

**G12 Chemistry: Class 14 Homework**

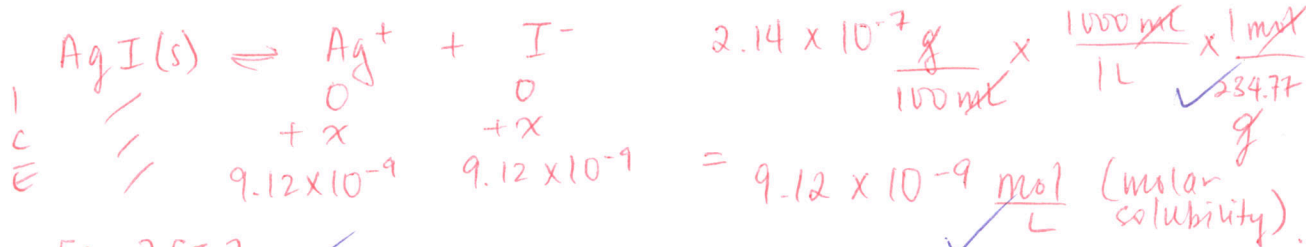
1. a) Show the balanced equation for the solubility equilibrium that would occur when a solution of  $\text{Ba}(\text{NO}_3)_2$  (aq) is mixed with a solution of  $\text{Na}_2\text{SO}_4$  (aq). [2 marks]



- b) Write the solubility product constant equation for this equilibrium system. [1 mark]

$$K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}] \quad \checkmark$$

2. Calculate the  $K_{sp}$  at  $25^\circ\text{C}$  for  $\text{AgI}$  (s), given that its solubility at this temperature is  $2.14 \times 10^{-7} \text{ g/100mL}$ . [4 marks]

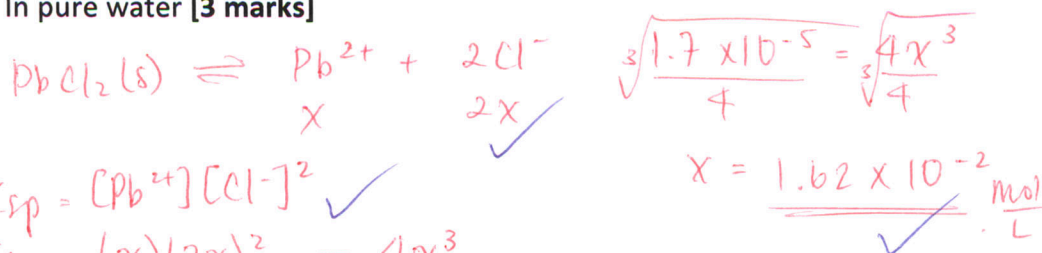


$$\begin{aligned} K_{sp} &= [\text{Ag}^+][\text{I}^-] \quad \checkmark \\ &= (9.12 \times 10^{-9})^2 \\ &= 8.31 \times 10^{-17} \quad \checkmark \end{aligned}$$

$$\therefore K_{sp} \text{ is } 8.31 \times 10^{-17}$$

3.  $K_{sp}$  for  $\text{PbCl}_2$  is  $1.7 \times 10^{-5}$  at  $25^\circ\text{C}$ . Calculate the molar solubility of  $\text{PbCl}_2$ .

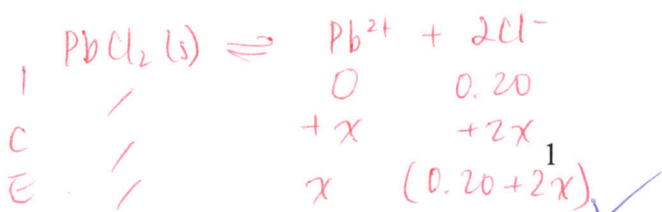
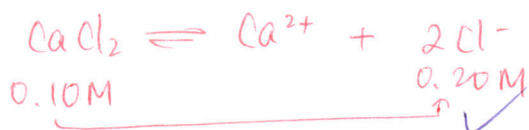
- a. In pure water [3 marks]



$$K_{sp} = [\text{Pb}^{2+}][\text{Cl}^-]^2 \quad \checkmark$$

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

- b. In  $0.10 \text{ mol/L CaCl}_2$  [4 marks]

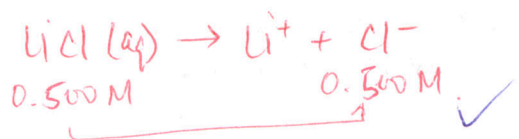


$$K_{sp} = [\text{Pb}^{2+}][\text{Cl}^-]^2 \quad \checkmark$$

$$1.7 \times 10^{-5} = (x)(0.20 + 2x)^2$$

$$x = 4.25 \times 10^{-4} \frac{\text{mol}}{\text{L}} \quad \checkmark$$

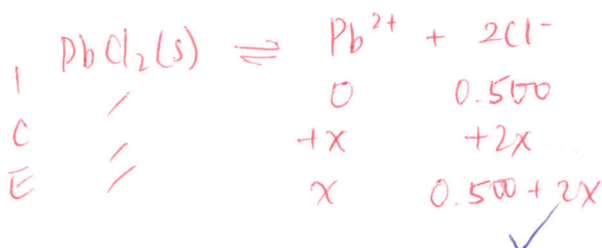
4. What amount of  $\text{PbCl}_2(\text{s})$  in grams, can dissolve in 1.00L of a 0.500 mol/L solution of  $\text{LiCl}(\text{aq})$ ?  $K_{\text{sp}}$  for  $\text{PbCl}_2$  is  $1.7 \times 10^{-5}$  at  $25^\circ\text{C}$ . [5 marks]



