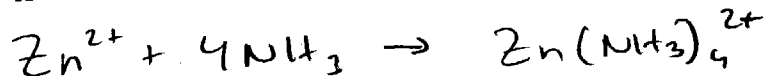
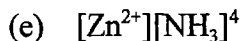
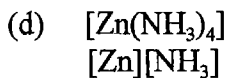
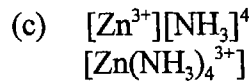
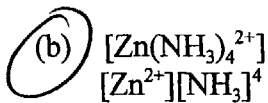
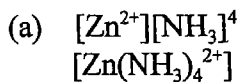
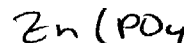


4. Zinc ion forms a complex ion with 4 NH₃'s. What is K_f expression for formation of this complex ion?



5. What would happen if you added NH₃ to a saturated solution of zinc phosphate in water?
~~zinc phosphate~~



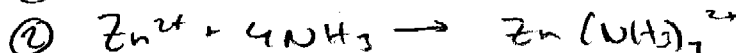
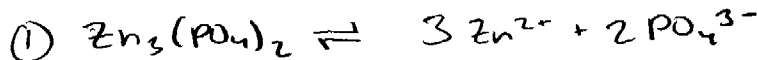
(a) The zinc phosphate solubility equilibrium shifts to the RIGHT and more solid precipitates out of solution.

(b) The zinc phosphate solubility equilibrium shifts to the RIGHT and more solid dissolves.

(c) The zinc phosphate solubility equilibrium shifts to the LEFT and more solid dissolves.

(d) The zinc phosphate solubility equilibrium shifts to the LEFT and more solid precipitates out of solution.

(e) Nothing happens.



In the presence of NH₃, rxn $\textcircled{2}$ happens. This causes $[\text{Zn}^{2+}] \downarrow$, rxn $\textcircled{1}$ shifts to take $(\text{Zn}^{2+}) \uparrow$. Goes to the RIGHT, so more solid dissolve.

these answers don't make sense

6. A solution of potassium sulfate and copper(II) chloride is mixed together. Which of the following most likely happens.

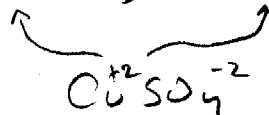
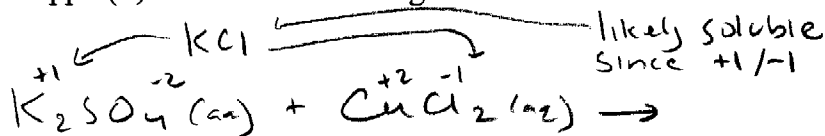
(a) Nothing (no reaction occurs).

(b) Cu metal precipitates.

(c) CuS precipitates

(d) CuSO₄ precipitates

(e) KCl precipitates.



most metal sulfates are soluble - so likely soluble

likely soluble since +1/-1

Consider the following titration for the next 5 questions:

40.0 mL of a 0.50 M aqueous solution of t-butylamine, $\text{H}_2\text{NC}(\text{CH}_3)_3$, is titrated with aqueous 0.40 M HCl.
← strong acid weak base

7. What is the overall reaction occurring in the titration?

- (a) $\text{H}_2\text{NC}(\text{CH}_3)_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{HNC}(\text{CH}_3)_3^-(\text{aq}) + \text{H}_2\text{Cl}^+(\text{aq})$
- (b) $\text{H}_2\text{NC}(\text{CH}_3)_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_3\text{NC}(\text{CH}_3)_3(\text{aq}) + \text{Cl}(\text{aq})$
- (c) $\text{H}_2\text{NC}(\text{CH}_3)_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{O} + \text{H}_3\text{NC}(\text{CH}_3)_3\text{Cl}(\text{aq})$
- (d) $\text{H}_2\text{NC}(\text{CH}_3)_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{O} + \text{CN}^-(\text{aq}) + (\text{CH}_3)_3\text{Cl}^+(\text{aq})$
- (e) $\text{H}_2\text{NC}(\text{CH}_3)_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_3\text{NC}(\text{CH}_3)_3^+(\text{aq}) + \text{Cl}^-(\text{aq})$

8. How many mL's of the HCl solution need to be added to reach the equivalence point of the titration?

- (a) 10.0 mL (b) 20.0 mL (c) 30.0 mL (d) 40.0 mL (e) 50.0 mL

at equivalence moles acid = moles base

$$C_a V_a = C_b V_b$$

$$V_a = \frac{C_b V_b}{C_a} = \frac{(0.50\text{M})(40.0\text{mL})}{(0.40\text{M})}$$

$$= \boxed{50.0\text{mL}}$$

9. What is in the flask at the equivalence point of the titration?

- (a) $\text{HOCH}_2\text{CH}_2\text{NH}(\text{aq})$ only
- (b) all reactants
- (c) all products
- (d) $\text{HOCH}_2\text{CH}_2\text{NH}(\text{aq})$ + all products
- (e) all reactants and all products

this is what the equiv. pt means - you've added just enough from buret to convert everything in flask to products with no extra.

these choices don't make a lot of sense! (because they are from form B titrations)

10. How is the solution in the flask at the equivalence point best characterized?

- (a) strong acid (b) weak acid (c) strong base (d) weak base
- (e) buffer (ab) neutral

Since $\text{H}_2\text{NC}(\text{CH}_3)_3$ is a weak base, its conj. acid $\text{H}_3\text{NC}(\text{CH}_3)_3^+$ is a weak acid.

