

Predicting Whether a Precipitate will Form

- when two solutions containing ions are mixed, there is a possibility that a precipitate will form
 - > if $[\text{ion}] \geq 0.1 \text{ M}$, a compound with **low solubility will precipitate**
 - > if $[\text{ion}] < 0.1 \text{ M}$, 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 $[\text{ion}] < 0.1 \text{ M}$

For the reaction:



the trial ion product is:

$$\text{TIP} = [\text{Ag}^+]^2[\text{CO}_3^{2-}]$$

$\text{TIP} > K_{\text{sp}}$ then precipitate

$\text{TIP} = K_{\text{sp}}$ then solution is saturated, no precipitate

$\text{TIP} < K_{\text{sp}}$ 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 $Pb(NO_3)_2$?

○ what is possible ppt?



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

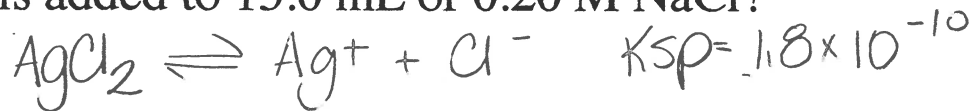
$$[Pb^{2+}] = \frac{100.0 \text{ mL} (.60 \text{ M})}{300.0 \text{ mL}} = 0.2 \text{ M}$$

$$[Cl^{-}] = \frac{200.0 \text{ mL} (.015 \text{ M})}{300.0 \text{ mL}} = 0.01 \text{ M}$$

$$\begin{aligned} \text{TIP} &= [Pb^{2+}][Cl^{-}]^2 \\ &= (0.20)(.01)^2 \\ &= 2.0 \times 10^{-5} \end{aligned}$$

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 ?



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

$$[\text{Ag}^+] = \left(\frac{25.0 \text{ mL}}{40.0 \text{ mL}} \right) (0.15 \text{ M}) \\ = 0.09375 \text{ M}$$

$$\text{TIP} = [0.094][0.075] \\ = 7.0 \times 10^{-3}$$

$$[\text{Cl}^-] = \left(\frac{15.0 \text{ mL}}{40.0 \text{ mL}} \right) (0.20 \text{ M}) \\ = 0.075 \text{ M}$$

$$\text{TIP} > K_{sp} \\ \Rightarrow \text{ppt forms}$$

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 $\text{Pb}(\text{NO}_3)_2$?



$$[\text{Pb}^{2+}] = \left(\frac{2.0 \text{ mL}}{5.0 \text{ mL}} \right) (1.0 \times 10^{-3} \text{ M}) \\ = 4.0 \times 10^{-4} \text{ M}$$

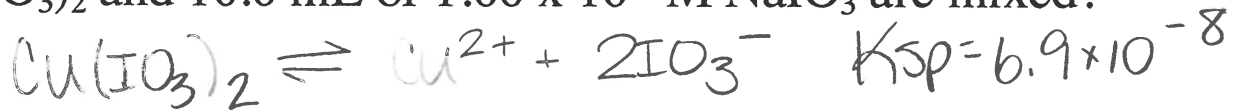
$$\text{TIP} = [\text{Pb}^{2+}][\text{Br}^-]^2 \\ = (4.0 \times 10^{-4})(6.0 \times 10^{-4})^2$$

$$[\text{Br}^-] = \left(\frac{3.0 \text{ mL}}{5.0 \text{ mL}} \right) (1.0 \times 10^{-3} \text{ M}) \\ = 6.0 \times 10^{-4} \text{ M}$$

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

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

3) Will a precipitate form when 90.0 mL of $1.00 \times 10^{-2} \text{ M}$ $\text{Cu}(\text{NO}_3)_2$ and 10.0 mL of $1.00 \times 10^{-2} \text{ M}$ NaIO_3 are mixed?



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

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

$$\text{TIP} = [\text{Cu}^{2+}][\text{IO}_3^-]^2$$

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

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

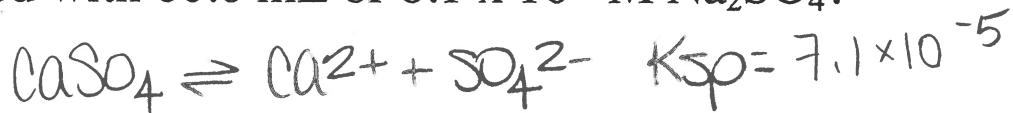
$$[\text{IO}_3^-] = \frac{10.0 \text{ mL} (1.00 \times 10^{-2} \text{ M})}{100.0 \text{ mL}}$$

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

$$\text{TIP} < K_{\text{sp}}$$

$$\Rightarrow \text{no ppt}$$

4) Will a precipitate form if 30.0 mL of 0.054 M $\text{Ca}(\text{NO}_3)_2$ is mixed with 60.0 mL of $8.1 \times 10^{-4} \text{ M}$ Na_2SO_4 ?



$$[\text{Ca}^{2+}] = \frac{30.0 \text{ mL} (0.054 \text{ M})}{90.0 \text{ mL}}$$

$$= 0.018 \text{ M}$$

$$\text{TIP} = [\text{Ca}^{2+}][\text{SO}_4^{2-}]$$

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

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

$$[\text{SO}_4^{2-}] = \frac{60.0 \text{ mL} (8.1 \times 10^{-4} \text{ M})}{90.0 \text{ mL}}$$

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

$$\text{TIP} < K_{\text{sp}}$$

$$\Rightarrow \text{no ppt}$$