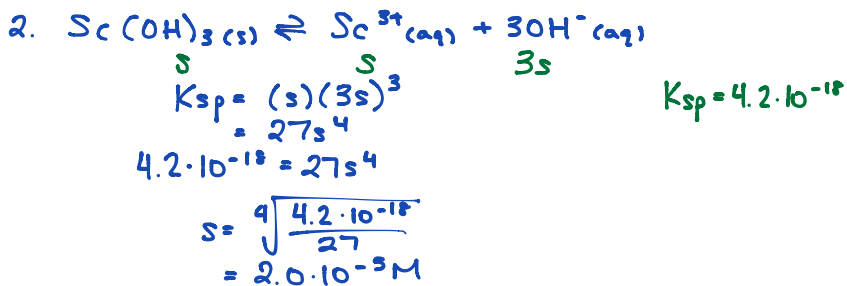
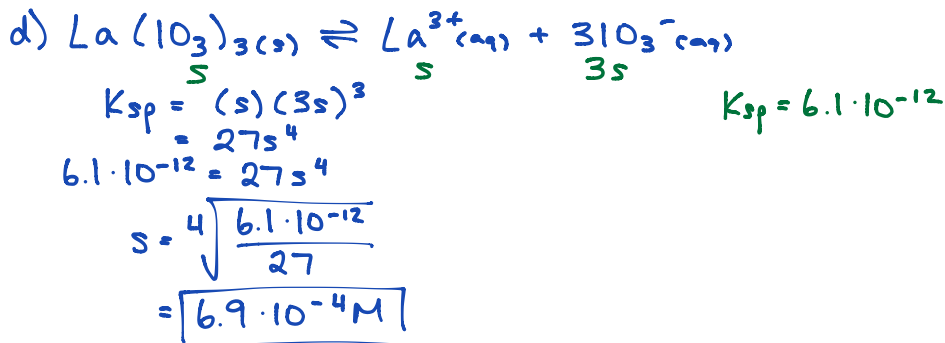
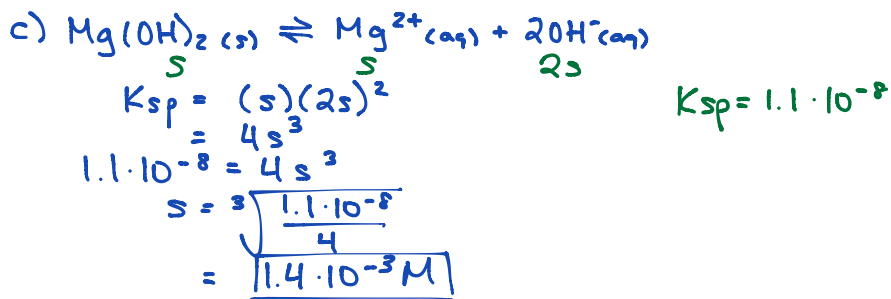
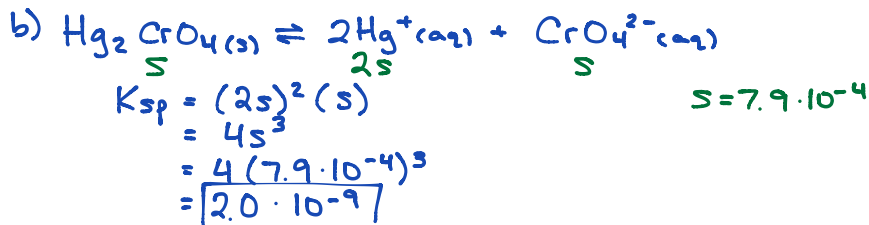
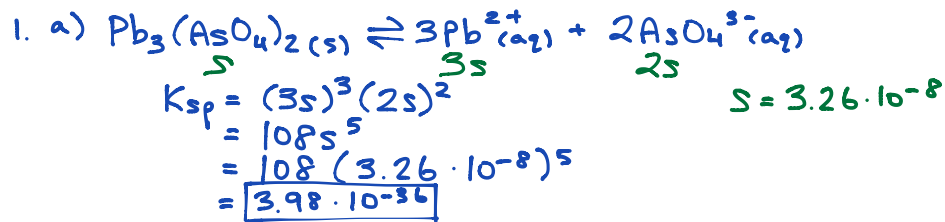


