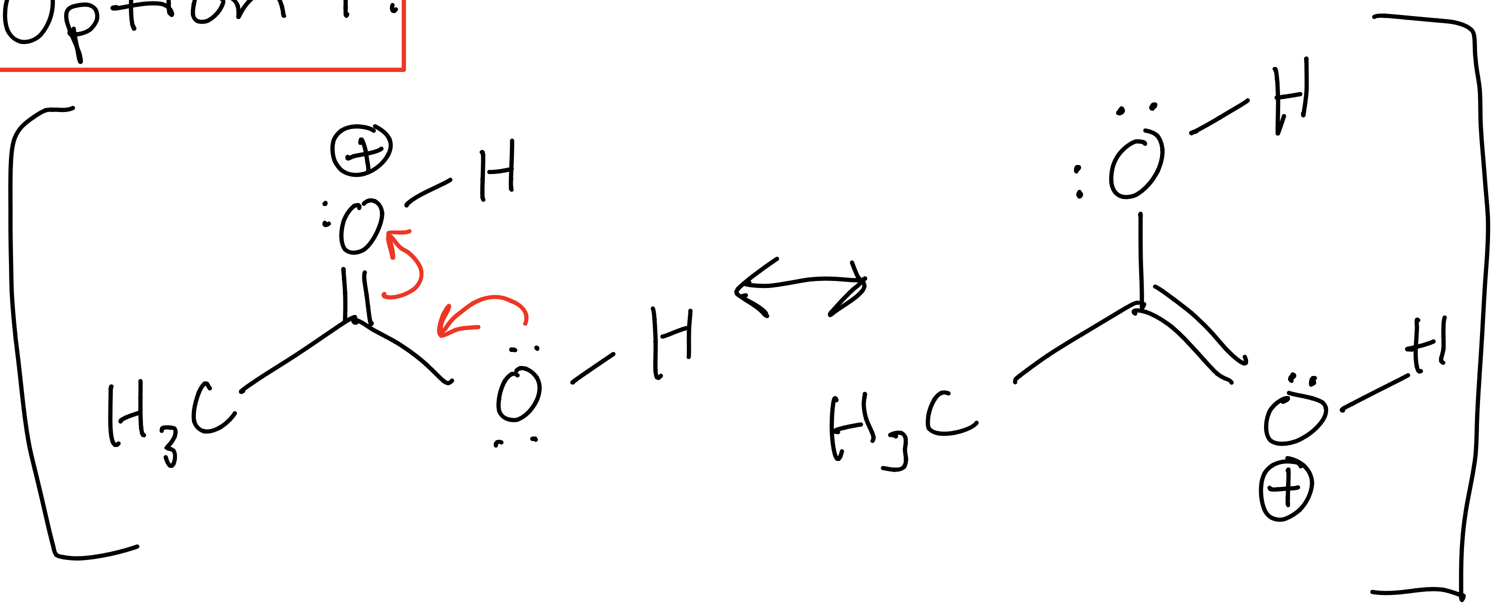


Example C

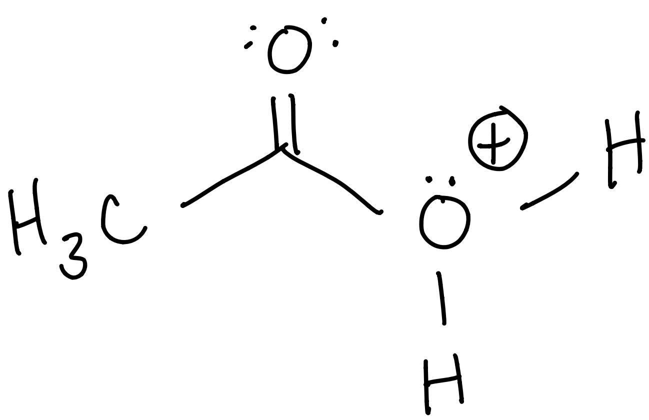
Which atom gets protonated?



