Worksheet: Molar Solubilities from Solubility Products

Q1: Which of the following calcium salts is the most soluble, in moles per liter?

Calcium Salt	$Ca(OH)_2$	$CaCO_3$	$CaSO_4 \cdot 2H_2O$	$CaC_2O_4 \cdot H_2O$	$Ca_3(PO_4)_2$
K_{sp}	1.3×10^{-6}	8.7×10^{-9}	6.1×10^{-5}	1.96×10^{-8}	1.3×10^{-32}

A $CaSO_4 \cdot 2H_2O$

B $Ca_3(PO_4)_2$

C $CaC_2O_4 \cdot H_2O$

D $CaCO_3$

E $Ca(OH)_2$

Q2: Solutions of Hg_2I_2 contain Hg_2^{2+} and I^- ions. What is the molar solubility of Hg_2I_2, given that its solubility product, K_{sp}, is 4.5×10^{-29}? Assume that dissolution is the only process affecting the value of K_{sp}.

A 3.7×10^{-9} M

B 2.2×10^{-10} M

C 1.4×10^{-10} M

D 4.1×10^{-9} M

E 3.6×10^{-10} M

Q3: What is the molar solubility of $Ag_4[Fe(CN)_6]$, a salt containing the $[Fe(CN)_6]^{4-}$ ion, given that its solubility product, K_{sp}, is 1.55×10^{-41}? Assume that dissolution is the only process affecting the value of K_{sp}.

A 2.27×10^{-9} M

B 9.38×10^{-11} M

C 3.21×10^{-8} M

D 1.57×10^{-11} M

E 6.89×10^{-9} M

Q4: What is the molar solubility of PbI_2, given that its solubility product, K_{sp}, is 1.4×10^{-8}? Assume that dissolution is the only process affecting the value of K_{sp}.

A 1.5×10^{-3} M

B 7.0×10^{-4} M

C 2.4×10^{-3} M

D 8.0×10^{-3} M

E 1.2×10^{-4} M

Q5: What is the molar solubility of aluminum hydroxide, $Al(OH)_3$, in a 0.015 M solution of aluminum nitrate, $Al(NO_3)_3$? The K_{sp} of $Al(OH)_3$ is 2×10^{-32}.

A 4×10^{-11} M

B 1×10^{-10} M

C 8×10^{-9} M

D 2×10^{-11} M

E 2×10^{-10} M

Q6: What is the molar solubility of cadmium sulfide (CdS) in a 0.010 M solution of cadmium bromide ($CdBr_2$)? The K_{sp} of CdS is 1.0×10^{-28}.

A 1.0×10^{-22} M

B 1.0×10^{-24} M

C 1.0×10^{-26} M

D 1.0×10^{-30} M

E 1.0×10^{-28} M

Q7: What is the molar solubility of MgF_2 if its solubility product, K_{sp}, is 6.4×10^{-9}?

A 8.0×10^{-4} M

B 1.5×10^{-3} M

C 2.3×10^{-3} M

D 1.9×10^{-3} M

E 1.2×10^{-3} M

Q8: Calomel, Hg_2Cl_2, is a compound composed of the diatomic ion of mercury(I), ${Hg_2}^{2+}$, and chloride ions, Cl^-. Although most mercury compounds are now known to be poisonous, eighteenth-century physicians used calomel as a medication. Their patients rarely suffered any mercury poisoning from the treatments because calomel is quite insoluble:

$$Hg_2Cl_2(s) <=> {Hg_2}^{2+}(aq) + 2\,Cl^-(aq), \quad K_{sp} = 1.1 \times 10^{-18}.$$

What is the molar solubility of Hg_2Cl_2?

A 8.2×10^{-7} M

B 1.0×10^{-6} M

C 6.5×10^{-7} M

D 1.3×10^{-6} M

E 1.6×10^{-6} M

Q9: The K_{sp} of lead(II) iodide, PbI_2, is 1.4×10^{-8}. What is the molar solubility of lead(II) iodide?

A 1.5×10^{-3} M

B 1.2×10^{-4} M

C 1.9×10^{-4} M

D 2.0×10^{-8} M

E 2.4×10^{-3} M

Q10: The K_{sp} of copper(I) bromide, CuBr, is 6.3×10^{-9}. What is the molar solubility of copper bromide?

A 4.0×10^{-17} M

B 7.9×10^{-5} M

C 6.3×10^{-9} M

D 3.2×10^{-9} M

E 1.8×10^{-3} M

Q11: The K_{sp} of silver iodide, AgI, is 1.5×10^{-16}. What is the molar solubility of silver iodide?

A 1.2×10^{-8} M

B 3.4×10^{-24} M

C 5.3×10^{-6} M

D 1.5×10^{-16} M

E 2.3×10^{-32} M

Q12: The K_{sp} of calcium hydroxide, $Ca(OH)_2$, is 1.3×10^{-6}. What is the molar solubility of calcium hydroxide?