### Wkst 3.2: $K_{sp}$ Calculations

- 1- Calculate the solubility product constant or solubility of the following:
  - a)  $Pb_3(AsO_4)_2$ , whose solubility is  $3.26 \times 10^{-8}$  M
  - b)  $Hg_2CrO_4$ , whose solubility is  $7.9 \times 10^{-4}$  M
  - c)  $Mg(OH)_2$  whose  $K_{sp}$  is  $1.1 \times 10^{-8}$
  - d)  $La(IO_3)_3$  whose  $K_{sp}$  is  $6.1 \times 10^{-12}$
- 2- The  $K_{sp}$  of scandium (III) hydroxide is  $4.2 \times 10^{-18}$ . Find its solubility in  $g \cdot L^{-1}$ .
- 3- The solubility of  $PbSO_4$  in water is  $3.8 \times 10^{-2}$   $g \cdot L^{-1}$ . Calculate the  $K_{sp}$  of  $PbSO_4$ .
- 4-  $[Ag^+] = 2.2 \times 10^{-4}$  M in a saturated solution of  $Ag_2C_2O_4$ . Determine the solubility product of the compound.
- 5-  $SrF_2$  has a  $K_{sp} = 2.18 \times 10^{-8}$ . Determine the concentrations of the strontium and fluoride ions in a saturated solution.
- 6-  $[IO_3^-] = 3.58 \times 10^{-3}$  M in a saturated solution of  $Cd(IO_3)_2$ . Determine the solubility product of the compound.
- 7-  $Li_3PO_4$  has a  $K_{sp} = 3.2 \times 10^{-9}$ . Find its solubility in  $g \cdot L^{-1}$ .
- 8- How many grams of thallium (I) sulphide can you dissolve in 500. mL of solution to achieve saturation?  $K_{sp} = 6.00 \times 10^{-22}$ .
- 9- How many grams of  $PbI_2$  will dissolve in 250. mL of water to form a saturated solution if its solubility product equals  $1.7 \times 10^{-5}$ ?
- 10- What is the volume of saturated solution of  $PbSO_4$  which can be prepared from 1.5 g of the compound?
- 11- A student reduces the volume of a saturated solution of lead (II) bromide from 10.0 L to 7.50 L by evaporation. What is the mass of precipitated lead (II) bromide?
- 12- Determine the maximum volume of saturated solution obtained by dissolving 7.50 grams of iron (II) hydroxide in water.
- 13- A student adds 0.500 grams of strontium fluoride to 2.00 L of water. He obtains a suspension of strontium fluoride. Determine the minimum volume of water that needs to be added to dissolve all the strontium fluoride.

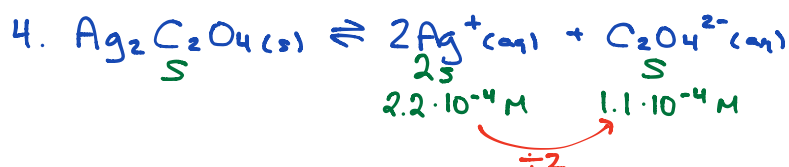


$$\frac{2.0 \cdot 10^{-5} \text{ mol}}{\text{L}} \times \frac{96.0 \text{ g}}{1 \text{ mol Sc}(\text{OH})_3} = \boxed{1.9 \cdot 10^{-3} \text{ g/L}}$$

