

Chapter 15: 35, 44, 53, 55, 60, 88, 90, 95, 96, 100, 101

①

15.35 (a)

(1) has 4 HA + 4 A⁻ ∴ pH = pK_a + log 4/4 ⇒ pH = pK_a = 6.0

(2) has 2 HA + 6 A⁻ ∴ pH = pK_a + log 6/2 ⇒ 6 + 0.477 = 6.48

(3) has 5 HA + 3 A⁻

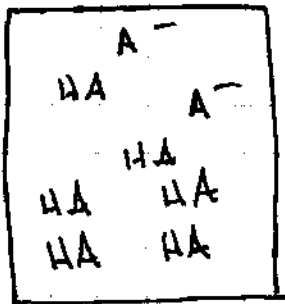
pH = pK_a + log 3/5 = 6 + (-0.222) = 5.78

(4) has 5 HA + 5 A⁻

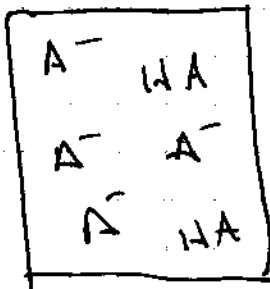
pH = pK_a + log 5/5 = pK_a = 6.0

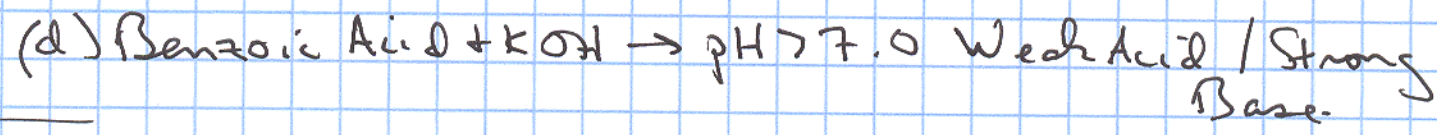
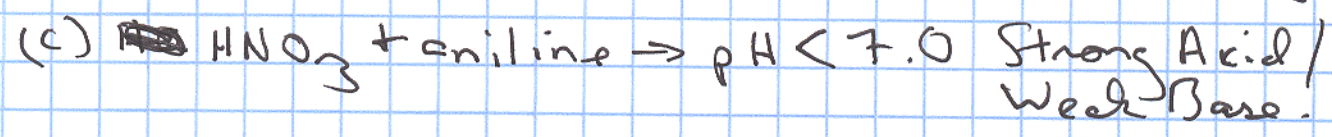
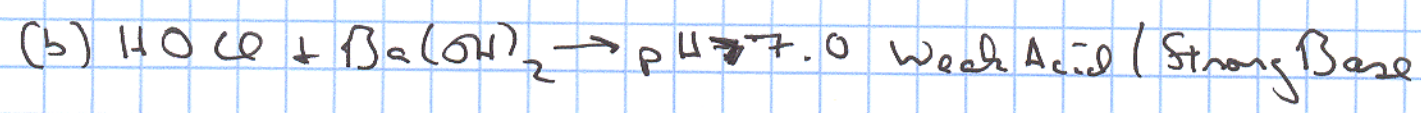
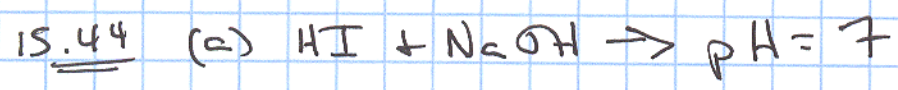
∴ Soln (2) has the highest pH value + Soln (3) has the lowest pH