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

$$1.7 \times 10^{-5} = (x)(0.500 + 2x)^2$$

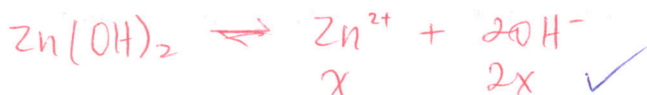
$$x = 6.8 \times 10^{-5} \text{ mol/L} \quad (\text{molar solubility}) \quad \checkmark$$



$$6.8 \times 10^{-5} \frac{\text{mol}}{\text{L}} \times 278.1 \frac{\text{g}}{\text{mol}}$$

$$= \boxed{1.9 \times 10^{-2} \text{ g/L}} \quad \checkmark$$

5. Calculate the molar solubility of  $\text{Zn}(\text{OH})_2(\text{s})$ , if the  $K_{\text{sp}}$  is  $3 \times 10^{-17}$  at  $25^\circ\text{C}$ . [3 marks]



$$K_{\text{sp}} = [\text{Zn}^{2+}][\text{OH}^-]^2$$

$$3 \times 10^{-17} = (x)(2x)^2$$

$$3 \times 10^{-17} = 4x^3 \quad \checkmark$$

$$x = \sqrt[3]{\frac{3 \times 10^{-17}}{4}}$$

$$= \underline{\underline{2 \times 10^{-6} \frac{\text{mol}}{\text{L}}}} \quad \checkmark$$

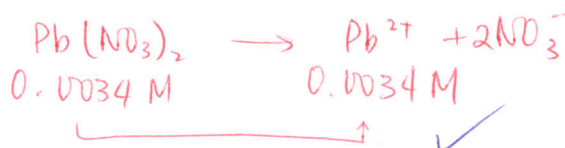
6. A solution contains 0.15 mol/L of  $\text{NaCl}$  and 0.0034 mol/L  $\text{Pb}(\text{NO}_3)_2$ . Does a precipitate form? Include a balanced chemical equation for the formation of the possible precipitate.  $K_{\text{sp}}$  for  $\text{PbCl}_2$  is  $1.7 \times 10^{-5}$  at  $25^\circ\text{C}$ . [4 marks]



$\text{NaCl}$  contributes  $[\text{Cl}^-]$



$\text{Pb}(\text{NO}_3)_2$  contributes  $[\text{Pb}^{2+}]$



$$Q_{\text{sp}} = [\text{Pb}^{2+}][\text{Cl}^-]^2$$

$$= (0.0034)(0.15)^2$$

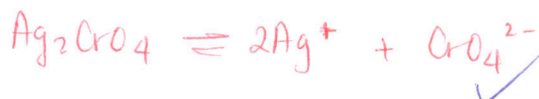
$$= \underline{\underline{7.65 \times 10^{-5}}} \rightarrow \underline{\underline{7.7 \times 10^{-5}}} \quad \checkmark$$

$Q_{\text{sp}} > K_{\text{sp}} \therefore$  ppt will form. ✓

7. One drop (0.050ml) of 1.5 mol/L potassium chromate,  $K_2CrO_4$  is added to 250 mL of 0.10 mol/L  $AgNO_3$ . Does a precipitate form? Include a balanced chemical equation for the formation of the possible precipitate.  $K_{sp}$  for  $Ag_2CrO_4$  is  $1.12 \times 10^{-12}$  at  $25^\circ$ . [6 marks]



insignificant volume.  $C = 1.5 M$   
 $V = 5.0 \times 10^{-5} L$   
 $C = 0.10 M$   
 $V = 0.250 L$



$AgNO_3$  contributes  $[Ag^+]$



$$[Ag^+] = \frac{0.10 M \times 0.250 L}{0.250 L}$$

$$= 0.10 M$$

$K_2CrO_4$  contributes  $[CrO_4^{2-}]$



$$[CrO_4^{2-}] = \frac{1.5 \times 5.0 \times 10^{-5}}{0.250}$$

$$= 3.0 \times 10^{-4} M$$

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

$$= (0.10)^2 (3.0 \times 10^{-4})$$

$$= 3.0 \times 10^{-6}$$

$$Q_{sp} > K_{sp} \therefore \text{ppt will form}$$

8. A chemist adds 0.010 g of  $CaCl_2$  to  $5.0 \times 10^2$  mL of 0.0015 mol/L sodium carbonate,  $Na_2CO_3$ . Does a precipitate of calcium carbonate form? Include a balanced chemical equation for the formation of the possible precipitate.  $K_{sp}$  for  $CaCO_3$  is  $3.36 \times 10^{-9}$ . [6 marks]