Option 1:

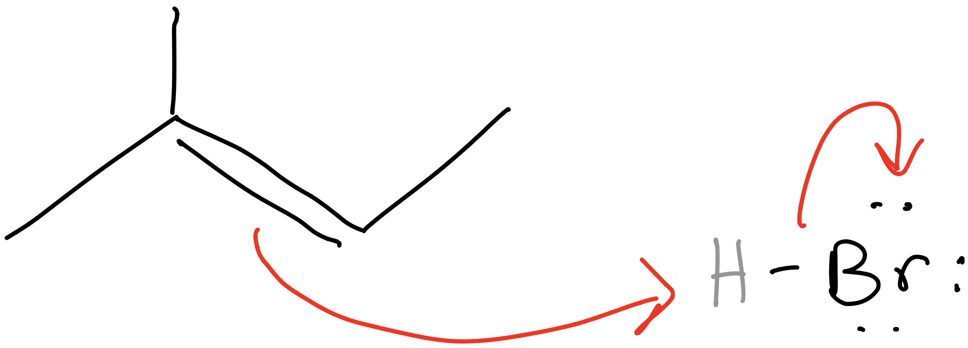


Option 2:



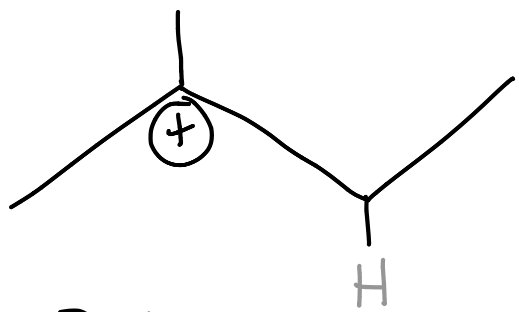
Pi bonds can act as nucleophiles / B-L bases

Example D

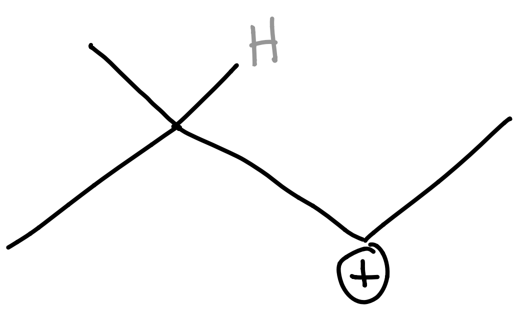


After the above reaction, which atom bears the positive charge?

Option 1:



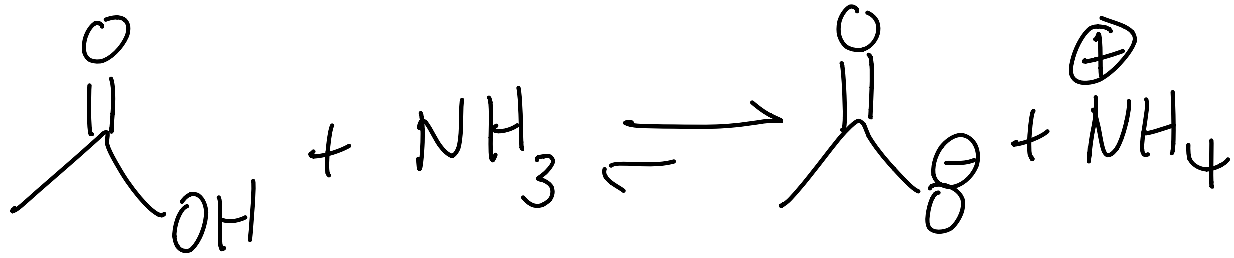
Option 2:



Equilibrium

→ Always favors
strong A/B →
weak A/B

Ex:



stronger acid | stronger base | weaker base | weaker acid

Lewis Acids and Bases

- → Lewis Acid is e^- pair acceptor
- → Lewis Base is e^- pair donor

Check with SERI!

acceptor atoms, more or less in a linear geometry.

