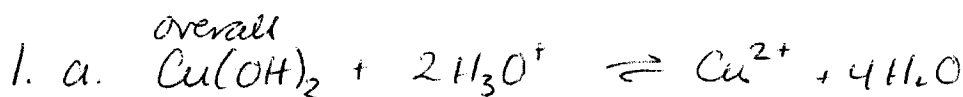
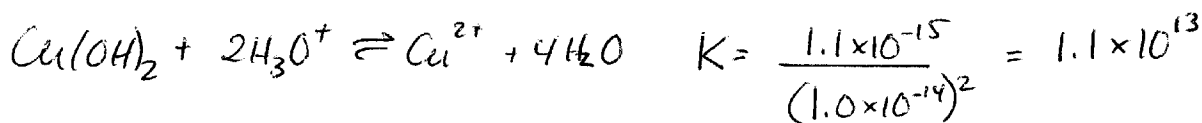
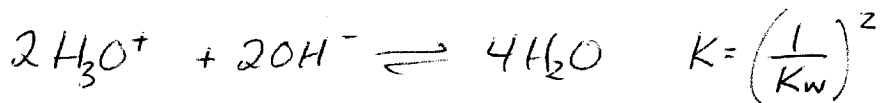
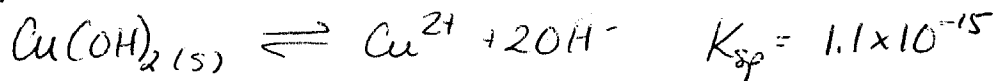


Answers - Additional Probs - Ch. 17 pt 2

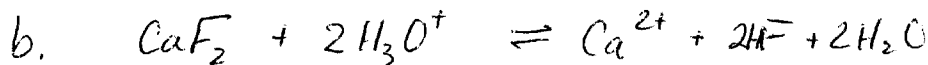
(1)



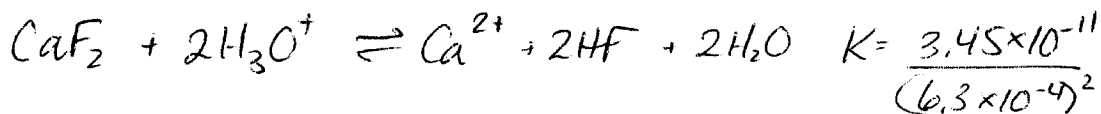
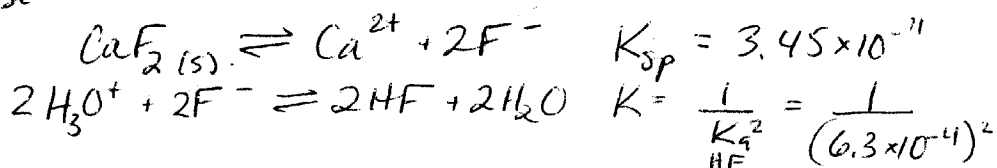
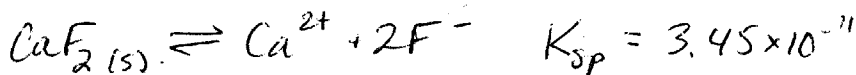
use:



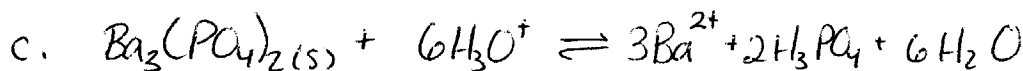
K is huge. Goes to completion.  
 $\text{Cu(OH)}_2$  is very soluble in acid.



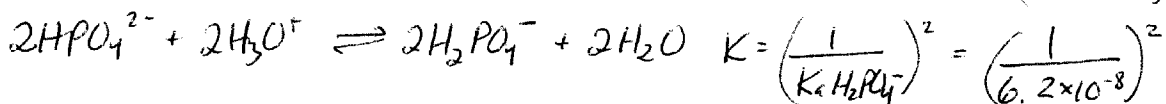
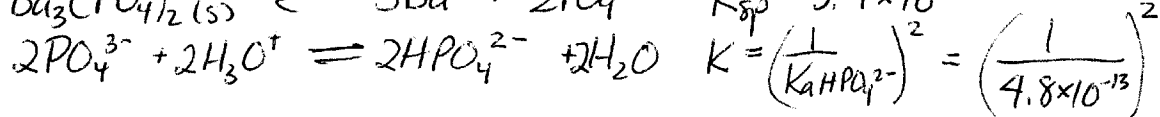
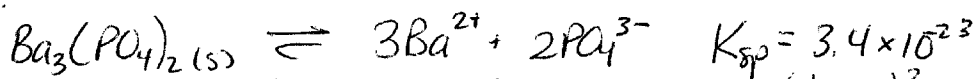
use