Continuation of the titration problem from previous page

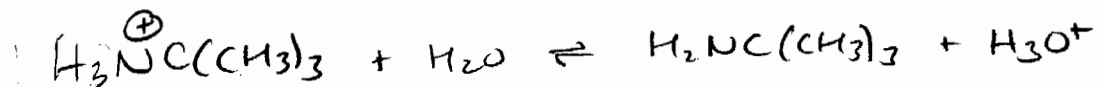
Since know will be a weak acid can eliminate answers w/ pH's ≥ 7

11. What is the pH at the equivalence point of the titration?

- (a) 4.99 (b) ~~8.33~~ (c) ~~7.00~~ (d) ~~9.01~~ (e) 5.67

$$K_b \text{ of } \text{H}_2\text{NC}(\text{CH}_3)_3 = 4.8 \times 10^{-4}$$

$$K_a = \frac{K_w}{K_b} = \frac{1.008 \times 10^{-14}}{4.8 \times 10^{-4}} = 2.10 \times 10^{-11}$$



$$K_a = \frac{[\text{H}_2\text{NC}(\text{CH}_3)_3][\text{H}_3\text{O}^+]}{[\text{H}_3\text{N}^+(\text{CH}_3)_3]} \Rightarrow \frac{x^2}{[\text{H}_3\text{N}^+(\text{CH}_3)_3]_{\text{init}}} = 2.10 \times 10^{-11}$$

$$\frac{x^2}{0.22} = 2.10 \times 10^{-11} \quad \sqrt{x^2} = \sqrt{(2.10 \times 10^{-11})(0.22)}$$

$$x = \quad "$$

$$= 2.16 \times 10^{-6} = [\text{H}_3\text{O}^+]$$

$$\text{pH} = -\log(2.16 \times 10^{-6}) = \boxed{5.67}$$

$$[\text{H}_3\text{N}^+(\text{CH}_3)_3]_{\text{init}} = \frac{\text{initial moles of } \text{H}_2\text{NC}(\text{CH}_3)_3}{\text{tot } V}$$

$$= \frac{C \cdot V_{\text{init}}}{\text{tot } V} = \frac{(0.50\text{M})(40.\text{mL})}{90.\text{mL}}$$

$$= 0.22\text{M}$$

12. What is the pH of a buffer solution prepared from 0.025 M lactic acid, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$, and 0.10 M sodium lactate $\text{Na}[\text{CH}_3\text{CH}(\text{OH})\text{CO}_2]$?
 (a) 3.25 (b) 2.47 (c) 3.85 (d) 4.46 (e) 5.24

$$\text{pH} = \text{pK}_a + \log \frac{\text{base}}{\text{acid}} = 3.854 + \log \left(\frac{0.10}{0.025} \right) = \boxed{4.46}$$

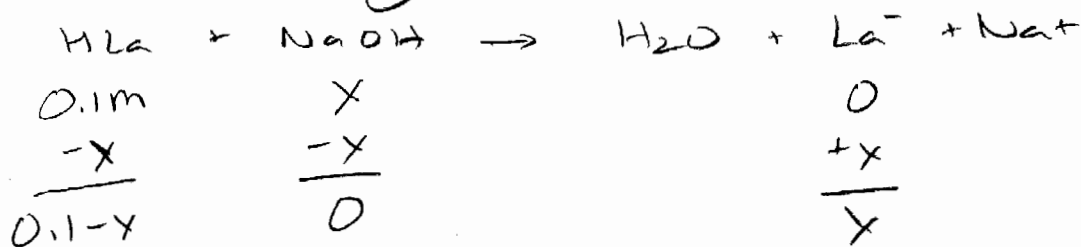
13. What buffer component ratio would be needed to make a pH 4.50 lactic acid/lactate buffer?

