DPP SOLUTION

- Subject – Physical Chemistry
- Chapter – Ionic Equilibrium

DPP No.- 04

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Question-

The solubility product of a salt having general formula MX_2, in water is 4×10^{-12}. The concentration of M^{2+} ions in the aqueous solution of the salt is

(1) 2.0×10^{-6} M

(2) 1.0×10^{-4} M

(3) 1.6×10^{-4} M

(4) 4.0×10^{-10} M

$K_{sp}(A_x B_y)$

$K_{sp}(MX_2) = 4 \times 10^{-12}$

$[M^{2+}] = S$

$1MX_2 + H_2O \rightleftharpoons 1M^{2+} + 2X^-$

$S \qquad\qquad S$

$K_{sp}(MX_2) = x^x y^y (S)^{x+y}$

$x = 1$

$y = 2$

$= (1)^1 (2)^2 (S)^{1+2}$

$= \cancel{4}S^3 = \cancel{4} \times 10^{-12}$

$S = (10^{-12})^{1/3}$

$S = 10^{-4}$ M $= [M^{2+}]$

Ans. (2)

Question-

Let the solubility of an aqueous solution of $Mg(OH)_2$ be x then its k_{sp} is

$S = x$ $\quad Mg(OH)_2 \quad x = 1, y = 2$

$K_{sp} = (x)^x (y)^y (S)^{x+y}$

$= (1)^1 (2)^2 (S)^{1+2}$

$= 4S^3$

$= 4x^3$

(1) $4x^3$

(2) $108x^5$

(3) $27x^4$

(4) $9x$

Ans. (1)

Question-

The solubility in water of a sparingly soluble salt AB_2 is 1.0×10^{-5} mol L^{-1}. Its solubility product will be

(1) 4×10^{-15}

(2) 4×10^{-10}

(3) 1×10^{-15}

(4) 1×10^{-10}

$S = 10^{-5}$ M

$K_{sp} = (1)^1 (2)^2 (S)^{x+y}$

$\underline{A}\,\underline{B_2}$

$x = 1$

$y = 2$

$= 4S^3 = 4(10^{-5})^3$

$K_{sp} = 4 \times 10^{-15}$

Ans. (1)

Question-

Solid $BaCO_3$ is gradually dissolved in a 1.0×10^{-4} M Na_2CO_3 solution. At what concentration of Ba^{+2} will a precipitate begin to form? (K_{sp} ; $BaCO_3 = 5.1 \times 10^{-9}$)

1. 4.1×10^{-5} M
2. 5.1×10^{-5} M
3. 8.1×10^{-8} M
4. 8.1×10^{-7} M

$BaCO_3$

S.S.S

Na_2CO_3

S.E.

$[Ba^{2+}] = ?$

$K_{sp}(BaCO_3) = [Ba^{2+}][CO_3^{2-}]$ Na_2CO_3

$5.1 \times \cancel{10^{-9}}^{\,10^{-5}} = [Ba^{2+}](\cancel{10^{-4}})$

$[Ba^{2+}] = 5.1 \times 10^{-5}$ M

Ans. (2)

Question-

Which is the correct representation of the solubility product constant of Ag_2CrO_4

1. $[Ag^+]^2\,[CrO_4^{-2}]$
2. $[Ag^+]\,[CrO_4^{-2}]$
3. $[2Ag^+]\,[CrO_4^{-2}]$
4. $[2Ag^+]^2\,[CrO_4^{-2}]$

$$Ag_2CrO_4 + H_2O \rightleftharpoons 2Ag^+ + 1\,CrO_4^{2-}$$

$$K_{sp} = [Ag^+]^2\,[CrO_4^{2-}]^1$$

Ans. (1)

Question-

Zirconium phosphate $[Zr_3(PO_4)_4]$ dissociates into three zirconium cations of charge +4 and four phosphate anions of charge −3 . If molar solubility of zirconium phosphate is denoted by S and its solubility product by K_{sp} then which of the following relationship between S and K_{sp} is correct?

1. $S = \{K_{sp}/(6912)^{1/7}\}$
2. $S = (K_{sp}/6912)^{1/7}$
3. $S = \{K_{sp}/144^{1/7}\}$
4. $S = \{K_{sp}/(6912)^{7}\}$

$$Zr_3(PO_4)_4 + H_2O \rightleftharpoons 3Zr^{4+} + 4PO_4^{3-}$$

S $x=3,\ y=4$

$$K_{sp} = x^x y^y (S)^{(x+y)}$$

$$K_{sp} = (3)^3 (4)^4 (S)^{3+4}$$

$$= 27 \times 256 (S)^7$$

$$K_{sp} = 6912\ S^7$$

$$S^7 = \frac{K_{sp}}{6912}$$

$$S = \left(\frac{K_{sp}}{6912}\right)^{1/7}$$

Ans. (2)

Question-

K_{sp} of $Mg(OH)_2$ is 4.0×10^{-6}. At what minimum pH, Mg^{2+}, ions starts precipitating 0.01 M $MgCl_2$ is:

(1) 2 + log 2

(2) 2 – log 2

(3) 12 + log 2

(4) 12 – log 2

$K_{sp} = 4 \times 10^{-6}$

pH = ?