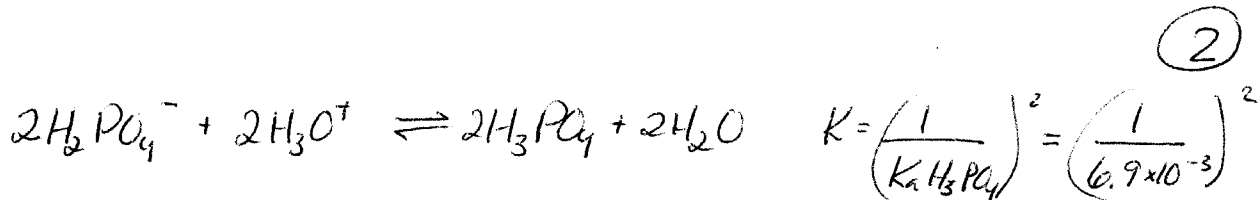


$K = 8.7 \times 10^{-5}$  not very large, but larger than  $3.45 \times 10^{-11}$ .  $\text{CaF}_2$  is more soluble in acid than in water, because  $\text{F}^-$  is a weak base.

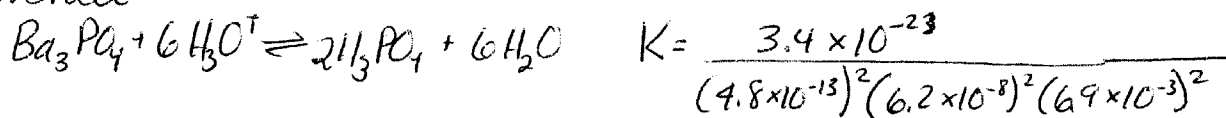


use:





overall:



$$K = 8.1 \times 10^{20} \text{ huge}$$

$\text{Ba}_3\text{PO}_4$  is very soluble in acid.

$$2. \quad K_{sp} \text{ Al(OH)}_3 = 4.6 \times 10^{-33} \quad K_{sp} = [\text{Al}^{3+}][\text{OH}^-]^3$$

$$K_{sp} \text{ Cd(OH)}_2 = 7.2 \times 10^{-15} \quad K_{sp} = [\text{Cd}^{2+}][\text{OH}^-]^2$$

$\text{Al}^{3+}$  will start to ppt when  $Q = K_{sp}$

$$[\text{OH}^-]^3 = \frac{K_{sp}}{[\text{Al}^{3+}]} \quad [\text{OH}^-] = \sqrt[3]{\frac{K_{sp}}{[\text{Al}^{3+}]}} = \sqrt[3]{\frac{4.6 \times 10^{-33}}{0.0020}} = 1.32 \times 10^{-10} \text{ M}$$

~~Al<sup>3+</sup>~~  $\text{OH}^-$  needed for  $\text{Al(OH)}_3$  to start to ppt.

$\text{Cd}^{2+}$  will start to ppt when  $Q = K_{sp}$

$$[\text{OH}^-] = \sqrt{\frac{K_{sp}}{[\text{Cd}^{2+}]}} = \sqrt{\frac{7.2 \times 10^{-15}}{0.0020}} = 1.9 \times 10^{-6} \text{ M } \text{OH}^-$$

needed for  $\text{Cd(OH)}_2$  to start to ppt.

$\text{Al(OH)}_3$  ppts first  $[\text{OH}^-] = 1.3 \times 10^{-10} \text{ M}$  at this point.

b. When  $\text{Cd}^{2+}$  starts to ppt,  $[\text{OH}^-] = 1.9 \times 10^{-6} \text{ M}$ .  
what is  $[\text{Al}^{3+}]$  at this point?

$$K_{sp} = [\text{Al}^{3+}][\text{OH}^-]^3 \quad [\text{Al}^{3+}] = \frac{K_{sp}}{[\text{OH}^-]^3} = \frac{4.6 \times 10^{-33}}{(1.9 \times 10^{-6})^3}$$

$$[\text{Al}^{3+}] = 6.7 \times 10^{-16} \text{ M}$$

$$\frac{6.7 \times 10^{-16} \text{ M}}{0.0020 \text{ M}} \times 100 = 3.4 \times 10^{-11} \% \text{ remains} \quad \text{yes! very complete.}$$

very little of the original remains.

$K_{sp} = 3.4 \times 10^{-23}$

(3)

3.  $(0.0200 L) \left( \frac{0.10 \text{ mol}}{L} \right) = 0.0333 \text{ M Na}_3\text{PO}_4$  after mixing, before rxn.