- (a) 4.4 (b) 0.23 (c) 7.1 (d) 0.14 (e) 1.3

$$10^{\text{pH} - \text{pK}_a} = 10^{(4.50 - 3.854)} = \boxed{4.4}$$

14. How many grams of NaOH would need to be added to 0.50 L of a 0.20 M lactic acid solution to make a pH 4.50 buffer? HLA

- (a) 0.49 g (b) 1.2 g (c) 3.3 g (d) 2.5g (e) 0.79 g



From previous question, to make pH 4.50 buffer

$$\frac{x}{0.10-x} = 4.4 = \frac{\text{La}^-}{\text{HLA}}$$

$$x = 4.4(0.10-x)$$

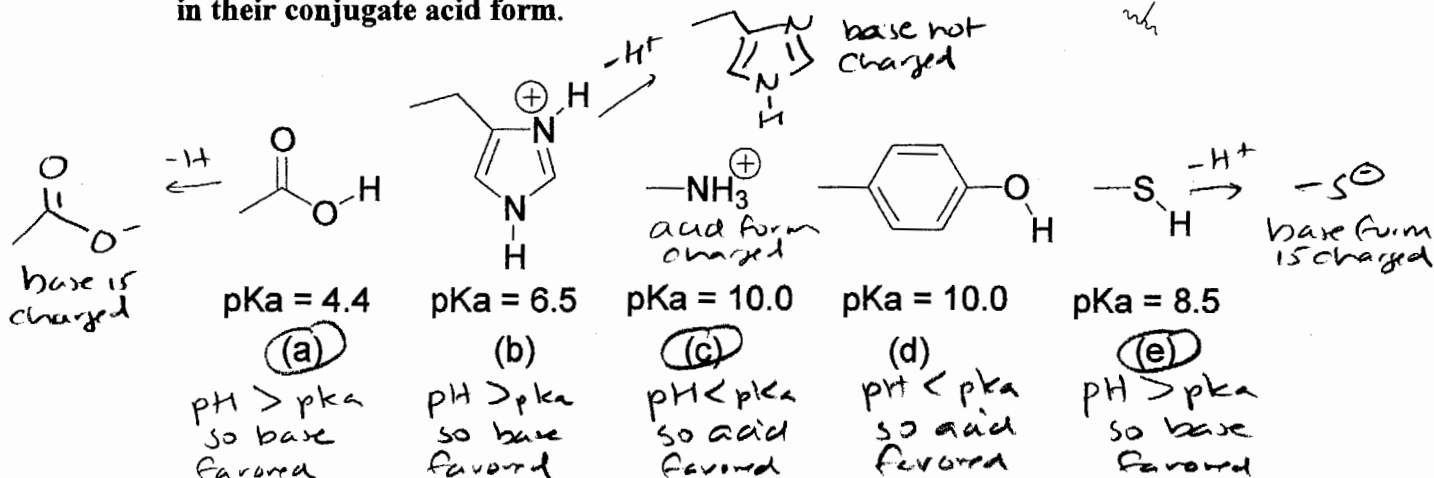
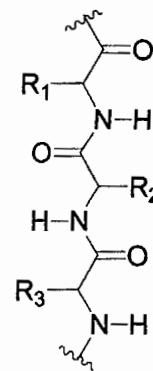
$$x = 0.44 - 4.4x$$

$$5.4x = 0.44$$

$$x = \frac{0.44}{5.4} = 0.08148 \text{ mol} = \frac{40.01 \text{ g}}{\text{mol}} = \boxed{3.26 \text{ g}}$$

$$\text{MW NaOH} = 40.01 \text{ g/mol}$$

15. As discussed in lecture, one of the reasons acid/base chemistry is so important is that acid-base reactions create charges in organic molecules, and the existence of charged sites plays a major role in determining the 3D structure in many biologically important molecules such as proteins. Proteins consist of linked amino acids as shown to the right. The R1, R2, R3 groups are the side chains of the amino acids. Shown below are the side chains of some of the amino acids that have acid/base character and the pKa's of the conjugate acid form of the side chain. **NOTE: all the side chains are drawn in their conjugate acid form.**



Based on the above information, which of these amino acid side chains will mainly exist in the charged form (either positive or negative) at pH 9? Circle all correct answers.

16. A buffer made from ^{base} C₅H₅N and ^{acid} [C₅H₅NH]⁺Cl⁻ would be most appropriate for which of the following pH ranges?

- (a) 8.4 to 10.4 (b) 7.8 to 9.8 (c) 3.6 to 5.6 (d) 4.2 to 6.2
(e) 4.2 to 9.8

$$K_b \text{ of } C_5H_5N = 1.7 \times 10^{-9}$$

$$K_a = \frac{1.008 \times 10^{-14}}{1.7 \times 10^{-9}} = 5.93 \times 10^{-6}$$

$$pK_a = -\log(5.93 \times 10^{-6}) = 5.23$$

pH for buffer should be ± 1 of desired pH

1. What is the pH of a buffer solution prepared from 0.10 M lactic acid, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$, and 0.025 M sodium lactate $\text{Na}^+[\text{CH}_3\text{CH}(\text{OH})\text{CO}_2]^-$?
↑
base acid

- (a) 2.47 (b) 4.46 (c) 3.25 (d) 5.24 (e) 3.85

$$\text{pH} = \text{pK}_a + \log \frac{\text{base}}{\text{acid}} = 3.854 + \log \left(\frac{0.025}{0.10} \right) = \boxed{3.25}$$

$$K_a \text{ of lactic acid} = 1.4 \times 10^{-4}$$

$$\text{pK}_a = -\log(1.4 \times 10^{-4}) = 3.854$$

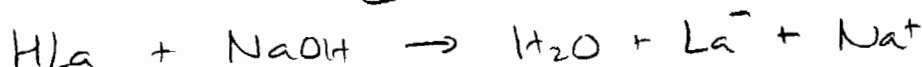
2. What buffer component ratio would be needed to make a pH 3.00 lactic acid/lactate buffer?

