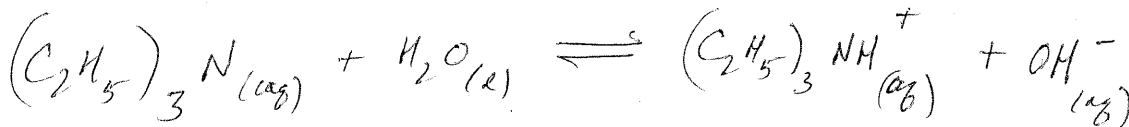


1) (20 points) Calculate the $[\text{OH}^-]$, $[\text{H}_3\text{O}^+]$, and the pH of a 0.20 M solution of triethylamine, $(\text{C}_2\text{H}_5)_3\text{N}$, $K_b = 4.0 \times 10^{-4}$. For full credit show the balanced equilibrium equation for the reaction of $(\text{C}_2\text{H}_5)_3\text{N}$ with H_2O . Be sure to include the reactant and product states.



	$[\text{B}]$	$[\text{BH}^+]$	$[\text{OH}^-]$
C	0.20	0	0
C	-x	+x	+x
C	0.20-x	x	x

$$\frac{x^2}{0.20-x} = 4.0 \times 10^{-4}$$

$$\frac{x^2}{0.20} = 4.0 \times 10^{-4}$$

$$x = 8.94 \times 10^{-3} = [\text{OH}^-]$$

$$[\text{H}_3\text{O}^+] = \frac{K_w}{[\text{OH}^-]} = \frac{1.0 \times 10^{-14}}{8.94 \times 10^{-3}} = 1.12 \times 10^{-12}$$

$$-\log(1.12 \times 10^{-12}) = 11.95_2$$

2) (8 points) Aqueous solutions of the following bases are prepared. Hydroxylamine, HONH_2 , has a $K_b = 1.1 \times 10^{-8}$. Recall that triethylamine, $(\text{C}_2\text{H}_5)_3\text{N}$ has a $K_b = 4.0 \times 10^{-4}$. Circle your response to each question.

a) For equal concentrations of each base which solution is more basic? $\text{HONH}_2_{(\text{aq})}$ or $(\text{C}_2\text{H}_5)_3\text{N}_{(\text{aq})}$

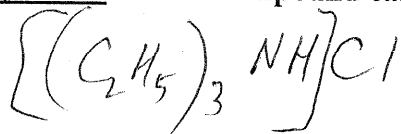
b) Which unionized base is more stable? HONH_2 or $(\text{C}_2\text{H}_5)_3\text{N}$

c) Which base has the stronger conjugate acid? HONH_2 or $(\text{C}_2\text{H}_5)_3\text{N}$

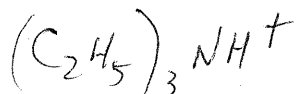
d) Which base solution can be diluted without significant competition from water's autoionization?

$\text{HONH}_2_{(\text{aq})}$ or $(\text{C}_2\text{H}_5)_3\text{N}_{(\text{aq})}$

3) (4 points) For 1.0 L of a 0.1 M solution of triethylamine, $(\text{C}_2\text{H}_5)_3\text{N}$, what compound and how many moles of that compound can be added to the solution to produce a buffer with $\text{pOH} = \text{p}K_b$?