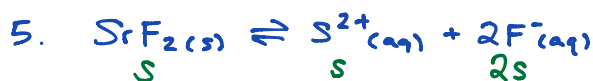


$$\frac{3.8 \cdot 10^{-2} \text{ g}}{\text{L}} \times \frac{1 \text{ mol PbSO}_4}{303.3 \text{ g}} = 1.3 \cdot 10^{-4} \text{ M} = S$$

$$K_{sp} = S^2 = (1.3 \cdot 10^{-4})^2 = \boxed{1.7 \cdot 10^{-8}}$$



$$K_{sp} = [\text{Ag}^+]^2 [\text{C}_2\text{O}_4^{2-}] = (2.2 \cdot 10^{-4})^2 (1.1 \cdot 10^{-4}) = \boxed{5.3 \cdot 10^{-12}}$$



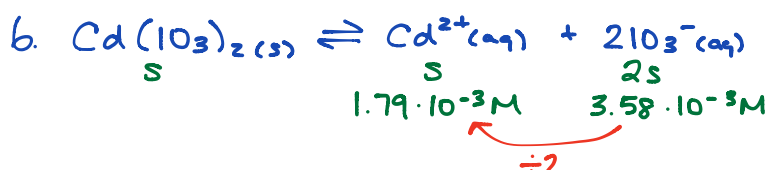
$$K_{sp} = 2.18 \cdot 10^{-8}$$

$$K_{sp} = (s)(2s)^2 = 4s^3$$

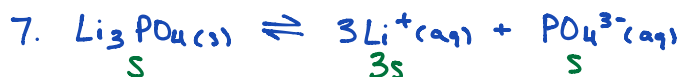
$$2.18 \cdot 10^{-8} = 4s^3$$

$$s = \sqrt[3]{\frac{2.18 \cdot 10^{-8}}{4}} = 1.76 \cdot 10^{-3}$$

$$\boxed{[\text{Sr}^{2+}] = 1.76 \cdot 10^{-3} \text{ M}} \\ \boxed{[\text{F}^-] = 3.52 \cdot 10^{-3} \text{ M}}$$



$$K_{sp} = (s)(2s)^2 = (1.79 \cdot 10^{-3})(3.58 \cdot 10^{-3})^2 = \boxed{2.29 \cdot 10^{-8}}$$



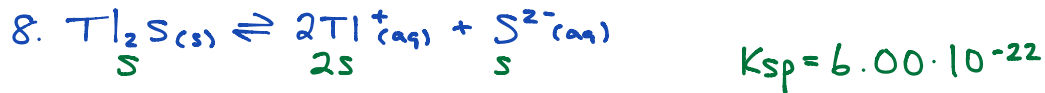
$$K_{sp} = (3s)^3(s) = 27s^4$$

$$3.2 \cdot 10^{-9} = 27s^4$$

$$s = \sqrt[4]{\frac{3.2 \cdot 10^{-9}}{27}} = 3.3 \cdot 10^{-3} \text{ M}$$

$$K_{sp} = 3.2 \cdot 10^{-9}$$

$$\frac{3.3 \cdot 10^{-3} \text{ mol}}{\text{L}} \times \frac{115.7 \text{ g}}{1 \text{ mol Li}_3\text{PO}_4} = \boxed{3.8 \cdot 10^{-1} \text{ g/L}}$$



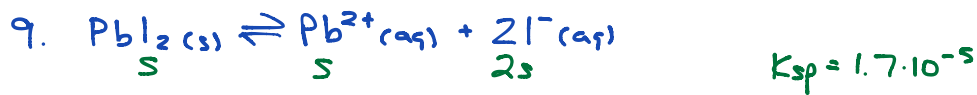
$$K_{sp} = 4s^3$$

$$6.00 \cdot 10^{-22} = 4s^3$$

$$s = \sqrt[3]{\frac{6.00 \cdot 10^{-22}}{4}}$$

$$= 5.31 \cdot 10^{-8} M$$

$$500. \cancel{mL} \times \frac{1 \cancel{L}}{1000 \cancel{mL}} \times \frac{5.31 \cdot 10^{-8} \cancel{mol}}{1 \cancel{L}} \times \frac{440. \text{g}}{1 \cancel{mol} Tl_2S} = \boxed{1.17 \cdot 10^{-5} g}$$