- (a) 4.4 (b) 0.23 (c) 7.1 (d) 0.14 (e) 0.055

$$10^{(\text{pH} - \text{pK}_a)} = \frac{\text{base}}{\text{acid}} = 10^{(3.00 - 3.854)} = \boxed{0.14}$$

3. How many grams of NaOH would need to be added to 0.50 L of a 0.20 M lactic acid solution to make a pH 3.00 buffer?
HLA

- (a) 0.79 g (b) 3.3 g (c) 1.2 g (d) 0.49 g (e) 2.5g



$$\begin{array}{r} 0.50\text{L} \times 0.20\text{mol/L} \\ = 0.10\text{mol} \end{array} \quad \begin{array}{r} 0.10\text{mol} \\ -x \\ \hline 0.10-x \end{array} \quad \begin{array}{r} x \\ -x \\ \hline 0 \end{array} \quad \begin{array}{r} 0 \\ +x \\ \hline x \end{array}$$

From previous question $\frac{\text{La}^-}{\text{HLA}} = 0.14 = \frac{x}{0.10-x}$

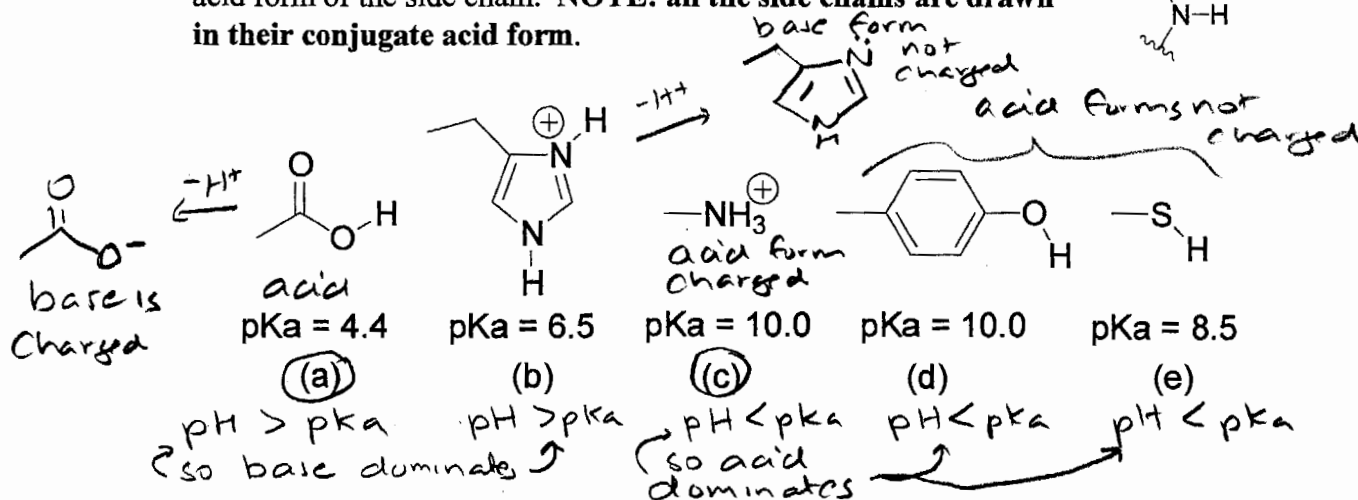
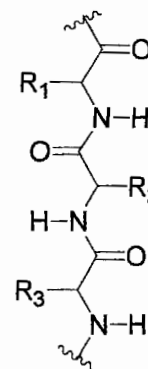
$$0.14(0.10-x) = x \quad \text{mw NaOH} = 23.00 + 16.00 + 1.01 = 40.01 \text{ g/mol}$$

$$0.014 - 0.14x = x$$

$$0.014 = 1.14x$$

$$\frac{0.014}{1.14} = x = 1.23 \times 10^{-2} \text{ mol NaOH} \times \frac{40.01 \text{ g}}{\text{mol}} = \boxed{0.49 \text{ g}}$$

4. As discussed in lecture, one of the reasons acid/base chemistry is so important is that acid-base reactions create charges in organic molecules, and the existence of charged sites plays a major role in determining the 3D structure in many biologically important molecules such as proteins. Proteins consist of linked amino acids as shown to the right. The R1, R2, R3 groups are the side chains of the amino acids. Shown below are the side chains of some of the amino acids that have acid/base character and the pKa's of the conjugate acid form of the side chain. **NOTE: all the side chains are drawn in their conjugate acid form.**



Based on the above information, which of these amino acid side chains will mainly exist in the charged form (either positive or negative) at pH 7? Circle all correct answers.