$$m = 0.010 g$$

$$C = 0.0015 M$$

$$M = 110.984 g/mol$$

$$V = 0.50 L$$

$$n = 9.01 \times 10^{-5} mol$$



$CaCl_2$  contributes  $[Ca^{2+}]$

$$[Ca^{2+}] = \frac{9.01 \times 10^{-5} mol}{0.50 L}$$

$$= 1.8 \times 10^{-4} M$$

$Na_2CO_3$  contributes  $[CO_3^{2-}]$

$$[CO_3^{2-}] = \frac{0.0015 \times 0.50}{0.50}$$

$$= 0.0015 M$$

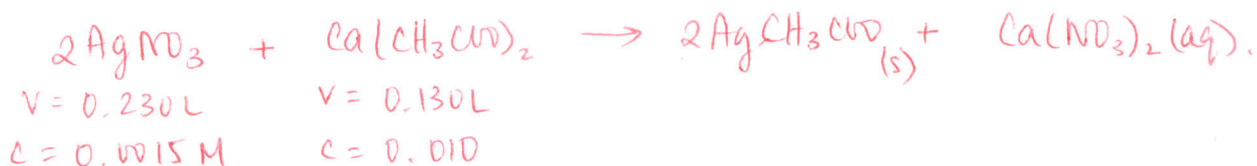
$$Q_{sp} = [Ca^{2+}] [CO_3^{2-}]$$

$$= (1.8 \times 10^{-4}) (0.0015)$$

$$= 2.7 \times 10^{-7}$$

$$Q_{sp} > K_{sp} \therefore \text{ppt will form}$$

9. 230ml of 0.0015M  $\text{AgNO}_3$  is added to 130ml of 0.010M calcium acetate,  $\text{Ca}(\text{CH}_3\text{COO})_2$ . Does a precipitate form? Include a balanced chemical equation for the formation of the possible precipitate.  $K_{sp}$  for  $\text{AgCH}_3\text{COO}$  is  $2.0 \times 10^{-3}$ . [6 marks]

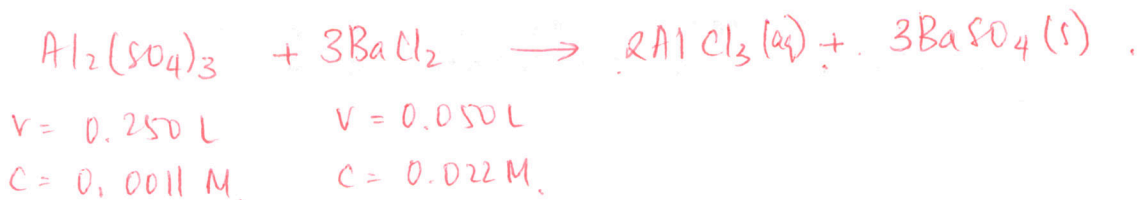


$\text{AgNO}_3$  contributes  $[\text{Ag}^+]$        $\text{Ca}(\text{CH}_3\text{COO})_2$  contributes  $2[\text{CH}_3\text{COO}^-]$   
 $[\text{Ag}^+] = \frac{0.0015 \times 0.230}{0.230 + 0.130}$        $[\text{CH}_3\text{COO}^-] = \frac{0.130 \times 0.010 \times 2}{0.360}$   
 $= 9.58 \times 10^{-4} \text{ M}$        $= 7.22 \times 10^{-3} \text{ M}$

$Q_{sp} = [\text{Ag}^+][\text{CH}_3\text{COO}^-]$   
 $= (9.58 \times 10^{-4})(7.22 \times 10^{-3})$   
 $= 6.92 \times 10^{-6}$

$Q_{sp} < K_{sp} \therefore \text{no ppt forms.}$

10. 250ml of 0.0011 mol/L  $\text{Al}_2(\text{SO}_4)_3$  is added to 50ml of 0.022M  $\text{BaCl}_2$ . Does a precipitate form? Include a balanced chemical equation for the formation of the possible precipitate.  $K_{sp}$  for  $\text{BaSO}_4$  is  $1.08 \times 10^{-10}$ . [6 marks]



$\text{Al}_2(\text{SO}_4)_3$  contributes  $3[\text{SO}_4^{2-}]$   
 $[\text{SO}_4^{2-}] = \frac{0.250 \times 0.0011}{0.300} \times 3$   
 $= 2.75 \times 10^{-3} \text{ M}$

$\text{BaCl}_2$  contributes  $[\text{Ba}^{2+}]$   
 $[\text{Ba}^{2+}] = \frac{0.050 \times 0.022}{0.300}$   
 $= 3.67 \times 10^{-3} \text{ M}$

$Q_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$   
 $= (3.67 \times 10^{-3})(2.75 \times 10^{-3})$   
 $= 1.01 \times 10^{-5}$

$Q_{sp} > K_{sp} \therefore \text{ppt will form}$