CHEM 223 (2024) SI Session #3

Learning Objectives: By the end of this session, students should be able to:

- Use intermolecular forces to predict solubility and boiling points
- Predict the products of any given acid-base reaction
- Compare acidity between different compounds using the 3 different properties
- Connect acidity to pKa
- Connect acids and bases to nucleophiles & electrophiles

Section 1: Bond Dipoles, Intermolecular forces & Solubility

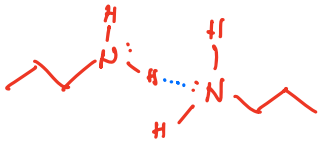
1. (From 2022's Exam 1) Which of the following molecules can hydrogen bond to another of the same compound?

A) $CH_3CH_2OCH_2CH_3$ ether
B) $CH_3CH_2COOCH_3$ ester
C) $(CH_3CH_2)_2CHOH$ alcohol
D) $CH_3CH_2COCH_2CH_3$ ether
E) all of the above

2. (From 2023's Exam 1) Which of the following molecules has the higher boiling point? Explain your choice.

① $(CH_3)_3N$ or ② $CH_3CH_2CH_2NH_2$

Compound ② has a higher boiling point, as it can hydrogen bond with itself.



3. Which of the following molecules has a higher boiling point? Explain your choice.

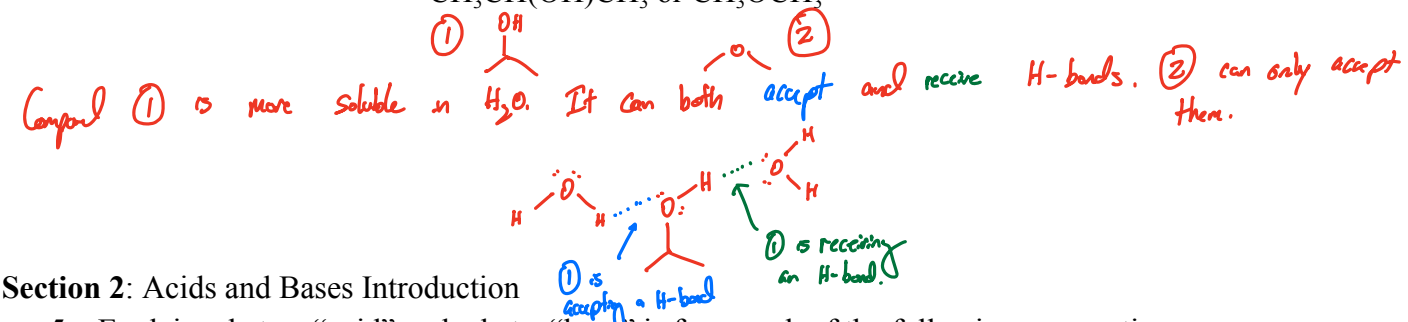
$(CH_3)_4C$ or $CH_3CH_2CH_2CH_2CH_3$

①  or ② 

Compound ② has a higher boiling point. Both ① and ② are completely non-polar, so london dispersion forces (LDFs) predominate. ② has a larger surface area, allowing for higher potentials of LDF interactions.

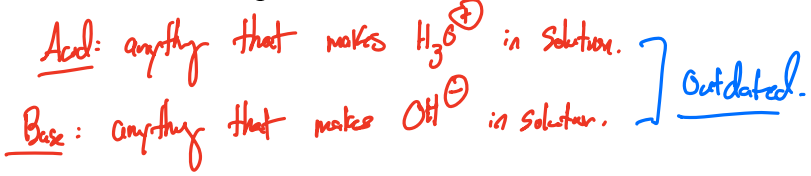
4. (Modified From 2020's Exam 1) Which of the following molecules is more soluble in water? Explain your choice.

$CH_3CH(OH)CH_3$ or CH_3OCH_3

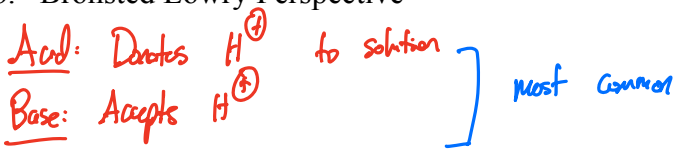


Section 2: Acids and Bases Introduction

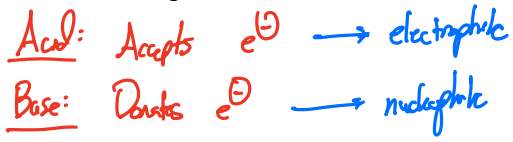
5. Explain what an "acid" and what a "base" is from each of the following perspectives
   a. Arrhenius Perspective



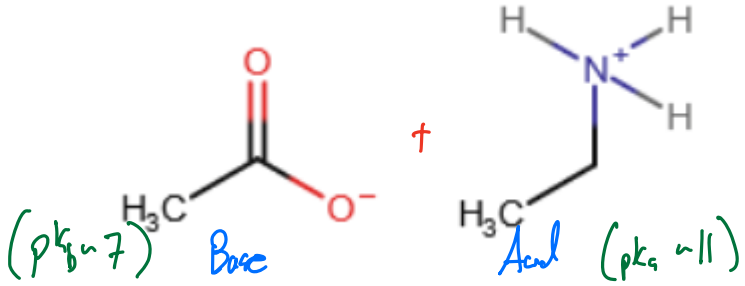
   b. Bronsted Lowry Perspective



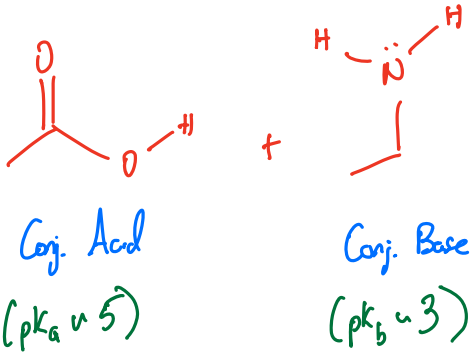
   c. Lewis Perspective



6. Using the reactants below to answer the following questions:



   a. Draw the products of the reaction



b. Label the Acid, Base, Conjugate Acid, and Conjugate Base.