~~0.0200 L~~  $0.0600 L$

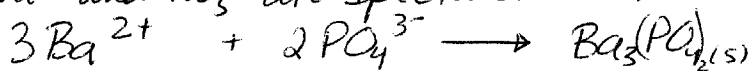
$= 0.10 \text{ M Na}^+, 0.0333 \text{ M PO}_4^{3-}$

$M_2 = \frac{M_1 V_1}{V_2} = (0.10 \text{ M}) \left( \frac{400 \text{ mL}}{600 \text{ mL}} \right) = 0.0667 \text{ M Ba(NO}_3)_2$

$0.0667 \text{ M Ba}^{2+}$

$0.133 \text{ M NO}_3^-$

$\text{Na}^+$  and  $\text{NO}_3^-$  are spectator ions.



$K = \frac{1}{K_{sp}}$  huge!  
 $K_{sp}$  goes to completion.

i  $0.0667 \text{ M} \quad 0.0333 \text{ M} \quad 0$

$\Delta \quad -3x \quad -2x \quad +x$

end  $(0.0667 - 3x) \quad (0.0333 - 2x)$

LR so = 0

$0.0333 - 2x = 0$

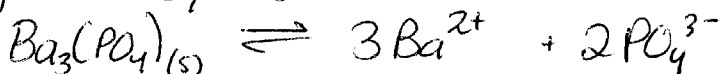
$\frac{0.0333}{2} = \frac{2x}{2}$

$x = 0.0167 \text{ M}$

$0.0667 - 3(0.0167)$

$= 0.0167 \text{ M} \quad 0$

goes to equilibrium



i some  $0.0167 \text{ M} \quad 0$

$\Delta \quad -x \quad +3x \quad +2x$

eq some  $-x \quad 0.0167 + 3x \quad 2x$

$K_{sp} = 3.4 \times 10^{-23} = (0.0167 + 3x)^3 (2x)^2 = (0.0167)^3 (4x^2)$

$\uparrow$  neglect

$x = \sqrt{\frac{3.4 \times 10^{-23}}{4 (0.0167)^3}} = 1.35 \times 10^{-9} \text{ M}$

$2x = 2.7 \times 10^{-9} \text{ M}$

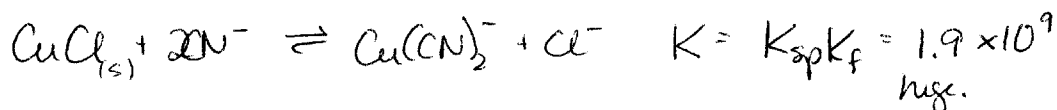
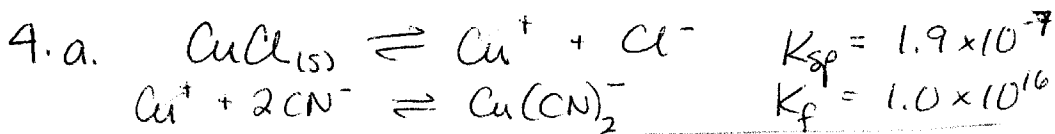
$[\text{Na}^+] = 0.10 \text{ M}$

$[\text{NO}_3^-] = 0.13 \text{ M}$

$[\text{Ba}^{2+}] = 0.017 \text{ M}$

$[\text{PO}_4^{3-}] = 2.7 \times 10^{-9} \text{ M}$

(4)



i	Some	1.5 M	0	0
Δ	-x	-2x	+x	+x
eq.	Some-x	1.5-2x	x	x

goes to completion!

LR=0  
 $1.5 - 2x = 0$   
 $1.5 = 2x$   
 $x = \frac{1.5}{2} = 0.75 \text{ M}$

x = amt that dissolves

So 0.75 M CuCl will dissolve.

$\left(\frac{0.75 \text{ mol CuCl}}{L}\right) \left(\frac{99.00 \text{ g}}{1 \text{ mol}}\right) = 74 \text{ g/L will dissolve!}$   
 \* More dissolves in presence of a ligand \*

b. In 1.5 M NaCl contains  $\text{Cl}^-$ , a common ion.

	$\text{CuCl}_{(s)}$	$\rightleftharpoons$	$\text{Cu}^+$	$+$	$\text{Cl}^-$
i	Some		0		1.5 M
Δ	-x		+x		+x
eq.	Some-x		x		1.5+x

$K_{sp} = 1.9 \times 10^{-7} = (x)(1.5+x)$   
 ↑  
 neglect

$x = \frac{K_{sp}}{1.5} = \frac{1.9 \times 10^{-7}}{1.5}$

$x = 1.27 \times 10^{-7} \text{ M} = \text{amt CuCl that dissolves.}$

$\left(\frac{1.27 \times 10^{-7} \text{ mol}}{L}\right) \left(\frac{99.00 \text{ g}}{1 \text{ mol}}\right) = 1.3 \times 10^{-5} \text{ g/L dissolves}$

\* less dissolves in the presence of a common ion \*

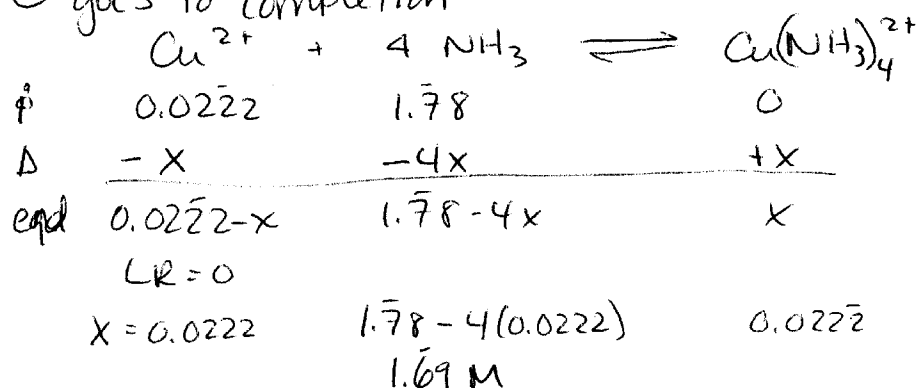
(5)

5. Find conc. after mixing, before rxn.

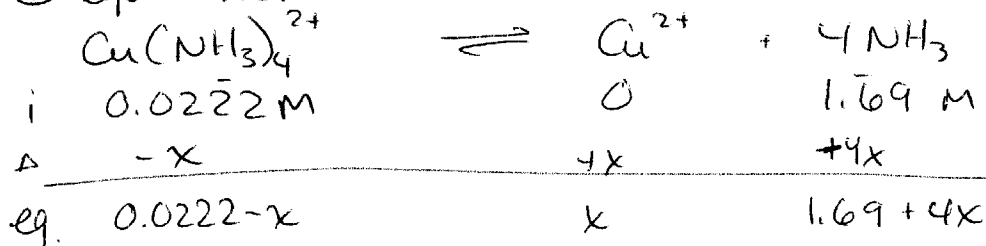
$$M_2 = \frac{M_1 V_1}{V_2} = \frac{(10.0 \text{ mL})(0.20 \text{ M})}{90.0 \text{ mL}} = 0.0222 \text{ M Cu}^{2+}$$

$$M_2 = \frac{(80.0 \text{ mL})(2.0 \text{ M})}{(90.0 \text{ mL})} = 1.78 \text{ M NH}_3$$

① goes to completion



② equilibrium

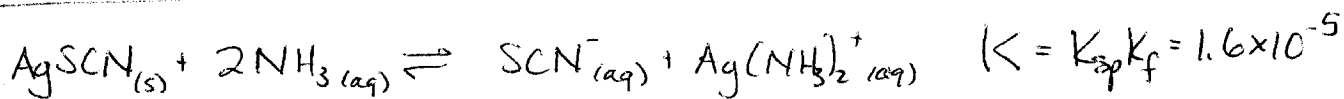
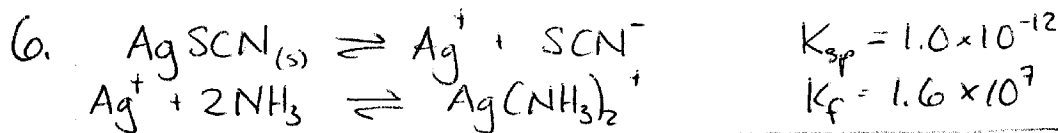


$$K = K_d = \frac{1}{K_f} = \frac{1}{6.8 \times 10^{12}} = 1.47 \times 10^{-13} = \frac{(x)(1.69+4x)^4}{(0.0222-x)}$$

neglect x's

$$K_d = \frac{(x)(1.69)^4}{0.0222}$$

$$x = \frac{K_d (0.0222)}{(1.69)^4} = 4.0 \times 10^{-16} \text{ M Cu}^{2+} \text{ remains}$$



i	Some	2.5 M	0	0
A	-x	-2x	+x	+x
eq.	Some -x	(2.5-2x) M	x	x M

$K = \frac{x^2}{(2.5-2x)^2} = 1.6 \times 10^{-5}$   $\sqrt{\text{both sides}}$

$\frac{x}{2.5-2x} = \sqrt{1.6 \times 10^{-5}} = 0.0040$

$x = 0.0040(2.5 - 2x)$

$x = 0.010 - 0.008x$   
 $+0.008x$   $+0.008x$

$\frac{1.008x}{1.008} = \frac{0.010}{1.008}$

$x = 0.00992$  = amt ~~AgSCN~~ AgSCN that dissolved.  
 (in M)

$\left( \frac{0.00992 \text{ mol AgSCN}}{L} \right) \left( \frac{165.99 \text{ g AgSCN}}{1 \text{ mol AgSCN}} \right) = 1.6466 \text{ g/L} \Rightarrow 1.6 \text{ g/L}$