(b) if 2 H₃O⁺ added, then 2 A⁻ will be used up + 2 HA will form

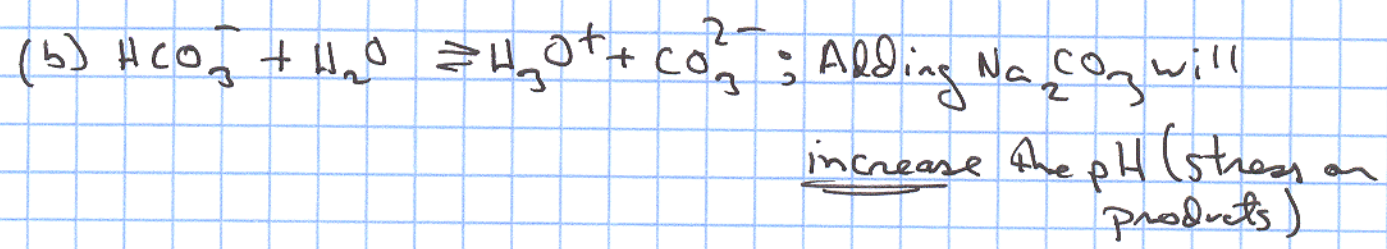
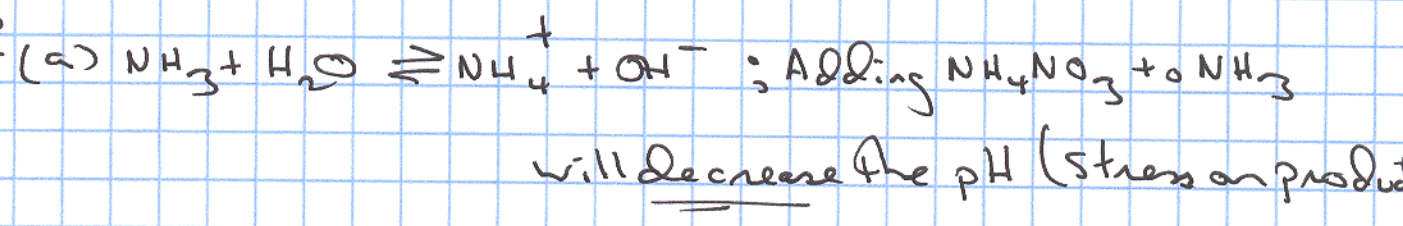


(c) if 2 OH⁻ added, then they will react with HA, so you end up with 2 less HA + 2 additional A⁻



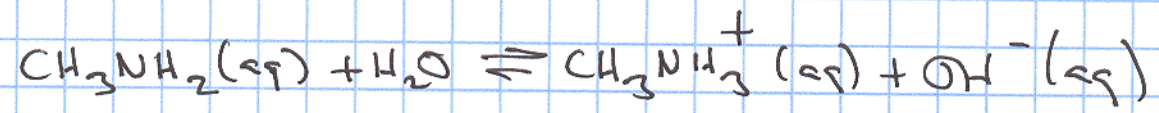


15.53



(c) No impact; since NaClO_4 is the conjugate base of a strong acid & is therefore weak. Also NaOH is a strong base & no altered by equilibrium.

15.55



Assume 1L of each $\therefore n_1v_1 = n_2v_2$ $\frac{(0.2)(1\text{L})}{2\text{L}} = M_2 = 0.1\text{M}$ CH_3NH_2

+ $\frac{(0.6)(1\text{L})}{2\text{L}} = M_2 = 0.3\text{M}$ $\text{CH}_3\text{NH}_3\text{Cl}$

if $K_b = 3.7 \times 10^{-4} \rightarrow \text{p}K_b = -\log K_b = 3.43$ & $\text{p}K_a = 14 - 3.43 = 10.57$

$\text{pH} = \text{p}K_a + \log \frac{[\text{CH}_3\text{NH}_2]}{[\text{CH}_3\text{NH}_3^+]} = 10.57 + \log \frac{(0.1)}{(0.3)} = \underline{\underline{10.1}}$

15.60

Soln (A) is the only one that directly forms a buffer.

$$(a) \text{ pH} = \text{p}K_a + \log \frac{[A^-]}{[HA]} = 3.46$$

BUT! Solns. (c) + (d) will also form buffer solns.

(c) 0.20M HF will react with 0.10M NaOH to form:

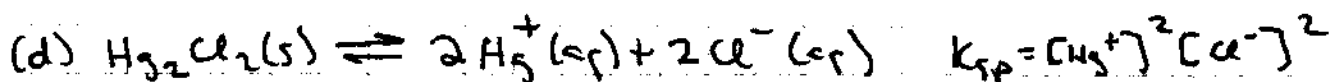
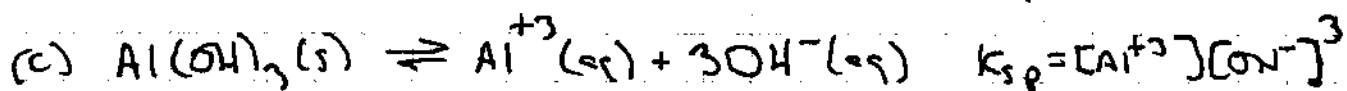
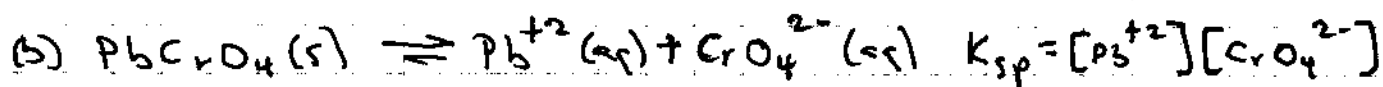
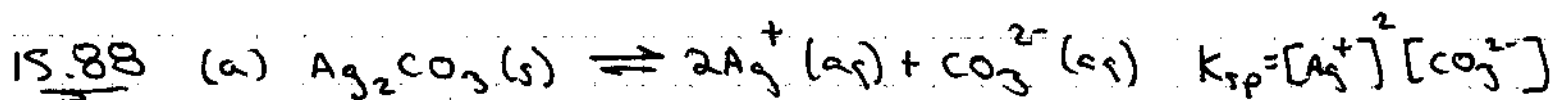
0.10M HF + 0.10M NaF, so is a buffer.

(d) 0.10M HCl will react with 0.20M NaF to form:

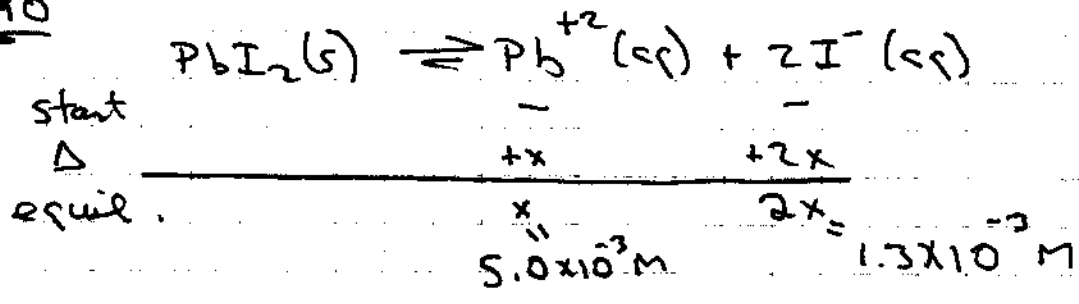
0.10M HF + 0.10M NaF, so is a buffer.

Note: (b) is not a buffer, but a neutralization rxn, since the conc. of the acid + the base are equal.

15.88



15.90



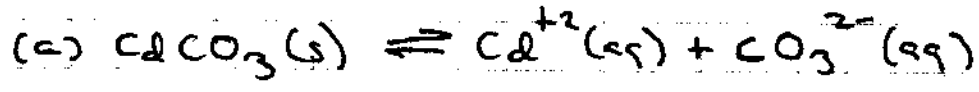
(a) $K_{sp} = [\text{Pb}^{+2}][\text{I}^{-}]^2 = (5.0 \times 10^{-3})(1.3 \times 10^{-3})^2 = 8.45 \times 10^{-9}$

(b) $[\text{Pb}^{+2}] = 2.5 \times 10^{-4} \text{ M}$ ~~.....~~

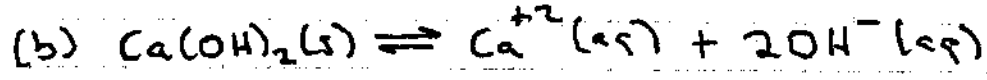
$\therefore [\text{I}^{-}] = \frac{K_{sp}}{\sqrt{[\text{Pb}^{+2}]}} = \sqrt{\frac{8.45 \times 10^{-9}}{(2.5 \times 10^{-4})}} = 5.81 \times 10^{-3} \text{ M I}^{-}$

(c) $[\text{I}^{-}] = 2.5 \times 10^{-4} \text{ M} \therefore [\text{Pb}^{+2}] = \frac{K_{sp}}{[\text{I}^{-}]^2} = \frac{8.45 \times 10^{-9}}{(2.5 \times 10^{-4})^2} = 0.14 \text{ M}$
Pb⁺²
5