Section 4.6 Molecular Structure and Acidity

- The acidity of an acid is determined by the stability of the anion formed on deprotonation, according to the rule that more acidic molecules form more stable anions upon deprotonation. Factors that influence the stability of an anion are:
  - Electronegativity of the atom bearing the negative charge because more electronegative atoms are more stable as anions.
  - Size of the atom bearing the negative charge because larger atoms can more easily accommodate a negative charge (it is spread over a larger area).
  - Delocalization of charge in the anion, usually described by resonance contributing structures because greater delocalization of charge is stabilizing.
  - The inductive effect because adjacent electronegative atoms such as the halogens will stabilize a nearby negative charge.
  - The hybridization of the atom bearing the negative charge because the greater the percentage of *s* character of an atom, the more stable it will be as an anion.

Section 4.7 Lewis Acids and Bases

Remember:

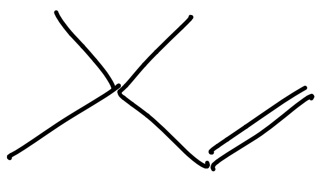
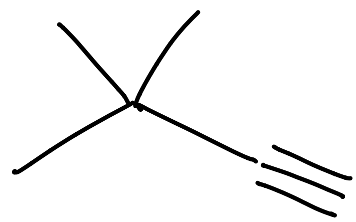
lone pairs atoms bonded to atoms with pi bonds are sp^2 hybridized

Problems

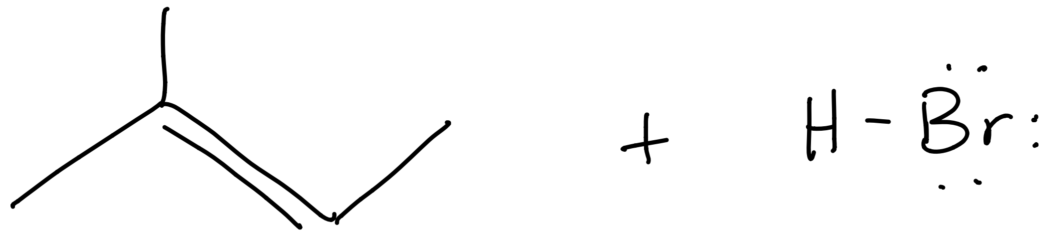
1. Provide reaction mechanism of the reaction of HOCN with water to produce the appropriate conjugate acid/base pairs. Show all non-zero formal charges, lone pairs, resonance structures, and proper flow of electrons.

(2) How do you qualitatively asses the strength of an acid?

(3) Choose the more acidic molecule from each of the following pairs of molecules:

	1		2
a)	H–I	vs.	H–Br
b)		vs.	
c)	H_3COH	vs.	H_3CSH
d)	ammonia	vs.	water

④



In the above reaction, what is the:

a) B/L acid from step 1?

b) B/L base from step 1?

