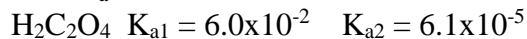
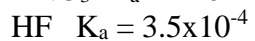
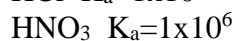
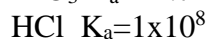
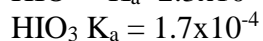
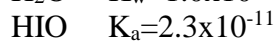
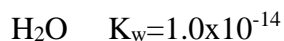
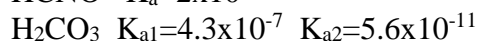
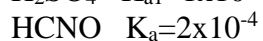
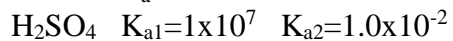
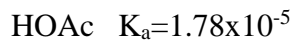


Please SHOW ALL WORK!!!!

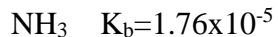
$$R = 0.082058 \frac{L \text{ atm}}{\text{mol K}} = 8.314 \frac{J}{\text{mol K}}$$

Dissociation constants of acids:



Strong Acids	Strong Bases
HCl	KOH
HNO ₃	NaOH
H ₂ SO ₄ (K_{a1})	Ba(OH) ₂
HClO ₄	Ca(OH) ₂
HBr	Sr(OH) ₂
HI	LiOH

Dissociation constants of bases:



$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1. (20 pt.) What is the pH of 0.100 M CH₃NH₂?

Hey, it's an equilibrium problem! It has THREE PARTS!

	CH ₃ NH ₂ (aq) +	H ₂ O (l)	→	OH ⁻ (aq) +	CH ₃ NH ₃ ⁺ (aq)
I	0.100			0	0
C	-x	-		+x	+x
E	0.100-x			x	x

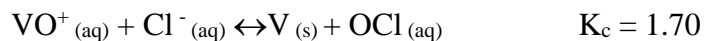
$$K_b = 4.4 \times 10^{-4} = \frac{(x)(x)}{(0.10 - x)}$$

Assume $x \ll 0.325$

$$4.4 \times 10^{-4} \approx \frac{(x)(x)}{(0.10)}$$
$$x = 6.63 \times 10^{-3}, \text{ good assumption}$$

$$\text{pOH} = -\log(0.00663) = 2.18$$
$$\text{pH} = 14 - \text{pOH} = 11.82$$

2. (20 pt.) Vanadium can be obtained by the reduction of vanadium salts (VO^+) by chloride ion at 298 K:



150 mL of 0.250 M VO^+ is mixed with 150 mL of 0.100 M Cl^- at 298 K. How many grams of Vanadium metal would I expect to make?

Hey, there's a K! It's an equilibrium problem. It must have 3 parts!

Don't forget the dilution!

$$(0.250 \text{ M VO}^+)(150 \text{ mL}) = M_2 (300 \text{ mL total})$$

$$M_2 = 0.125 \text{ M Sn}^{2+}$$

$$(0.100 \text{ M Cl}^-)(150 \text{ mL}) = M_2 (300 \text{ mL total})$$

$$M_2 = 0.05 \text{ M Co}^{2+}$$

	$\text{VO}^+ (aq)$	$+ \text{Cl}^- (aq)$	\leftrightarrow	$\text{V} (s)$	$+ \text{OCl}^- (aq)$
<i>I</i>	0.125	0.05 M		0	0
<i>C</i>	-x	-x		+x	+x
<i>E</i>	0.125-x	0.05-x		X	X

Solids have an activity of 1, so it doesn't appear in K

$$K = 1.7 = \frac{(x)}{(0.125 - x)(0.05 - x)}$$

$$x = 0.0088 \text{ M or } 0.709 \text{ M}$$

Only the 1st root makes sense, 0.709 M is way too big in the ICE chart.

$$\frac{0.0088 \text{ mol}}{L} 0.300 L = 0.00264 \text{ mol} \frac{50.94 \text{ g}}{\text{mol}} = 0.135 \text{ g}$$