5. A buffer made from $C_6H_5NH_2$ and $[C_6H_5NH_3^+]Cl$ would be most appropriate for which of the following pH ranges?

- (a) 8.4 to 10.4 (b) 3.6 to 5.6 (c) 4.2 to 6.2 (d) 7.8 to 9.8
(e) 4.6 to 9.4

$$K_b \text{ of } C_6H_5NH_2 = 4.0 \times 10^{-10}$$

$$K_a = \frac{K_w}{K_b} = \frac{1.008 \times 10^{-14}}{4.0 \times 10^{-10}} = 2.52 \times 10^{-5}$$

$$pK_a = -\log(2.52 \times 10^{-5}) = 4.60 = pK_a$$

pH for buffer is ± 1 of pK_a

so 3.6 to 5.6

6. Fill in the blanks. Physical processes such as chemical reactions tend to go towards lower energy and higher entropy.

The answers in order are

- (a) lower, lower (b) higher, higher (c) lower, higher (d) higher, lower

7. If a physical system undergoes a change corresponding to a positive ΔS , which one of the following statements has to be TRUE?

- (a) The energy in the final state would be distributed in a more probable fashion than in the initial state. T
 (b) The final state would be more ordered than the initial state. F final state is less ordered
 (c) The energy of the final state would be higher than the initial state.
 (d) The energy of the final state would be lower than the initial state. } depends on ΔH , not ΔS

8. Which one of the following reactions most likely has a negative ΔS ?

- (a) $2 \text{NaCl(s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{Na}_2\text{SO}_4\text{(aq)} + 2 \text{HCl(g)}$ $2 \text{ s} \rightarrow 2 \text{ g}$ pos. ΔS
 (b) $3 \text{NO}_2\text{(g)} + \text{H}_2\text{O(l)} \rightarrow 2 \text{HNO}_3\text{(aq)} + \text{NO(g)}$ $3 \text{ g} \rightarrow 1 \text{ g}$ neg. ΔS
 and $4 \text{ molecules} \rightarrow 3 \text{ molecules}$
 (c) $4 \text{NH}_3\text{(g)} + 3 \text{O}_2\text{(g)} \rightarrow 2 \text{N}_2\text{(g)} + 6 \text{H}_2\text{O(g)}$ $7 \text{ molecules} \rightarrow 8 \text{ molecules}$ pos. ΔS
 (d) $\text{HF(aq)} + \text{HCO}_3^-\text{(aq)} \rightarrow \text{F}^-\text{(aq)} + \text{H}_2\text{CO}_3\text{(aq)}$ no net change in #^o or phase so $\Delta S \approx \phi$

9. Calculate ΔS° for the following reaction:



4 molecules \rightarrow 5 molecules
should have positive ΔS

S° of $\text{N}_2\text{O(g)} = 219.7 \text{ J/(K}\cdot\text{mol)}$; S° of $\text{NO}_2\text{(g)} = 239.9 \text{ J/(K}\cdot\text{mol)}$; S° of $\text{N}_2\text{(g)} = 191.5 \text{ J/(K}\cdot\text{mol)}$;

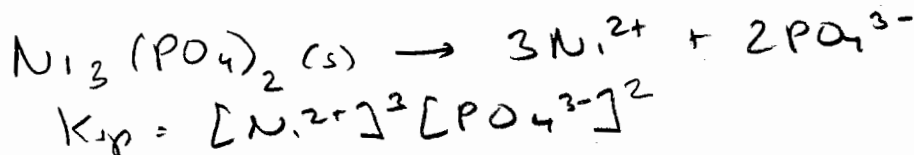
- (a) ~~784.3 J/K~~ (b) ~~-175.5 J/K~~ (c) 211.8 J/K
 (d) ~~-211.8 J/K~~ (e) 175.5 J/K (ab) ~~-784.3 J/K~~

$$\begin{aligned} \Delta S^\circ_{\text{rxn}} &= \sum S^\circ_{\text{prod}} - \sum S^\circ_{\text{react}} \\ &= (2S^\circ_{\text{NO}_2} + 3S^\circ_{\text{N}_2}) - 4S^\circ_{\text{N}_2\text{O}} \\ &= 2(239.9) + 3(191.5) - 4(219.7) \\ &= \boxed{175.5 \text{ J/K}} \end{aligned}$$



