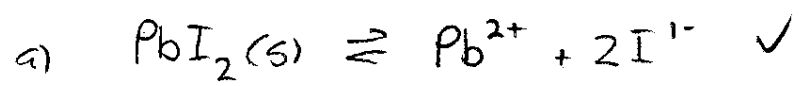


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Name: _____

SCH 4U
K_{sp} Test

1. Using the K_{sp} value for PbI₂ found in the attached table, calculate:
- the solubility in mol/L for PbI₂
 - the concentration of Pb²⁺ ion in a saturated solution of lead iodide in parts per million (Note: Parts per million or p.p.m. is a common unit for expressing small amounts of solute, ionic or otherwise. The unit p.p.m is a short form of the composite unit mg/L)



Let s represent the solubility ✓

$[Pb^{2+}] = s$ ✓

$[I^{-}] = 2s$ ✓

$K_{sp} = [Pb^{2+}][I^{-}]^2$ ✓

$7.1 \times 10^{-9} = s(2s)^2$ ✓

$7.1 \times 10^{-9} = 4s^3$

$s = 1.21 \times 10^{-3} \text{ mol/L}$ ✓

b)
$$\frac{1.21 \times 10^{-3} \text{ mol PbI}_2}{1 \text{ L}} \times \frac{1 \text{ mol Pb}^{2+}}{1 \text{ mol PbI}_2} \times \frac{207.2 \text{ g Pb}^2}{1 \text{ mol Pb}^2} \times \frac{1000 \text{ mg}}{1 \text{ g}}$$

$\checkmark \qquad \checkmark \qquad \checkmark \qquad \checkmark$

$= \frac{251 \text{ mg}}{1 \text{ L}}$ ✓

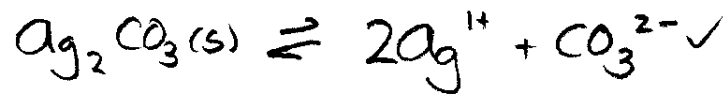
∴ 251 p.p.m. Pb²⁺ ✓

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2. Determine the $[Ag^+]$ in M needed to just begin precipitate formation in a solution that has an carbonate ion concentration equal to 0.0001 M (i.e. $[CO_3^{2-}] = 0.0001$ M)



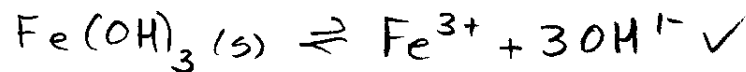
$$K_{sp} = [Ag^+]^2 [CO_3^{2-}] \checkmark$$

$$[Ag^+] = \sqrt{\frac{K_{sp}}{[CO_3^{2-}]}} \checkmark$$

$$[Ag^+] = \sqrt{\frac{8.2 \times 10^{-12}}{0.0001}}$$

$$[Ag^+] = 2.86 \times 10^{-4} \text{ M} \checkmark$$

3. Calculate the K_{sp} value for $Fe(OH)_3$ given that the solubility of ferric hydroxide is 2.17×10^{-10} mol/L. Use the table of K_{sp} values for confirmation purposes only.



$$[Fe^{3+}] = 2.17 \times 10^{-10} \text{ M} \checkmark$$

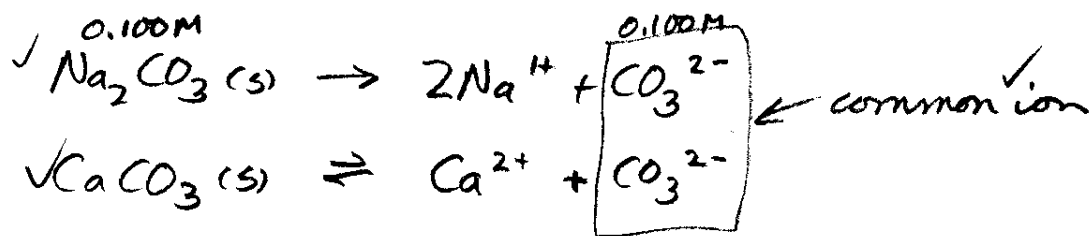
$$[OH^-] = 3(2.17 \times 10^{-10} \text{ M}) \\ = 6.51 \times 10^{-10} \text{ M} \checkmark$$

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

$$K_{sp} = (2.17 \times 10^{-10})(6.51 \times 10^{-10})^3$$

$$K_{sp} = 5.98 \times 10^{-38} \checkmark$$

4. Determine the solubility of CaCO_3 in a solution of 0.100 M Na_2CO_3 . Given your answer, determine the mass of CaCO_3 in mg that would be required to saturate 750 mL of the sodium carbonate solution.