A 6.9×10^{-3} M

B 1.1×10^{-3} M

C 1.3×10^{-6} M

D 1.1×10^{-2} M

E 8.7×10^{-6} M

Q13: Most barium compounds are very poisonous; however, barium sulfate is often administered internally as an aid in the X-ray examination of the lower intestinal tract. This use of $BaSO_4$ is possible because of its low solubility. To 3 significant figures, what is the mass of barium present in 1.75 L of water saturated with $BaSO_4$? The K_{sp} for $BaSO_4$ is 2.30×10^{-8}.

A 2.08×10^{-2} g

B 6.19×10^{-2} g

C 3.64×10^{-2} g

D 4.11×10^{-2} g

E 5.91×10^{-2} g

Q14: The K_{sp} of $NiCO_3$ is $1.36{\times}10^{-7}$. What is the minimum volume of water needed to dissolve 0.100 g of $NiCO_3$?

A 0.543 L

B 2.28 L

C 1.45 L

D 7.82 L

E 15.4 L

Q15: The K_{sp} of silver(I) bromide (AgBr) is 5.0×10^{-13}. What is the molar solubility of AgBr in a 0.025 M aqueous solution of NaBr?

A 6.1×10^{-11} M

B 1.7×10^{-7} M

C 2.0×10^{-11} M

D 5.0×10^{-13} M

E 7.0×10^{-6} M

Q16: The K_{sp} of milk of magnesia ($Mg(OH)_2$) is 7.1×10^{-12}. How many grams of milk of magnesia would be soluble in 200 mL of water at 25°C?

A 9.1×10^{-2} g

B 6.0×10^{-2} g

C 1.4×10^{-3} g

D 3.8×10^{-2} g

E 4.1×10^{-4} g

Q17: The K_{sp} of zinc(II) cyanide ($Zn(CN)_2$) is 3.0×10^{-16} and the molar mass is 117.44 g/mol. How many grams of $Zn(CN)_2$ would be soluble in 125 mL of water?

- A 6.2×10^{-5} g
- B 4.4×10^{-7} g
- C 5.0×10^{-4} g
- D 5.3×10^{-7} g
- E 7.0×10^{-12} g

Q18: Two hypothetical salts, LM_2 and LQ_3, have the same molar solubility in water. If K_{sp} of LM_2 is 3.20×10^{-5}, what is the K_{sp} of LQ_3?

- A 8.39×10^{-7} M
- B 1.09×10^{-7} M
- C 4.32×10^{-6} M
- D 5.61×10^{-7} M
- E 1.02×10^{-6} M

Q19: What is the molar solubility of $BaSO_4$ in a 0.250 M solution of $NaHSO_4$?
Take $K_{sp}(BaSO_4) = 2.3 \times 10^{-8}$ and $K_a(HSO_4^-) = 1.2 \times 10^{-2}$.

- A 8.7×10^{-3} M
- B 4.7×10^{-7} M
- C 9.2×10^{-8} M
- D 2.3×10^{-8} M
- E 1.5×10^{-4} M

Q20: What is the molar solubility of $Tl(OH)_3$ in a 0.15 M solution of NH_3?
Take $K_{sp}(Tl(OH)_3) = 6.3 \times 10^{-46}$ and $K_b(NH_3) = 1.8 \times 10^{-5}$.

- A 2.5×10^{-23} M
- B 6.9×10^{-18} M
- C 1.4×10^{-37} M
- D 2.1×10^{-43} M
- E 7.6×10^{-33} M

Q21: The acid dissociation constant, K_a, of HF is 7.2×10^{-4} and the solubility product, K_{sp}, of CaF_2 is 4.0×10^{-11}. Calculate, to 2 significant figures, the molar solubility of CaF_2 in a 0.125 M solution of HF.

A 3.6×10^{-7} M

B 5.4×10^{-7} M

C 4.4×10^{-7} M

D 4.8×10^{-7} M

E 4.2×10^{-7} M

Q22: The solubility product, K_{sp}, of $Pb(OH)_2$ is 1.2×10^{-15} and the base dissociation constant, K_b, of CH_3NH_2 is 4.4×10^{-4}. Calculate, to 2 significant figures, the molar solubility of $Pb(OH)_2$ in a 0.138 M solution of CH_3NH_2.

A 2.1×10^{-11} M

B 1.6×10^{-13} M

C 9.8×10^{-16} M

D 1.7×10^{-15} M

E 3.5×10^{-8} M

Q23: The acid dissociation constant, K_a, of HF is 6.8×10^{-4} and the solubility product, K_{sp}, of BaF_2 is 2.4×10^{-5}. Calculate, to 2 significant figures, the molar solubility of BaF_2 in a buffer solution containing 0.15 M HF and 0.25 M NaF.

A 7.7×10^{-8} M

B 1.4×10^{-2} M

C 5.6×10^{-6} M

D 9.6×10^{-5} M

E 3.8×10^{-4} M