10. What is the K_{sp} expression for nickel(II) phosphate?

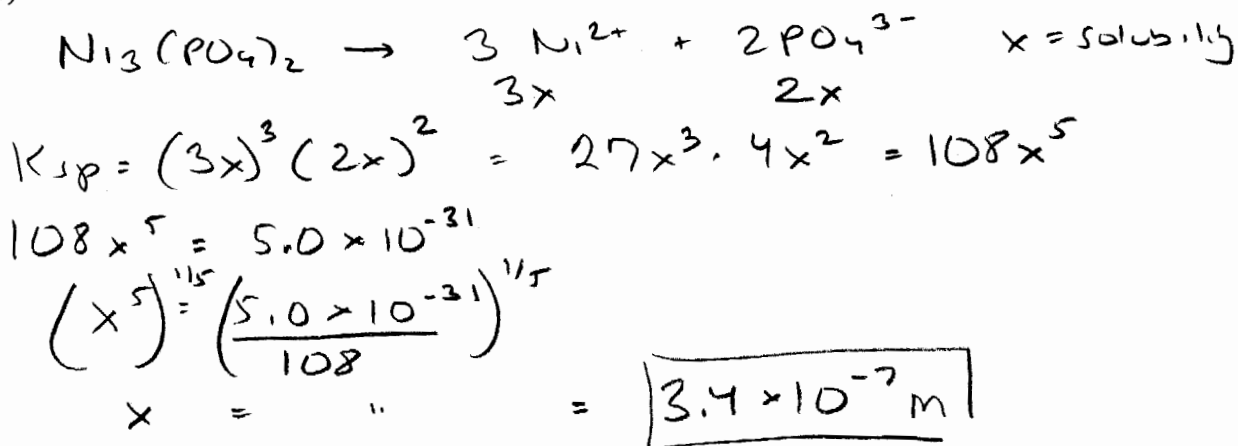
- (a) $[\text{Ni}^{2+}]^2[\text{PO}_4^{3-}]^3$ (b) $[\text{Ni}^{2+}]^3[\text{PO}_4^{3-}]^2$ (c) $[\text{Ni}^{2+}][\text{PO}_4^{2-}]$ (d) $[\text{Ni}^{2+}][\text{PO}_4^-]^3$
 (e) $[\text{Ni}][\text{PO}_4]^3$



11. What is the molar solubility of nickel(II) phosphate in pure water?

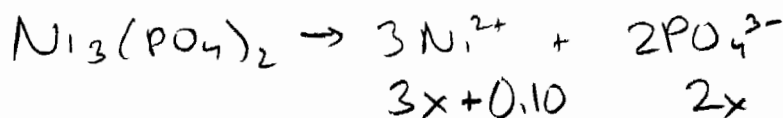
K_{sp} of nickel(II) phosphate = 5.0×10^{-31}

- (a) $4.3 \times 10^{-9} \text{ M}$ (b) $1.2 \times 10^{-8} \text{ M}$ (c) $5.0 \times 10^{-11} \text{ M}$ (d) $3.4 \times 10^{-7} \text{ M}$
 (e) $1.5 \times 10^{-7} \text{ M}$



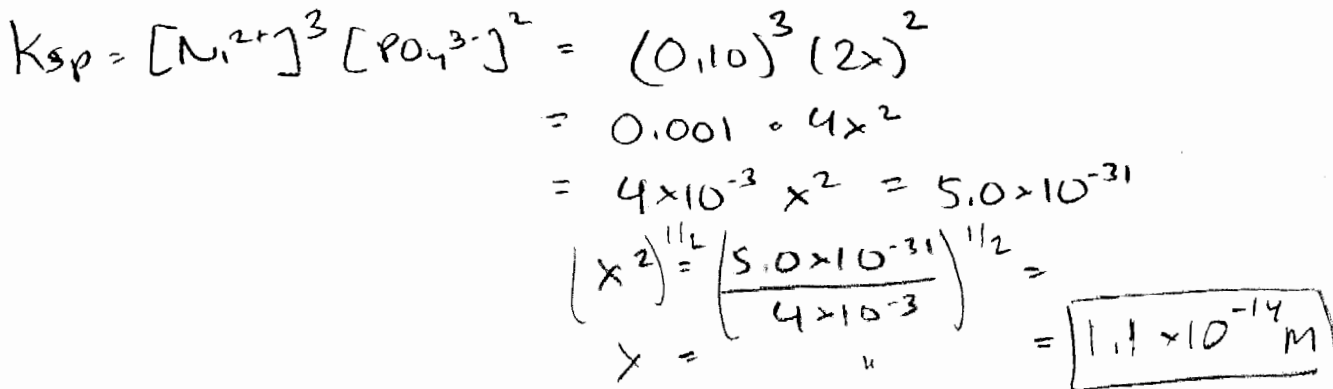
12. What is the molar solubility of nickel(II) phosphate in 0.10 M nickel(II) nitrate?