15.95



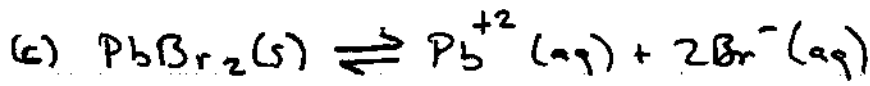
$K_{sp} = [\text{Cd}^{+2}][\text{CO}_3^{2-}]$ + since $[\text{Cd}^{+2}] = 1.0 \times 10^{-6} \text{ M}$
 $K_{sp} = (1 \times 10^{-6})(1 \times 10^{-6}) = \underline{1 \times 10^{-12}}$



$K_{sp} = [\text{Ca}^{+2}][\text{OH}^{-}]^2$ + since $[\text{Ca}^{+2}] = 1.06 \times 10^{-2} \text{ M}$
 $K_{sp} = (x)(2x)^2 = 4x^3 = 4(1.06 \times 10^{-2})^3 = \underline{4.76 \times 10^{-6}}$

cont. =>

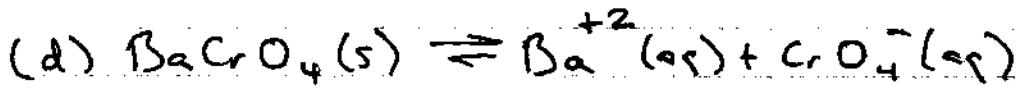
15.95 cont.



+ if 4.34g PbBr₂/L dissolves that is equal to:

$$\frac{4.34\text{g PbBr}_2}{1\text{L}} \times \frac{1\text{mol}}{367\text{g}} = 0.012\text{M Pb}^{+2} = [\text{PbBr}_2] \text{ in soln}$$

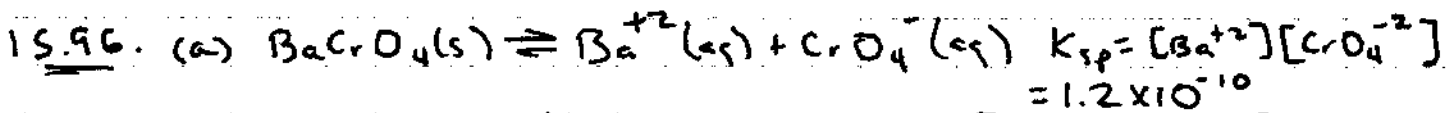
$$K_{sp} = [\text{Pb}^{+2}][\text{Br}^-]^2 = x \cdot (2x)^2 = 4x^3 = 4(0.012)^3 = 6.9 \times 10^{-6}$$



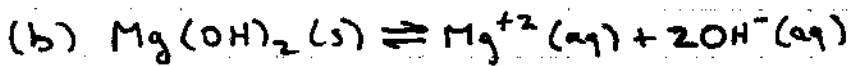
+ if 2.8 x 10⁻³g/L dissolves:

$$\frac{2.8 \times 10^{-3}\text{g BaCrO}_4}{1\text{L}} \times \frac{1\text{mol}}{253\text{g}} = 1.11 \times 10^{-5}\text{M Ba}^{+2} = [\text{BaCrO}_4] \text{ in soln}$$

$$K_{sp} = [\text{Ba}^{+2}][\text{CrO}_4^{2-}] = x \cdot x = x^2 = (1.11 \times 10^{-5})^2 = 1.23 \times 10^{-10}$$

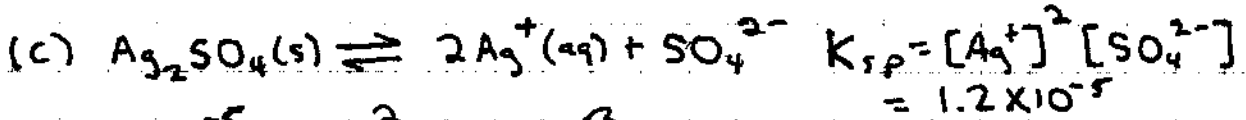


$$x^2 = K_{sp} \therefore [\text{Ba}^{+2}] = [\text{BaCrO}_4] = \sqrt{K_{sp}} = 1.1 \times 10^{-5}\text{M BaCrO}_4$$



$$K_{sp} = [\text{Mg}^{+2}][\text{OH}^-]^2 = 5.6 \times 10^{-12} = x \cdot (2x)^2 = 4x^3 \therefore$$

$$[\text{Mg}^{+2}] = [\text{Mg(OH)}_2] = \sqrt[3]{4 \cdot K_{sp}} = 2.82 \times 10^{-4}\text{M Mg(OH)}_2$$