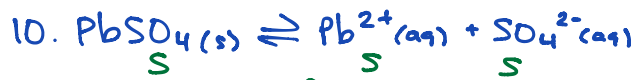
$$K_{sp} = (s)(2s)^2$$

$$1.7 \cdot 10^{-5} = 4s^3$$

$$s = \sqrt[3]{\frac{1.7 \cdot 10^{-5}}{4}}$$

$$= 1.6 \cdot 10^{-2} M$$

$$250 \cancel{mL} \times \frac{1 \cancel{L}}{1000 \cancel{mL}} \times \frac{1.6 \cdot 10^{-2} \cancel{mol}}{1 \cancel{L}} \times \frac{461. \text{g}}{1 \cancel{mol} PbI_2} = \boxed{1.8 g}$$



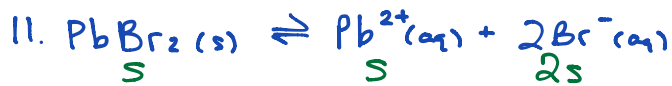
$$K_{sp} = s^2$$

$$1.8 \cdot 10^{-8} = s^2$$

$$s = 1.3 \cdot 10^{-4} M$$

$$K_{sp} = 1.8 \cdot 10^{-8} \text{ (from table)}$$

$$1.5 \cancel{g} PbSO_4 \times \frac{1 \cancel{mol}}{303.3 \cancel{g}} \times \frac{1 \cancel{L}}{1.3 \cdot 10^{-4} \cancel{mol}} = \boxed{38 L}$$



\* At 10.0L, the solution is saturated. If the volume is reduced to 7.50L, the mass of the precipitate will be found in the 2.50L that evaporated.

$$K_{sp} = 6.6 \cdot 10^{-6} = 4s^3$$

$$s = \sqrt[3]{\frac{6.6 \cdot 10^{-6}}{4}}$$

$$= 1.2 \cdot 10^{-2} M$$

$$2.50 \cancel{L} \times \frac{1.2 \cdot 10^{-2} \cancel{mol}}{1 \cancel{L}} \times \frac{367. \text{g}}{1 \cancel{mol} PbBr_2} = \boxed{11 g}$$

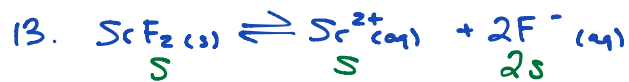


$$K_{sp} = 4.9 \cdot 10^{-17} = 4S^3$$

$$S = \sqrt[3]{\frac{4.9 \cdot 10^{-17}}{4}}$$

$$= 2.3 \cdot 10^{-6} \text{ M}$$

$$7.50 \text{ g} \times \frac{1 \text{ mol Fe(OH)}_2}{89.8 \text{ g}} \times \frac{\textcircled{L}}{2.3 \cdot 10^{-6} \text{ mol}} = \boxed{3.6 \cdot 10^4 \text{ L}}$$



$$K_{sp} = 4.3 \cdot 10^{-9} = 4S^3$$

$$S = \sqrt[3]{\frac{4.3 \cdot 10^{-9}}{4}}$$

$$= 1.0 \cdot 10^{-3} \text{ M}$$

$$0.500 \text{ g} \times \frac{1 \text{ mol}}{125.6 \text{ g}} \times \frac{\textcircled{L}}{1.0 \cdot 10^{-3} \text{ mol}} = 4.0 \text{ L}$$

To dissolve all of the 0.500g of  $\text{SrF}_2$ ,  
4.0 L is needed.

The extra volume of water needed is :

$$4.0 \text{ L} - 2.00 \text{ L} = \boxed{2.0 \text{ L}}$$