- (a) $1.1 \times 10^{-14} \text{ M}$ (b) $7.2 \times 10^{-4} \text{ M}$ (c) $2.8 \times 10^{-5} \text{ M}$ (d) $3.2 \times 10^{-11} \text{ M}$
 (e) $5.7 \times 10^{-8} \text{ M}$



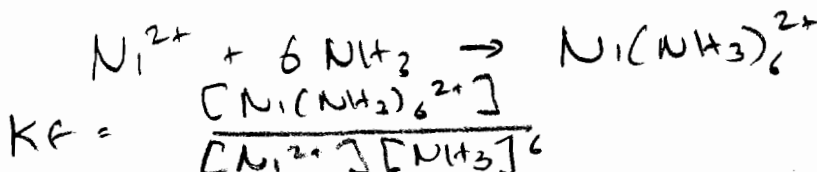
this provides another source of Ni²⁺

Since x is small $3x + 0.10 \approx 0.10$

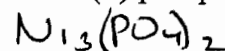


13. Nickel(II) forms a complex ion with 6 NH₃'s. What is the K_f expression for formation of this complex ion?

- (a) $\frac{[\text{Ni}(\text{NH}_3)_6]}{[\text{Ni}][\text{NH}_3]^6}$ (b) $\frac{[\text{Ni}^{2+}][\text{NH}_3]^6}{[\text{Ni}(\text{NH}_3)_6^{2+}]}$ (c) $\frac{[\text{Ni}^{2+}]^6[\text{NH}_3]^2}{[\text{Ni}(\text{NH}_3)_6^{2+}]}$
 (d) $\frac{[\text{Ni}(\text{NH}_3)_6^{2+}]}{[\text{Ni}^{2+}][\text{NH}_3]^6}$ (e) $[\text{Ni}^{2+}][\text{NH}_3]^6$



14. What would happen if you added NH₃ to a saturated solution of nickel(II) phosphate in water? ~~nickel phosphate~~



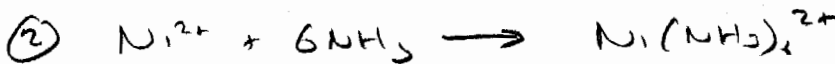
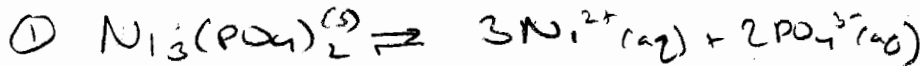
(a) The nickel(II) phosphate solubility equilibrium shifts to the LEFT and more solid precipitates out of solution.

(b) The nickel(II) phosphate solubility equilibrium shifts to the LEFT and more solid dissolves.

(c) The nickel(II) phosphate solubility equilibrium shifts to the RIGHT and more solid precipitates out of solution.

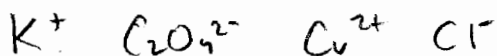
(d) The nickel(II) phosphate solubility equilibrium shifts to the RIGHT and more solid dissolves.

(e) Nothing happens.



In the presence of NH₃, rxn ② happens. This causes [Ni²⁺] ↓, rxn ① shifts to take [Ni²⁺] ↑ -

Goes to RIGHT, so more solid dissolves



15. A solution of potassium oxalate and copper(II) chloride is mixed together. Which of the following most likely happens.

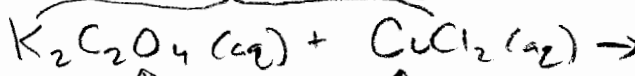
(a) Nothing (no reaction occurs).

(b) KCl precipitates.

(c) CuCO₃ precipitates

(d) Cu metal precipitates.

(e) CuC₂O₄ precipitates



CuC₂O₄ likely insoluble since +2/-2 and not an exception

KCl - likely soluble since +1/-1

Consider the following titration for the next 5 questions:

40.0 mL of a 0.60 M aqueous solution of ethanolamine, $\text{H}_2\text{NCH}_2\text{CH}_2\text{OH}$, is titrated with aqueous 0.80 M HCl.

strong acid

weak base

16. What is the overall reaction occurring in the titration?

- (a) $\text{HOCH}_2\text{CH}_2\text{NH}_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{HOCH}_2\text{CH}_2\text{NH}_3^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- (b) $\text{HOCH}_2\text{CH}_2\text{NH}_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{HOCH}_2\text{CH}_2\text{NH}_3(\text{aq}) + \text{Cl}(\text{aq})$
- (c) $\text{HOCH}_2\text{CH}_2\text{NH}_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{O} + \text{ClCH}_2\text{CH}_2\text{NH}(\text{aq})$
- (d) $\text{HOCH}_2\text{CH}_2\text{NH}_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{O} + \text{CH}_2\text{CH}_2\text{NH}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- (e) $\text{HOCH}_2\text{CH}_2\text{NH}_2(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{HOCH}_2\text{CH}_2\text{NH}^-(\text{aq}) + \text{H}_2\text{Cl}^+(\text{aq})$

17. How many mL's of the HCl solution need to be added to reach the equivalence point of the titration?

- (a) 10.0 mL
- (b) 20.0 mL
- (c) 30.0 mL
- (d) 40.0 mL
- (e) 50.0 mL

equivalence moles acid = moles base

$$C_{\text{acid}} V_{\text{acid}} = C_{\text{base}} V_{\text{base}}$$

$$V_{\text{acid}} = \frac{C_{\text{base}} V_{\text{base}}}{C_{\text{acid}}} = \frac{(0.60\text{M})(40.0\text{mL})}{(0.80\text{M})} = \boxed{30.0\text{mL}}$$