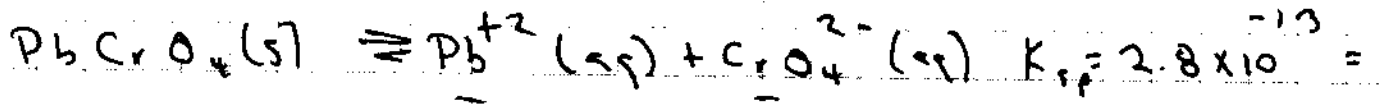
$$1.2 \times 10^{-5} = (2x)^2(x) = 4x^3$$

$$x = \sqrt[3]{4 \cdot K_{sp}} = [\text{SO}_4^{2-}] = [\text{Ag}_2\text{SO}_4] = 3.63 \times 10^{-2}\text{M}$$

15.10a

Solubility of $PbCrO_4$ in

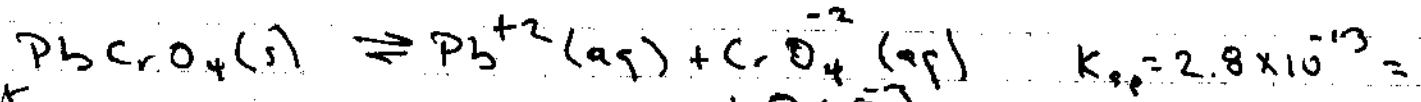
(a) Pure H_2O



start			
Δ	+x	+x	$[Pb^{+2}][CrO_4^{2-}]$
equil.	x	x	$2.8 \times 10^{-13} = x^2$

$x = [Pb^{+2}] = [PbCrO_4] =$
 $5.29 \times 10^{-7} M$

(b) in $1.0 \times 10^{-3} M K_2CrO_4$



start		$1.0 \times 10^{-3} M$	
Δ	+x	+x	$[Pb^{+2}][CrO_4^{2-}]$
equil.	x	$1.0 \times 10^{-3} + x$	$x(1.0 \times 10^{-3} + x) = 2.8 \times 10^{-13}$

~~$x(1.0 \times 10^{-3} + x) = 2.8 \times 10^{-13}$~~

simplifies to

$(1.0 \times 10^{-3})x = 2.8 \times 10^{-13}$

$x = 2.8 \times 10^{-10} M = [Pb^{+2}] =$

$[PbCrO_4]$ in K_2CrO_4 soln.

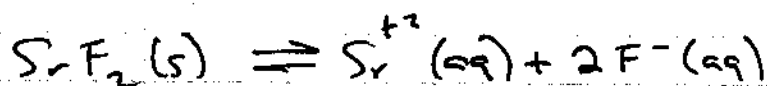
15.101

$$K_{sp} = 4.37 \times 10^{-9}$$

(7)

Solubility of SrF_2 in

(a) 0.01M $Sr(NO_3)_2$



start	0.01M	-	$K_{sp} = 4.37 \times 10^{-9} =$
Δ	+x	+2x	$[Sr^{+2}][F^{-}]^2 =$
equil.	0.01+x	2x	

$$(0.01+x)(2x)^2 =$$

$$(0.01+x)(4x^2) = K_{sp}$$

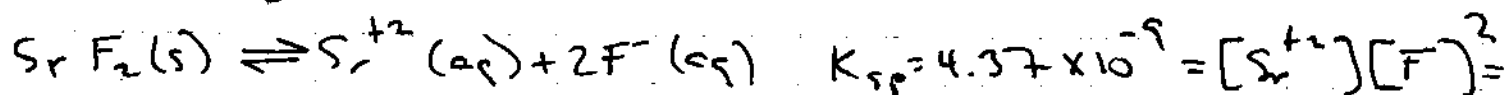
$$(0.01)(4x^2) = 4.37 \times 10^{-9}$$

$$0.04x^2 = 4.37 \times 10^{-9}$$

$$x = [Sr^{+2}] = 3.31 \times 10^{-4} M = [SrF_2] \text{ in}$$

the $Sr(NO_3)_2$ soln.

(b) Solubility of SrF_2 in 0.01M NaF



start	-	0.01M	
Δ	+x	+2x	$(x)(0.01+2x)^2 \approx (x)(0.01)$
equil.	x	0.01+2x	$x = 4.37 \times 10^{-7} M = [Sr^{+2}] =$

$[SrF_2]$ in the NaF soln.