3. (20 pt.) 0.3 moles of CO_(g) and 0.3 moles of chlorine gas are mixed in an otherwise evacuated 2 Liter flask at 298 K. Carbon monoxide and chlorine will combine to form COCl_{2(g)} at 298 K. When equilibrium has been established, the total pressure in the flask is found to be 4.24 atm. What is the K_p of this reaction.

$$PV=nRT$$

$$P = \frac{nRT}{V} = \frac{(0.3 \text{ mol})(0.082058 \frac{\text{Latm}}{\text{molK}})(298 \text{ K})}{2 \text{ L}} = 3.668 \text{ atm}$$

	$\text{CO(g)} + \text{Cl}_2 \text{(g)} \leftrightarrow \text{COCl}_2\text{(g)}$		
I	3.668 atm	3.668 atm	0 atm
C	-x	-x	+x
E	3.668-x	3.668-x	x

$$P_{\text{tot}} = 4.24 \text{ atm} = P_{\text{CO}} + P_{\text{Cl}_2} + P_{\text{COCl}_2} = 3.668-x + 3.668-x + x$$

$$X = 3.096$$

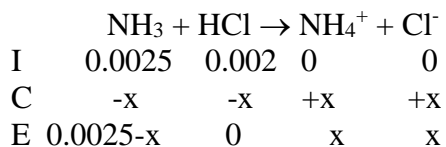
$$K_p = \frac{P_{\text{COCl}_2}}{P_{\text{CO}}P_{\text{Cl}_2}} = \frac{3.096}{(3.668-3.096)(3.668-3.096)} = 9.46$$

4. (20 pt) 10.00 mL of 0.250 M NH_3 ($K_b=1.8 \times 10^{-5}$) is titrated with a 0.100 M solution of HCl. What is the pH of the solution after 20.00 mL of HCl has been added?

$$0.250 \text{ M NH}_3 * 0.010 \text{ L} = 0.0025 \text{ mol NH}_3$$

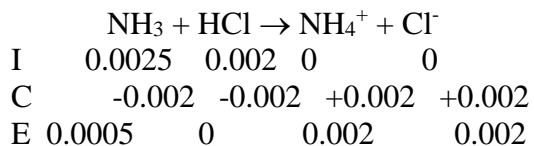
$$0.100 \text{ M HCl} * 0.020 \text{ L} = 0.002 \text{ mol HCl}$$

Neutralization:

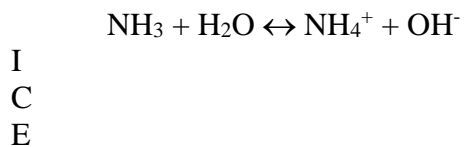


$$0.002-x=0$$

$$x=0.002$$



It's a buffer!



$$\text{pH} = \text{pK}_a + \log[\text{NH}_3]/[\text{NH}_4^+]$$

$$\text{pH} = 9.26 + \log(0.0005/0.002)$$

$$\text{pH} = 8.66$$

5. (20 pt.) A 3.2 M aqueous solution of caproic acid ($\text{HC}_6\text{H}_{11}\text{O}_2$) has a pH of 2.94. What is the K_a of the acid?



A 3.2 M aqueous solution of caproic acid ($\text{HC}_6\text{H}_{11}\text{O}_2$) has a pH of 2.94. What is the K_a of the acid?



I	3.2 M	0	0
C	-x	+x	+x
E	3.2-x	x	x

$$\text{pH} = -\log [\text{H}_3\text{O}^+]$$

$$2.94 = -\log [\text{H}_3\text{O}^+]$$

$$[\text{H}_3\text{O}^+] = 10^{-2.94} = 1.15 \times 10^{-3}$$

$$K_a = (x \cdot x) / (3.2 - x) = (1.15 \times 10^{-3})^2 / (3.2 - 1.15 \times 10^{-3})$$

$$K_a = 4.12 \times 10^{-7}$$