18. What is in the flask at the equivalence point of the titration?

- (a) $\text{HOCH}_2\text{CH}_2\text{NH}(\text{aq})$ only
- (b) all reactants
- (c) $\text{HOCH}_2\text{CH}_2\text{NH}(\text{aq})$ + all products
- (d) all reactants and all products
- (e) all products

this is what equivalence pt means - you've added just enough am burst to convert everything in flask to products

19. How is the solution in the flask at the equivalence point best characterized?

- (a) neutral
- (b) strong acid
- (c) strong base
- (d) weak base
- (e) weak acid
- (f) buffer

Since $\text{HOCH}_2\text{CH}_2\text{NH}_2$ is a weak base its conj. acid $\text{HOCH}_2\text{CH}_2\text{NH}_3^+$ is a weak acid

Continuation of the titration problem from previous page

20. What is the pH at the equivalence point of the titration?

- (a) ~~8.33~~ (b) 5.67 (c) ~~9.01~~ (d) ~~7.00~~

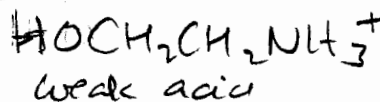
Since know will be weak acid can eliminate answers with $\text{pH} \geq 7$

(e) 4.99

@ equivalence will have

$$K_b \text{ of } \text{HOCH}_2\text{CH}_2\text{NH}_2 = 3.2 \times 10^{-5}$$

$$K_w = K_a \cdot K_b \Rightarrow K_a = \frac{K_w}{K_b} = \frac{1.008 \times 10^{-14}}{3.2 \times 10^{-5}} = 3.15 \times 10^{-10}$$



$$K_a = \frac{[\text{HOCH}_2\text{CH}_2\text{NH}_2][\text{H}_3\text{O}^+]}{[\text{HOCH}_2\text{CH}_2\text{NH}_3^+]} \Rightarrow \frac{x^2}{[\text{HOCH}_2\text{CH}_2\text{NH}_3^+]_{\text{init}}} = 3.15 \times 10^{-10}$$

$$[\text{HOCH}_2\text{CH}_2\text{NH}_3^+]_{\text{init}} = \frac{\text{orig mol } \text{HOCH}_2\text{CH}_2\text{NH}_2}{\text{tot V}} = \frac{C \cdot V_{\text{orig}}}{\text{tot V}}$$

$$= \frac{(40. \text{mL})(0.60 \text{M})}{70.0 \text{mL}} = 0.343 \text{M}$$

$$\frac{x^2}{0.34} = 3.15 \times 10^{-10}$$

$$x = [\text{H}_3\text{O}^+]$$

$$x = \sqrt{(0.34)(3.15 \times 10^{-10})}$$

$$= 1.039 \times 10^{-5} \text{M} = [\text{H}_3\text{O}^+]$$

$$\text{pH} = -\log(1.039 \times 10^{-5}) = \boxed{4.98}$$

ADDITIONAL INFORMATION and EQUATIONS

Some K_a Values at 25 °C

	K_{a1}	K_{a2}	K_{a3}
$\text{CH}_3\text{CO}_2\text{H}$	1.8×10^{-5}		
$\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$	1.4×10^{-4}		
$\text{C}_6\text{H}_5\text{CO}_2\text{H}$	6.3×10^{-5}		
H_2CO_3	4.3×10^{-7}	5.6×10^{-11}	
$\text{H}_2\text{C}_2\text{O}_4$	5.6×10^{-2}	5.4×10^{-5}	
HCO_2H	1.8×10^{-4}		
H_3PO_4	7.5×10^{-3}	6.2×10^{-8}	4.8×10^{-13}
H_2SO_4	very large	1.2×10^{-2}	
HF	3.5×10^{-4}		

Some K_b values at 25 °C

	K_b
NH_3	1.8×10^{-5}
$\text{HOCH}_2\text{CH}_2\text{NH}_2$	3.2×10^{-5}
$(\text{CH}_3)_3\text{CNH}_2$	4.8×10^{-4}
$\text{C}_5\text{H}_5\text{N}$	1.7×10^{-9}
$\text{C}_6\text{H}_5\text{NH}_2$	4.0×10^{-10}

$$K_a K_b = K_w = 1.008 \times 10^{-14}$$

$$pH = pK_a + \log \frac{[\text{base}]}{[\text{acid}]} \qquad pK_a = -\log(K_a)$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$K_w = 1.008 \times 10^{-14}$$

$$R = 8.314 \times 10^{-3} \text{ kJ}/(\text{mol}\cdot\text{K})$$

$$0^\circ \text{C} = 273.15 \text{ K}$$