0.1 mol

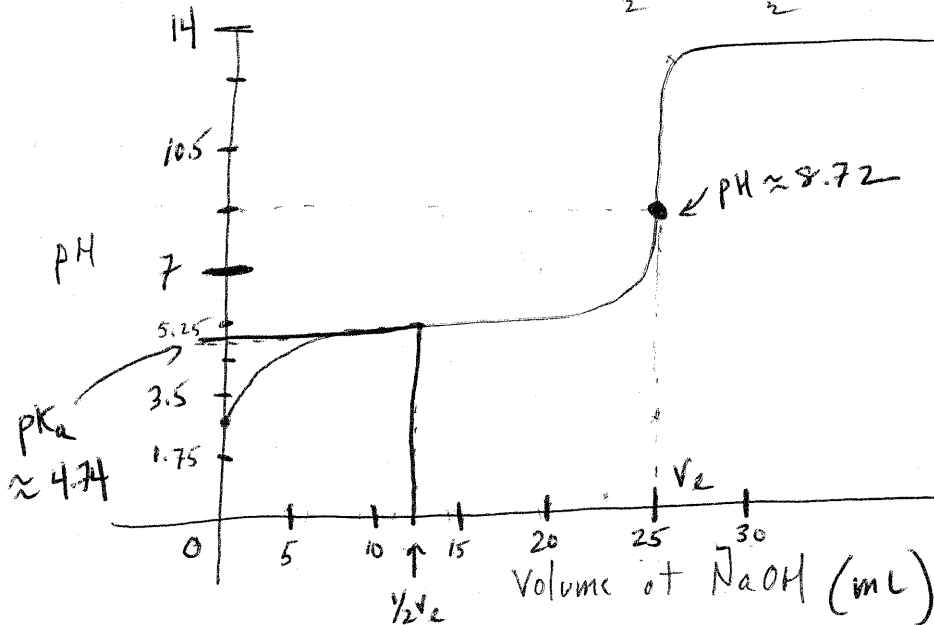


4) (5 points) Arrange the following 0.10 M solutions in order from most basic to most acidic: HI, LiCl, LiNO₂, NH₄I & LiOH.

most basic LiOH LiNO₂ LiCl NH₄I HI most acidic

5) (13 points) Titration of 25.0 mL of 0.10 M acetic acid ($K_a = 1.8 \times 10^{-5}$) with 0.10 M NaOH.

a) Sketch the graph of **pH vs. volume of NaOH** for this titration. Make sure to label the axes, show approximate scales, show plateau regions, show the endpoint, show the endpoint volume, show the pK_a . When I say approximate scales, it means that I should be able to read from your graph an approximate value that makes sense for endpoint, endpoint volume, and pK_a .



$$\frac{x^2}{0.1} = 1.8 \times 10^{-5}$$

$$x = 1.34 \times 10^{-3}$$

$$pH_{initial} = 2.87$$

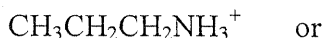
$$\frac{x^2}{0.05} = 5.6 \times 10^{-10}$$

$$x = 5.29 \times 10^{-6}$$

$$pH_{Ve} = -\log\left(\frac{1 \times 10^{-14}}{5.29 \times 10^{-6}}\right) = 8.72$$

4) (10 points) Circle the

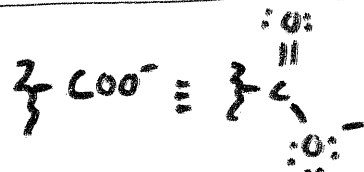
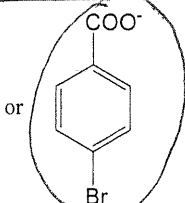
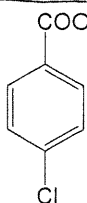
a) strongest acid



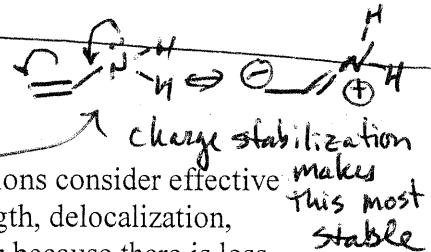
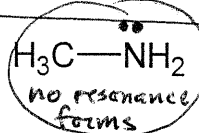
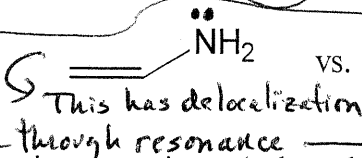
b) most stable acid



c) strongest base



d) least stable base



e) Explain two of the six comparisons (a, b, c, d, e, or f). In your explanations consider effective nuclear charge, electronegativity, charge density, bond polarization, bond strength, delocalization, resonance, hybridization, or inductive effect. An explanation like "it is stronger because there is less oxygen ..." is not acceptable by itself.

a) compare conjugate bases: CH3CH2CH2NH2 vs. CH3CH2CH2OH

more stable (weaker) due to the EN of Oxygen ($EN_O > EN_N$)

b) compare conjugate bases: CH3OCH2CH2CH2O- vs. CH3CH2OCH2CH2O-

The oxygen stabilizes the lone pair e⁻s.

∴ the strongest base is the least stable base. Br is less EN than Cl and cannot stabilize the charge through induction

more stable (weaker) due to greater inductive effect from the oxygen