Above

c. Predict which side is favored in equilibrium

Favor the reactants; the carboxylate base is more stable than its carboxylic acid counterpart.

Section 3: Comparing Acids and Bases

7. Describe what pKa tells us, in terms of acid strength.

Lower pK_a => stronger acid.

8. (Modified From 2023's Exam 1) For (a-c), order the compounds in terms of increasing acidity. Explain your reasoning.

   a. HBr, HF, HCl, HI

Big idea: Stronger acids have stable conj. bases! ☆

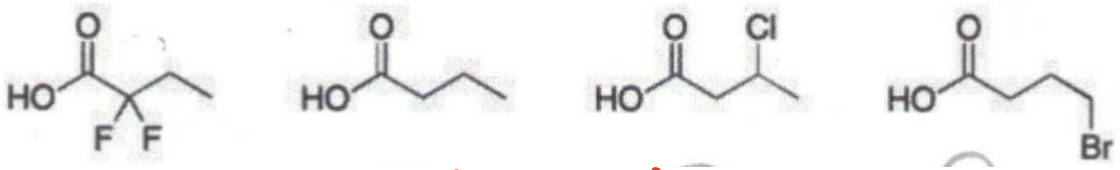
Acid: H-F < H-Cl < H-Br < H-I

CB: F^- Cl^- Br^- I^-

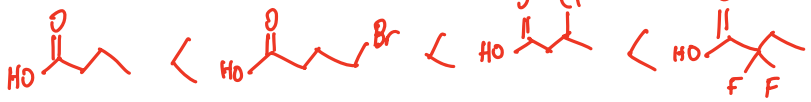
F^-: small, cannot adequately delocalize ⊖ charge

I^-: large, can easily delocalize ⊖ charge.

b.



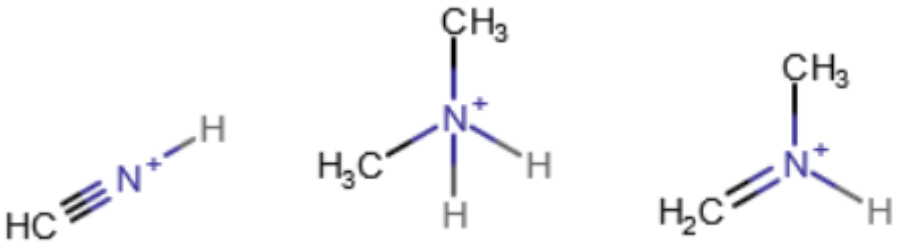
Acid:



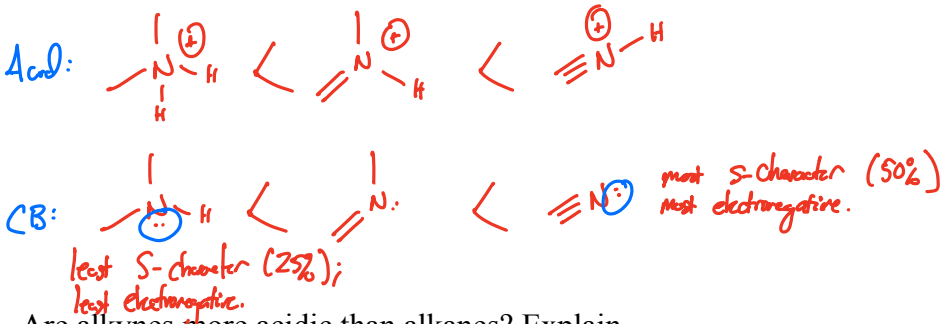
CB:

no inductive stabilization of ⊖ charge

highly electronegative => can inductively stabilize the ⊖ charge.

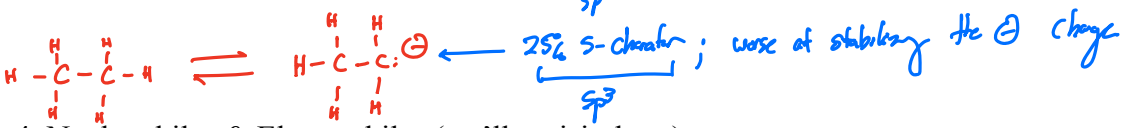


c.



9. Are alkynes more acidic than alkanes? Explain.

Yes.



Section 4: Nucleophiles & Electrophiles (we'll revisit these)

10. What's another name for a lewis base? What's another name for a lewis acid?

nucleophile; e⊖ rich species that can donate them.

electrophile; e⊖ poor/deficient species that can accept them.

11. Draw the reaction that occurs between BH_3 and NH_3. Label the nucleophile and electrophile, and draw arrows to describe the formation of any new bond(s).