KSP PROBLEM SHEET

1. a) $CaSO_4 \rightleftharpoons Ca^{2+} + SO_4^{2-}$

$[Ca^{2+}] = 5\times10^{-3} M$

$[SO_4^{2-}] = 5\times10^{-3} M$

$Ksp = [Ca^{2+}][SO_4^{2-}]$

$Ksp = (5\times10^{-3})^2$

$Ksp = 2.5\times10^{-5}$

b) $MgF_2 \rightleftharpoons Mg^{2+} + 2F^{1-}$

$[Mg^{2+}] = 2.7\times10^{-3}\ M$

$[F^-] = 2\times2.7\times10^{-3} M$

$= 5.4\times10^{-3} M$

$Ksp = [Mg^{2+}][F^-]^2$

$Ksp = (2.7\times10^{-3})(5.4\times10^{-3})^2$

$Ksp = 7.87\times10^{-8}$

c) $\frac{1.02g}{100mL} \times \frac{1000mL}{1L} \times \frac{1mol}{166.92g} = 6.11\times10^{-2} M$

$agC_2H_3O_2 \rightleftharpoons ag^+ + C_2H_3O_2^{1-}$

$[ag^+] = 6.11\times10^{-2} M$

$[C_2H_3O_2^-] = 6.11\times10^{-2} M$

$Ksp = [ag^+][C_2H_3O_2^{1-}]$

$Ksp = (6.11\times10^{-2})^2$

$Ksp = 3.73\times10^{-3}$

d) $\frac{12.2 mg}{100mL} \times \frac{1000mL}{1L} \times \frac{1g}{1000mg} \times \frac{1mol}{125.62g} = 9.71\times10^{-4} M$

$SrF_2 \rightleftharpoons Sr^{2+} + 2F^-$

$[Sr^{2+}] = 9.71\times10^{-4} M$

$[F^-] = 2\times9.71\times10^{-4} M$

$= 1.94\times10^{-3} M$

$Ksp = [Sr^{2+}][F^-]^2$

$Ksp = (9.71\times10^{-4})(1.94\times10^{-3})^2$

$Ksp = 3.66\times10^{-9}$

2. a) $agCN \rightleftharpoons ag^+ + CN^-$ Let s represent the solubility

$[ag^+] = s$

$[CN^-] = s$

$Ksp = [ag^+][CN^-]$

$2\times10^{-12} = s^2$

$s = 1.41\times10^{-6}$ mol/L

$\therefore [ag^+] = 1.41\times10^{-6}$

$[CN^-] = 1.41\times10^{-6}$

b) $BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{2-}$ *Let s* ———

$[Ba^{2+}] = s$

$[SO_4^{2-}] = s$

$K_{sp} = [Ba^{2+}][SO_4^{2-}]$

$1.5\times10^{-9} = s^2$

$s = 3.87\times10^{-5}$

$\therefore [Ba^{2+}] = 3.87\times10^{-5}$ M

$[SO_4^{2-}] = 3.87\times10^{-5}$ M

c) $FeS \rightleftharpoons Fe^{2+} + S^{2-}$ *Let s* ———

$[Fe^{2+}] = s$

$[S^{2-}] = s$

$K_{sp} = [Fe^{2+}][S^{2-}]$

$3.7\times10^{-19} = s^2$

$s = 6.08\times10^{-10}$

$\therefore [Fe^{2+}] = 6.08\times10^{-10}$ M

$[S^{2-}] = 6.08\times10^{-10}$ M

d) $Mg(OH)_2 \rightleftharpoons Mg^{2+} + 2OH^-$ *Let s represent* ———

$[Mg^{2+}] = s$

$[OH^-] = 2s$

$K_{sp} = [Mg^{2+}][OH^-]^2$

$9\times10^{-12} = s(2s)^2$

$9\times10^{-12} = s \times 4s^2$

$4s^3 = 9\times10^{-12}$

$s = 1.31\times10^{-4}$

$\therefore [Mg^{2+}] = 1.31\times10^{-4}$ M

$[OH^-] = 2\times1.31\times10^{-4}$ M

$= 2.62\times10^{-4}$ M

e) $Ag_2S \rightleftharpoons 2Ag^+ + S^{2-}$ *Let s* ———

$[Ag^+] = 2s$

$[S^{2-}] = s$

$K_{sp} = [Ag^+]^2[S^{2-}]$

$1.6\times10^{-49} = (2s)^2 s$

$4s^3 = 1.6\times10^{-49}$

$s = 3.42\times10^{-17}$

$\therefore [Ag^+] = 2\times3.42\times10^{-17}$ M

$= 6.84\times10^{-17}$ M

$[S^{2-}] = 3.42\times10^{-17}$ M

f) $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$ *Let s* ———

$[Ca^{2+}] = s$

$[F^-] = 2s$

$K_{sp} = [Ca^{2+}][F^-]^2$

$4.9\times10^{-11} = s(2s)^2$

$4s^3 = 4.9\times10^{-11}$

$s = 2.31\times10^{-4}$

$\therefore [Ca^{2+}] = 2.31\times10^{-4}$ M

$[F^-] = 2\times2.31\times10^{-4}$ M

$= 4.61\times10^{-4}$ M

3. (1) $PbS \rightleftharpoons Pb^{2+} + S^{2-}$ *Let s* ———

$[Pb^{2+}] = s$

$[S^{2-}] = s$

$K_{sp} = [Pb^{2+}][S^{2-}]$

$8.4\times10^{-28} = s^2$

$s = 2.90\times10^{-14}$ M

$\therefore$ *the solubility of PbS is* 2.90×10^{-14} *mol/L*

(2) $PbSO_4 \rightleftharpoons Pb^{2+} + SO_4^{2-}$ Let s ~~~

$[Pb^{2+}] = s$

$[SO_4^{2-}] = s$

$K_{sp} = [Pb^{2+}][SO_4^{2-}]$

$1.6 \times 10^{-8} = s^2$

$s = 1.26 \times 10^{-4}$ M

∴ the solubility of $PbSO_4$ is 1.26×10^{-4} mol/L

(3) $Pb(IO_3)_2 \rightleftharpoons Pb^{2+} + 2IO_3^{1-}$ Let s ~~~

$[Pb^{2+}] = s$

$[IO_3^{1-}] = 2s$

$K_{sp} = [Pb^{2+}][IO_3^{-}]^2$

$2.6 \times 10^{-13} = s(2s)^2$

$4s^3 = 2.6 \times 10^{-13}$

$s = 4.02 \times 10^{-5}$ M

∴ the solubility of $Pb(IO_3)_2$ is 4.02×10^{-5} mol/L

a) $PbSO_4$

b) see above

c) $1L \times \frac{1.26 \times 10^{-4} mol}{1L} \times \frac{303.25 g}{1 mol} = 0.0384 g$

d) - add a soluble sulphate such as Na_2SO_4

- the ↑ $[SO_4^{2-}]$ will force the equilibrium to the left

e) $\frac{2.90 \times 10^{-14} mol}{1L}$ from (1) above

4.a) $Cu(OH)_2(s) \rightleftharpoons Cu^{2+} + 2OH^{1-}$

$[Cu^{2+}] = ?$

$[OH^-] = 1.0 \times 10^{-4}$ M

$K_{sp} = [Cu^{2+}][OH^-]^2$

$[Cu^{2+}] = \frac{K_{sp}}{[OH^-]^2}$

$[Cu^{2+}] = \frac{1.6 \times 10^{-19}}{(1 \times 10^{-4} M)^2}$

$[Cu^{2+}] = 1.6 \times 10^{-11}$ M

$\frac{1.6 \times 10^{-11} mol}{1L} \times \frac{63.54 g\ Cu}{1 mol\ Cu} \times \frac{1000 mg}{1g} \times \frac{1L}{1000 mL} = 1.02 \times 10^{-9}$ mg/mL

b) $Fe(OH)_3(s) \rightleftharpoons Fe^{3+} + 3OH^{1-}$

$[Fe^{3+}] = ?$

$[OH^-] = 1 \times 10^{-4}$ M

$K_{sp} = [Fe^{3+}][OH^-]^3$

$[Fe^{3+}] = \frac{K_{sp}}{[OH^-]^3}$

$[Fe^{3+}] = \frac{6.0 \times 10^{-38}}{(1 \times 10^{-4})^3}$

$[Fe^{3+}] = 6 \times 10^{-26}$ M

$\frac{6 \times 10^{-26} mol}{1L} \times \frac{55.85 g\ Fe}{1 mol\ Fe} \times \frac{1000 mg}{1g} \times \frac{1L}{1000 mL} = 3.35 \times 10^{-24}$ mg/mL

4(c) $Mg(OH)_2(s) \rightleftharpoons Mg^{2+} + 2OH^-$

$[Mg^{2+}] = ?$

$[OH^-] = 1 \times 10^{-4}\,M$

$K_{sp} = [Mg^{2+}][OH^-]^2$

$[Mg^{2+}] = \dfrac{K_{sp}}{[OH^-]^2}$

$[Mg^{2+}] = \dfrac{9.0 \times 10^{-12}}{(1 \times 10^{-4})^2}$

$[Mg^{2+}] = 9 \times 10^{-4}\,M$

$$\frac{9 \times 10^{-4}\,mol}{1L} \times \frac{24.31g}{1mol} \times \frac{1000mg}{1g} \times \frac{1L}{1000mL} = 2.19 \times 10^{-2}\,mg/mL$$

5. Precipitation will begin once equilibrium conditions are obtained

a) $AgBr(s) \rightleftharpoons Ag^+ + Br^-$

$[Ag^+] = ?$

$$[Br^-] = \frac{1mg}{1mL} \times \frac{1g}{1000mg} \times \frac{1000mL}{1L} \times \frac{1mol}{79.91g} = 0.0125\,M$$

$K_{sp} = [Ag^+][Br^-]$

$[Ag^+] = \dfrac{K_{sp}}{[Br^-]}$

$[Ag^+] = \dfrac{7.7 \times 10^{-13}}{0.0125}$

$[Ag^+] = 6.15 \times 10^{-11}\,M$

b) $Ag_2S(s) \rightleftharpoons 2Ag^+ + S^{2-}$

$[Ag^+] = ?$

$[S^{2-}] = 0.0312\,M$ (see 5a))

$K_{sp} = [Ag^+]^2[S^{2-}]$

$[Ag^+]^2 = \dfrac{K_{sp}}{[S^{2-}]}$

$[Ag^+] = \sqrt{\dfrac{K_{sp}}{[S^{2-}]}}$

$[Ag^+] = \sqrt{\dfrac{1.6 \times 10^{-49}}{0.0312}}$

$[Ag^+] = 2.26 \times 10^{-24}\,M$

c) $AgBrO_3(s) \rightleftharpoons Ag^{1+} + BrO_3^{1-}$

$[Ag^+] = ?$

$$[BrO_3^-] = \frac{1mg}{1mL} \times \frac{1g}{1000mg} \times \frac{1000mL}{1L} \times \frac{1mol}{127.91g} = 7.82 \times 10^{-3}\,M$$

$K_{sp} = [Ag^+][BrO_3^-]$

$[Ag^+] = \dfrac{K_{sp}}{[BrO_3^-]}$

$[Ag^+] = \dfrac{6.0 \times 10^{-5}}{7.82 \times 10^{-3}}$

$[Ag^+] = 7.67 \times 10^{-3}\,M$

d) $Ag_2CrO_4(s) \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

$[Ag^+] = ?$

$[CrO_4^{2-}] = 8.62 \times 10^{-3}$ M

$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$

$$[Ag^+] = \sqrt{\frac{K_{sp}}{[CrO_4^{2-}]}}$$

$$[Ag^+] = \sqrt{\frac{1.1 \times 10^{-12}}{8.62 \times 10^{-3}}}$$

$[Ag^+] = 1.13 \times 10^{-5}$

e) $AgIO_3(s) \rightleftharpoons Ag^+ + IO_3^{1-}$ $[IO_3^{1-}] = 5.72 \times 10^{-3}$

⋮

$[Ag^+] = 5.42 \times 10^{-6}$ M

6. a) $TlI(s) \rightleftharpoons Tl^{1+} + I^{1-}$ Let s ~~~~

$[Tl^+] = s$

$[I^-] = s$

$K_{sp} = [Tl^+][I^-]$

$8.9 \times 10^{-8} = s^2$

$s = 2.98 \times 10^{-4}$ M

$$500\,mL \times \frac{1\,L}{1000\,mL} \times \frac{2.98 \times 10^{-4}\,mol}{1\,L} \times \frac{331.27\,g}{1\,mol} \times \frac{1000\,mg}{1\,g} = 49.4\,mg$$

b) $TlNO_3(s) \rightarrow Tl^+ + NO_3^-$ all $TlNO_3$ dissolves

∴ a 0.1 M $TlNO_3$ solution has $[Tl^+] = 0.1$ M

After some TlI dissolves and reaches equilibrium

$TlI(s) \rightleftharpoons Tl^+ + I^-$

$[Tl^+] = \underbrace{0.1}_{\text{from } TlNO_3} + \underbrace{s}_{\text{from } TlI}$

$[I^-] = s$

$K_{sp} = [Tl^+][I^-]$

$8.9 \times 10^{-8} = (s + 0.1)(s)$

$s^2 + 0.1s - 8.9 \times 10^{-8} = 0$

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

$$s = \frac{-0.1 \pm \sqrt{0.1^2 - 4(1)(-8.9 \times 10^{-8})}}{2(1)}$$

$$s = \frac{-0.1 \pm 0.1000018}{2}$$ ← careful, these digits matter

$s = \cancel{-0.1}$ (extraneous) or $s = 9 \times 10^{-7}$ M

$$500\,mL \times \frac{1\,L}{1000\,mL} \times \frac{9 \times 10^{-7}\,mol}{L} \times \frac{331.27\,g}{1\,mol} \times \frac{1000\,mg}{1\,g} = 0.149\,mg$$

c) $[Tl^+] = s$

$[I^-] = s + 0.02$

$K_{sp} = [Tl^+][I^-]$

$8.9\times10^{-8} = s(s+0.02)$

$s^2 + 0.02s - 8.9\times10^{-8} = 0$

$$s = \frac{-0.02 \pm \sqrt{0.02^2 - 4(1)(-8.9\times10^{-8})}}{2(1)}$$

$$s = \frac{-0.02 \pm 0.0200089}{2}$$

$s =$ ~~-0.02~~ (extraneous) or 4.45×10^{-6} M

$0.500L \times \frac{4.45\times10^{-6}\text{ mol}}{1L} \times \frac{331.27g}{1\text{ mol}} \times \frac{1000\text{ mg}}{1g} = 0.737$ mg

7. $AgBr_{(s)} \rightleftharpoons Ag^+ + Br^-$

1) Determine $[Br^-]$ from $CaBr_2$

$CaBr_{2(s)} \rightarrow Ca^{2+} + 2Br^-$

0.01 M → 0.02 M

$C_2 = \frac{C_1V_1}{V_2}$

$C_2 = \frac{0.02M \times 50.0mL}{100mL}$

$C_2 = 0.01M\ Br^-$

2) $[Ag^+]$ from $AgNO_3$

$AgNO_{3(s)} \rightarrow Ag^+ + NO_3^{1-}$

0.008M → 0.008M

$C_2 = \frac{C_1V_1}{V_2}$

$C_2 = \frac{0.008M \times 50mL}{100mL}$

$C_2 = 0.004M\ Ag^+$

$K_{sp} = [Ag^+][Br^-]$

$[Ag^+][Br^-] = (0.004)(0.01)$

$[Ag^+][Br^-] = 4\times10^{-5}$

$K_{sp} = 7.7\times10^{-13}$

$\therefore K_{sp} < [Ag^+][Br^-]$ ∴ a ppte forms and the solubility of additional AgBr is zero

8. $AgNO_{3(s)} \rightarrow Ag^+ + NO_3^-$

0.1M → 0.1M

$C_2 = \frac{C_1V_1}{V_2}$

$C_2 = \frac{0.1M \times 50mL}{200mL}$

$C_2 = 0.025M$

$\therefore [Ag^+] = 0.025M$

$CaCl_{2(s)} \rightarrow Ca^{2+} + 2Cl^{1-}$

0.1M → 0.2M

$C_2 = \frac{C_1V_1}{V_2}$

$C_2 = \frac{0.2M \times 150mL}{200mL}$

$C_2 = 0.15M$

$\therefore [Cl^{1-}] = 0.15M$

With these concentration an AgCl ppte will definitely form (i.e. $[Ag^+][Cl^-] > K_{sp}$)

Let x represent the amount of AgCl ppte that forms

	$AgCl_{(s)}$ ⇌	Ag^+ +	Cl^-
Initial amount	∅	(n=cV, n=0.1×0.05) 0.005 mol	0.03 mol
Final amount	x	0.005 − x	0.03 − x
Final [ ]		$\frac{0.005-x}{0.2}$	$\frac{0.03-x}{0.2}$

$K_{sp} = [Ag^+][Cl^-]$

$1.8\times10^{-10} = \left(\frac{0.005-x}{0.2}\right)\left(\frac{0.03-x}{0.2}\right)$

$7.2\times10^{-12} = (0.005-x)(0.03-x)$

$7.2\times10^{-12} = 1.5\times10^{-4} - 0.035x + x^2$

$x^2 - 0.035x + 1.5\times10^{-4} = 0$

$= \frac{0.035 \pm \sqrt{(0.035)^2 - 4(1)(1.5\times10^{-4})}}{2(1)}$

$= \frac{0.035 \pm 2.5\times10^{-2}}{2}$ ∴ ~~$x = 0.03$~~ (extraneous) or $x = 5\times10^{-3}$ *

→ this root also appears extraneous (gives $[Ag^+]=0$
However, the actual value is 0.004999999712

∴ $[Ag^+] = \frac{0.005 - 0.004999999712}{0.2}$ *

$[Ag^+] = 1.44\times10^{-9}$ M

$[Cl^-] = \frac{0.03 - 0.005}{0.2}$ * ← same number, right!

$[Cl^-] = 0.125$ M

Note $[Ag^+][Cl^-] = (1.44\times10^{-9})(0.125) = 1.8\times10^{-10}$!!
$K_{sp} = 1.8\times10^{-10}$!!

9 a ppte will form if the solubility product exceeds K_{sp}

a) $AgNO_3 \rightarrow Ag^+ + NO_3^-$ $C = \frac{n}{V}$

$10.0\text{ mL} \times \frac{1\text{ L}}{1000\text{ mL}} \times \frac{0.01\text{ mol}}{1\text{ L}} = 1\times10^{-4}$ mol Ag^+ $C = \frac{1\times10^{-4}\text{ mol}}{0.020\text{ L}}$

∴ $[Ag^+] = 5\times10^{-3}$ M $C = 5\times10^{-3}$ mol/L

$Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$ $C = \frac{n}{V}$

$10.0\text{ mL} \times \frac{1\text{ L}}{1000\text{ mL}} \times \frac{0.01\text{ mol}}{1\text{ L}} = 1\times10^{-4}$ mol SO_4^{2-} $C = \frac{1\times10^{-4}\text{ mol}}{0.020\text{ L}}$

∴ $[SO_4^{2-}] = 5\times10^{-3}$ M $C = 5\times10^{-3}$ mol/L

$Ag_2SO_4 \rightleftharpoons 2Ag^+ + SO_4^{2-}$

$K_{sp} = [Ag^+]^2[SO_4^{2-}]$

$[Ag^+]^2[SO_4^{2-}] = (5\times10^{-3})^2 \times 5\times10^{-3}$
$= 1.25\times10^{-7}$

$K_{sp} = 1.2\times10^{-5}$

∴ $K_{sp} > [Ag^+]^2[SO_4^{2-}]$ ∴ no ppte forms

b) From the table 16-1 $MgC_2O_4 \rightleftharpoons Mg^{2+} + C_2O_4^{2-}$ $K_{sp} = 8.6 \times 1($
is the equilibrium in question

$MgCl_2 \rightarrow Mg^{2+} + 2Cl^{1-}$

$1\,mg\,MgCl_2 \times \frac{1\,g}{1000\,mg} \times \frac{1\,mol\,MgCl_2}{95.21\,g\,MgCl_2} \times \frac{1\,mol\,Mg^{2+}}{1\,mol\,MgCl_2} = 1.0503 \times 10^{-5}\,mol$

$C = \frac{n}{V}$ $C = \frac{1.0503 \times 10^{-5}\,mol}{1\,L}$ (assume no change in volume) $C = 1.0503 \times 10^{-5}\,M$ $\therefore [Mg^{2+}] = 1.0503 \times 10^{-5}\,M$

$Na_2C_2O_4 \rightarrow 2Na^{+} + C_2O_4^{2-}$

$\therefore [C_2O_4^{2-}] = 0.01\,M$

$MgC_2O_4 \rightleftharpoons Mg^{2+} + C_2O_4^{2-}$

$K_{sp} = [Mg^{2+}][C_2O_4^{2-}]$

$[Mg^{2+}][C_2O_4^{2-}] = (1.0503 \times 10^{-5})(0.01)$
$= 1.0503 \times 10^{-7}$

$K_{sp} = 8.6 \times 10^{-5}$

$\therefore K_{sp} > [Mg^{2+}][C_2O_4^{2-}]$ $\therefore$ no ppte forms

c) $Ca(NO_3)_2 \rightarrow Ca^{2+} + 2NO_3^{1-}$ $[Ca^{2+}] = 1.0 \times 10^{-4}\,M$

$HF \rightarrow H^{+} + F^{-}$ $[F^{-}] = 1.0 \times 10^{-2}\,M$ * This is an over simplification

$CaF_2 \rightleftharpoons Ca^{2+} + F^{-}$ $K_{sp} = 4.9 \times 10^{-11}$

GOOD EXAM QUESTION

$[Ca^{2+}][F^{-}]^2 = (1 \times 10^{-4})(1.0 \times 10^{-2})^2$
$= 1 \times 10^{-8}$

$\therefore K_{sp} < [Ca^{2+}][F^{-}]^2$ $\therefore$ a ppte forms

d) $Ca(NO_3)_2 \rightarrow Ca^{2+} + 2NO_3^{1-}$ $[Ca^{2+}] = 1 \times 10^{-4}\,M$

$HF \rightarrow H^{+} + F^{-}$ $[F^{-}] = 1.0 \times 10^{-2}\,M$

$CaF_2 \rightleftharpoons Ca^{2+} + F^{-}$ $K_{sp} = 4.9 \times 10^{-11}$

$[Ca^{2+}][F^{-}]^2 = (1 \times 10^{-4})(1 \times 10^{-2})^2$
$= 1 \times 10^{-8}$

$\therefore K_{sp} < [Ca^{2+}][F^{-}]^2$ $\therefore$ a ppte forms

e) $[Ag^{+}] = 0.001\,M$

$[Br^{-}] = 9.386 \times 10^{-4}\,M$ $1.5\,mg \times \frac{1\,g}{1000\,mg} \times \frac{1\,mol}{79.91\,g} = 1.88 \times 10^{-5}\,mol$

$C = \frac{n}{V}$ $C = \frac{1.88 \times 10^{-5}\,mol}{0.020\,L}$ $C = 9.39 \times 10^{-4}$

$[Ag^{+}][Br^{-}] = 9.386 \times 10^{-7}$

$K_{sp} = 7.7 \times 10^{-13}$

$\therefore K_{sp} < [Ag^{+}][Br^{-}]$ $\therefore$ a ppte forms

10. For a precipitate to form ksp < solubility product constant

$NaCl \rightarrow Na^{+} + Cl^{1-}$ ∴ $[Cl^{1-}] = 0.135\,M$

$PbCl_2 \rightleftharpoons Pb^{2+} + 2Cl^{1-}$

$K_{sp} = [Pb^{2+}][Cl^{1-}]^2$

for ppte

$K_{sp} < [Pb^{2+}][Cl^{1-}]^2$

$[Pb^{2+}] > \frac{K_{sp}}{[Cl^{1-}]^2}$

$[Pb^{2+}] > \frac{1.6 \times 10^{-5}}{(0.135)^2}$

$[Pb^{2+}] > 8.78 \times 10^{-4}\,M$

$n = CV$

$n = 8.78 \times 10^{-4} \times 0.010L$

$n = 8.78 \times 10^{-6}\,mol$

$8.78 \times 10^{-6}\,mol \times \frac{207.19g}{1mol} \times \frac{1000\,mg}{1g} = 1.82\,mg$

∴ more than 1.82 mg of Pb^{2+} must be added

11. a) $TlI \rightleftharpoons Tl^{1+} + I^{1-}$ $K_{sp} = 8.9 \times 10^{-8}$

vs

$AgI \rightleftharpoons Ag^{+} + I^{1-}$ $K_{sp} = 8.3 \times 10^{-17}$

Since both equilibrium are of similar form and [. the AgI should ppte first (i.e. Ksp is exceeded for AgI before TlI)

b) Find [I⁻] when TlI begins to ppte

$TlI \rightleftharpoons Tl^{1+} + I^{1-}$ $K_{sp} = 8.9 \times 10^{-8}$

$[Tl^{1+}] = 0.01\,M$

$K_{sp} = [Tl^{+}][I^{-}]$

$[I^{-}] = \frac{K_{sp}}{[Tl^{1+}]}$

$[I^{-}] = \frac{8.9 \times 10^{-8}}{0.01}$

$[I^{-}] = 8.9 \times 10^{-6}\,M$

→ $AgI \rightleftharpoons Ag^{+} + I^{-}$

$[Ag^{+}] = \frac{K_{sp}}{[I^{-}]}$

$[Ag^{+}] = \frac{8.3 \times 10^{-17}}{8.9 \times 10^{-6}}$

$[Ag^{+}] = 9.32 \times 10^{-12}\,M$

$100\,mL \times \frac{1L}{1000\,mL} \times \frac{9.32 \times 10^{-12}\,mol}{1L} \times \frac{107.87g\,Ag^{+}}{1mol\,Ag^{+}} \times \frac{1000.}{1g}$

$= 1 \times 10^{-7}\,mg\;Ag^{1+}$