Let s represent the solubility of CaCO_3 ✓

$$\therefore [\text{Ca}^{2+}] = s \quad \checkmark$$

$$[\text{CO}_3^{2-}] = s + 0.1 \quad \checkmark$$

$$K_{sp} = [\text{Ca}^{2+}][\text{CO}_3^{2-}] \quad \checkmark$$

$$4.8 \times 10^{-9} = s(s + 0.1) \quad \checkmark$$

assume $s \ll 0.1$

$$\therefore 4.8 \times 10^{-9} = s(0.1)$$

$$s = 4.8 \times 10^{-8} \text{ mol/L} \quad \checkmark \checkmark \quad \therefore \text{assumption was valid}$$

$$750 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{4.8 \times 10^{-8} \text{ mol CaCO}_3}{1 \text{ L}} \times \frac{100.09 \text{ g CaCO}_3}{1 \text{ mol CaCO}_3} \times \frac{1000 \text{ mg}}{1 \text{ g}}$$

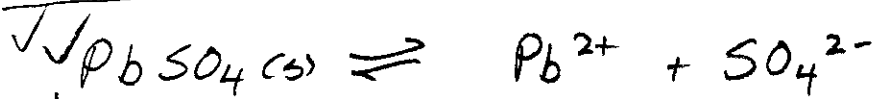
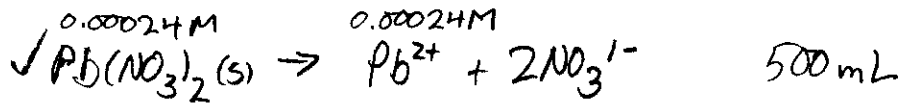
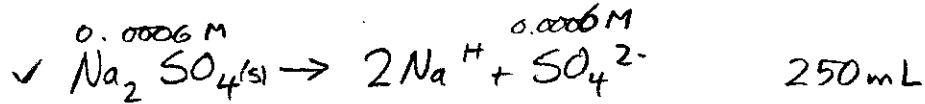
$$= 0.0036 \text{ mg} \quad \checkmark$$

or 3.6 μg

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0.00024 M $Pb(NO_3)_2$. May I suggest use of a table for your solution.



initial []	N.A.	/	/
Initial amount	0 ✓	$n = CV$ $n = 0.00024 \times 0.5$ $n = 0.00012\text{ mol}$	$n = CV$ $n = 0.0006 \times 0.25$ $n = 0.00015\text{ mol}$
Final amount	x ✓	$0.00012 - x$	$0.00015 - x$
Final []	N.A.	$\frac{0.00012 - x}{0.75}$	$\frac{0.00015 - x}{0.75}$

750 mL

↳ 0.75 L ✓

Let x represent the amount of $PbSO_4$ that forms

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

$$1.6 \times 10^{-8} = \left(\frac{0.00012 - x}{0.75} \right) \left(\frac{0.00015 - x}{0.75} \right) \checkmark$$

$$9 \times 10^{-9} = 1.8 \times 10^{-8} - 2.7 \times 10^{-4} x + x^2$$

$$0 = x^2 - 2.7 \times 10^{-4} x + 9 \times 10^{-9}$$

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

$$x = \frac{2.7 \times 10^{-4} \pm \sqrt{(2.7 \times 10^{-4})^2 - 4(1)(9 \times 10^{-9})}}{2(1)}$$

$$x = \frac{2.7 \times 10^{-4} \pm 1.92 \times 10^{-4}}{2}$$

∴ $x = 2.3 \times 10^{-4}\text{ mol}$
extremes
(too large)
or $x = 3.895 \times 10^{-5}\text{ mol}$

$$3.895 \times 10^{-5}\text{ mol } PbSO_4$$

$$\times \frac{303.27\text{ g } PbSO_4}{1\text{ mol } PbSO_4} \checkmark$$

$$\times \frac{1000\text{ mg}}{1\text{ g}} \checkmark$$

$$= 11.81\text{ mg } PbSO_4$$

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