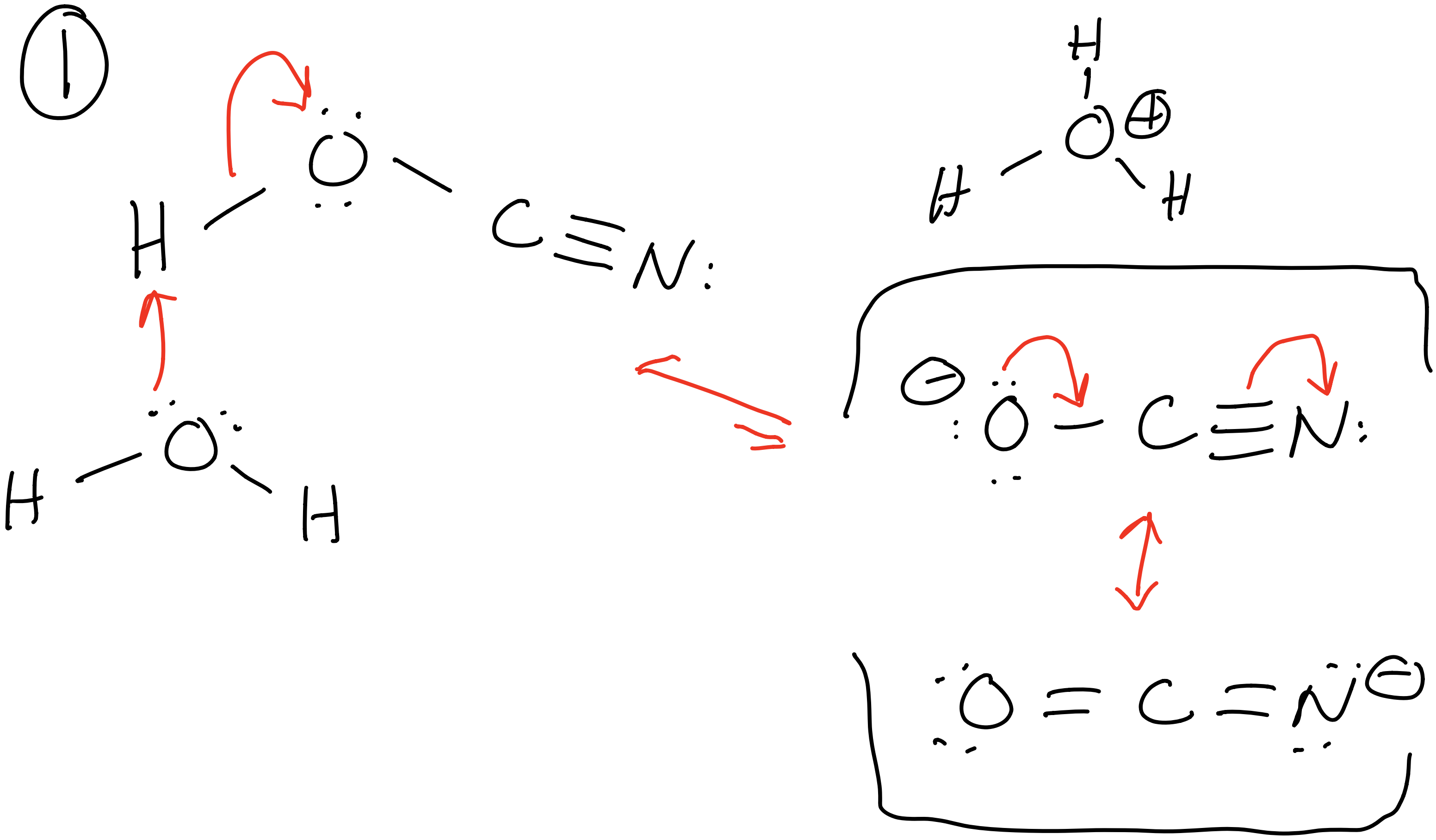
c) Lewis acid from step 2?

d) Lewis base from step 2?

(Hint: it may be easier to first do the mechanism in order to better see the chemistry that's happening)

Solutions

(1)



(2) Deprotonate the molecule, and determine the stability of the conjugate base using SERI. The more stable the conjugate base is, the likelier the acid is to give up a proton.

(3) a) 1: HI is larger than HBr, therefore H-I bond is broken more easily

b) 2: sp carbon is more electronegative than an sp^2 carbon

c) 2: sulfer is larger than oxygen, and can therefore better handle the negative charge upon deprotonation

d) 1: Oxygen is more electronegative than nitrogen, and is therefore better suited to lose a proton and gain a negative charge

④ a) HBr : $H^{\oplus}$ donor

b) 2-methyl-2-butene: $H^{\oplus}$ acceptor

c) [carbocation]‡ : e^- pair acceptor

d) $Br^{\ominus}$: e- pair donator

mech: