Predicting Whether a Precipitate will Form

- when two solutions containing ions are mixed, there is a possibility that a precipitate will form
  - > if [ion] ≥ 0.1 M, a compound with **low solubility** will **precipitate**
  - > if [ion] < 0.1 M, a calculation must be done to determine if a precipitate will form
- a TRIAL ION PRODUCT (TIP) calculation is required to determine whether a precipitate will form when [ion] < 0.1 M

For the reaction:

$$Ag_2CO_3(s) \rightleftarrows 2Ag^+(aq) + CO_3^{2-}(aq)$$

the trial ion product is:

$$TIP = [Ag^+]^2[CO_3^{2-}]$$

TIP > K_{sp} then precipitate
TIP = K_{sp} then solution is saturated, no precipitate
TIP < K_{sp} then solution is not saturated, no precipitate

Q. If the K_{sp} for $PbCl_2$ is 1.8×10^{-4}, will a precipitate form when 200.0 mL of 0.015 M NaCl is mixed with 100.0 mL of 0.60 M $Pb(NO_3)_2$?

① what is possible ppt?

$$PbCl_{2(s)} \rightleftharpoons Pb^{2+} + 2Cl^-$$

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

$$[Pb2+] = \frac{100.0mL\ (.60M)}{300.0mL}$$

$$= 0.20M$$

$$[Cl^-] = \frac{200.0mL\ (.015M)}{300.0mL}$$

$$= 0.01M$$

$$TIP = [Pb^{2+}][Cl^-]^2$$

$$= (0.20)(.01)^2$$

$$= 2.0 \times 10^{-5}$$

$TIP < K_{sp} \Rightarrow$ no ppt

1) Will a precipitate form when 25.0 mL of 0.15 M $AgNO_3$ is added to 15.0 mL of 0.20 M NaCl?

$AgCl_2 \rightleftharpoons Ag^+ + Cl^-$ $K_{sp} = 1.8 \times 10^{-10}$

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

$[Ag] = \left(\frac{25.0mL}{40.0mL}\right)(.15M)$

$= 0.09375M$

$[Cl^-] = \left(\frac{15.0mL}{40.0mL}\right)(.20M)$

$= 0.075M$

$TIP = [.094][.075]$

$= 7.0 \times 10^{-3}$

$TIP > K_{sp}$

$\Rightarrow$ ppt forms

2) Does a precipitate form when 3.0 mL of 1.0×10^{-3} M NaBr is added to 2.0 mL of 1.0×10^{-3} M $Pb(NO_3)_2$?

$Pb(Br)_2 \rightleftharpoons Pb^{2+} + 2Br^-$ $K_{sp} = 6.6 \times 10^{-6}$

$[Pb^{2+}] = \left(\frac{2.0mL}{5.0mL}\right)(1.0 \times 10^{-3}M)$

$= 4.0 \times 10^{-4}M$

$[Br^-] = \left(\frac{3.0mL}{5.0mL}\right)(1.0 \times 10^{-3}M)$

$= 6.0 \times 10^{-4}M$

$TIP = [Pb^{2+}][Br^-]^2$

$= (4.0 \times 10^{-4})(6.0 \times 10^{-4})^2$

$= 1.4 \times 10^{-10}$

$TIP < K_{sp}$

$\Rightarrow$ no ppt

3) Will a precipitate form when 90.0 mL of 1.00×10^{-2} M $Cu(NO_3)_2$ and 10.0 mL of 1.00×10^{-2} M $NaIO_3$ are mixed?

$Cu(IO_3)_2 \rightleftharpoons Cu^{2+} + 2IO_3^-$ $K_{sp} = 6.9 \times 10^{-8}$

$[Cu^{2+}] = \left(\frac{90.0\,mL}{100.0\,mL}\right)(1.00 \times 10^{-2}\,M)$

$= 9.00 \times 10^{-3}\,M$

$[IO_3^-] = \left(\frac{10.0\,mL}{100.0\,mL}\right)(1.00 \times 10^{-2}\,M)$

$= 1.00 \times 10^{-3}\,M$

$TIP = [Cu^{2+}][IO_3^-]^2$

$= (9.00 \times 10^{-3})(1.00 \times 10^{-3})^2$

$= 9.00 \times 10^{-9}$

$TIP < K_{sp}$

$\Rightarrow$ no ppt

4) Will a precipitate form if 30.0 mL of 0.054 M $Ca(NO_3)_2$ is mixed with 60.0 mL of 8.1×10^{-4} M Na_2SO_4?

$CaSO_4 \rightleftharpoons Ca^{2+} + SO_4^{2-}$ $K_{sp} = 7.1 \times 10^{-5}$

$[Ca^{2+}] = \left(\frac{30.0\,mL}{90.0\,mL}\right)(.054\,M)$

$= 0.018\,M$

$[SO_4^{2-}] = \left(\frac{60.0\,mL}{90.0\,mL}\right)(8.1 \times 10^{-4}\,M)$

$= 5.4 \times 10^{-4}\,M$

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

$= (0.018)(5.4 \times 10^{-4})$

$= 9.7 \times 10^{-6}$

$TIP < K_{sp}$

$\Rightarrow$ no ppt