$[H^+] = ?$

0.01 M $MgCl_2$ → S.E.

$Mg(OH)_2$ → S.S.S

$[H^+] = \frac{K_w}{[OH^-]}$

$K_{sp} = [Mg^{2+}][OH^-]^2$ S.E.

$4 \times 10^{-6} = 10^{-2}[OH^-]^2$

$4 \times 10^{-4} = [OH^-]^2$

$[OH^-] = 2 \times 10^{-2}$ M

pOH = (2 - log 2)

$MgCl_2 \rightarrow Mg^{2+}$

0.01   0.01 $= 10^{-2}$

pH = 14 - pOH

= 14 - 2 + log 2

= 12 + log 2

Ans. (3)

Question-

The pH of an aqueous solution of $Ba(OH)_2$ is 10. If the K_{sp} of $Ba(OH)_2$ is 1×10^{-9}, then the concentration of Ba^{+2} ions in the solution in mol L^{-1} is

(1) 1×10^{-2}

(2) 1×10^{-4}

(3) 1×10^{-1} ✓

(4) 1×10^{-5}

$pH_{Ba(OH)_2} = 10$ $\quad$ $K_{sp}\ Ba(OH)_2 = 10^{-9}$

$\underset{S}{Ba(OH)_2} + H_2O \longrightarrow \underset{S}{Ba^{2+}} + 2OH^-$

$pOH = 14 - pH$

$= 14 - 10 = 4$

$[OH^-] = 10^{-4}\ M$

$[Ba^{2+}] = S$

$K_{sp} = [Ba^{2+}]^1 [OH^-]^2$

$10^{-9} = [Ba^{2+}] (10^{-4})^2$

$10^{-1}\ \cancel{10^{-9}} = [Ba^{2+}]\ \cancel{10^{-8}}$

Ans. (3)

Question-

The K_{sp} for $Cr(OH)_3$ is 1.6×10^{-30}. The molar solubility of this compound in water is

1. $\sqrt[2]{1.6 \times 10^{-30}}$
2. $\sqrt[4]{1.6 \times 10^{-30}}$
3. $\sqrt[4]{\frac{1.6\times10^{-30}}{27}}$
4. $\frac{1.6\times10^{-30}}{27}$

$K_{sp} = 1.6 \times 10^{-30}$ $\quad S = ?$ $\quad x = 1$, $y = 3$

$K_{sp} = x^x y^y (S)^{x+y}$

$1.6\times10^{-30} = (1)^1 (3)^3 (S)^{1+3}$

$1.6\times10^{-30} = 27 S^4$

$S = \left(\frac{1.6\times10^{-30}}{27}\right)^{\frac{1}{4}}$

Ans. (3)

Question-

The molar solubility (in mol L^{-1}) of a sparingly soluble salt MX_4 is s. The corresponding solubility product is K_{sp}. s is given in terms of K_{sp} by the relation

1. $s = \left(\frac{K_{sp}}{128}\right)^{1/4}$
2. $s = \left(\frac{K_{sp}}{256}\right)^{1/5}$
3. $s = (256\,Ksp)^{1/5}$
4. $s = (256\,Ksp)^{1/4}$

$S = ?$

$x = 1,\ y = 4$

$K_{sp} = x^x y^y (S)^{x+y}$

$= (1)^1 (4)^4 (S)^{1+4}$

$K_{sp} = 256\, S^5$

$S^5 = \frac{K_{sp}}{256}$

$S = \left(\frac{K_{sp}}{256}\right)^{\frac{1}{5}}$

Ans. (2)

Question-

The solubility of CaF_2 in water at 20°C is 15.6 mg per dm^3 solution. What will be the solubility product of CaF_2?

$x = 1, y = 2$

1 dm^3

1. 4.0×10^{-4}
2. 8.0×10^{-8}
3. 32.0×10^{-12}
4. None

$K_{sp} = ?$

$S = 15.6 \text{ mg/L}$

$M_{CaF_2} = 40 + 2 \times 19 = 78$

$K_{sp} = x^x y^y (S)^{x+y}$

$= \frac{15.6}{1000} \text{ g/L}$

$= (1)^1 (2)^2 (S)^{1+2}$

$= \frac{\cancel{156}^{2}}{10000 \times \cancel{78}} \text{ mol/L}$

$= 4S^3$

$= 2 \times 10^{-4} \text{ M}$

$= 4 \times (2 \times 10^{-4})^3$

$= 4 \times 8 \times 10^{-12}$

$K_{sp} = 32 \times 10^{-12}$

Ans. (3)

Question-

Given the solubility product A_3B_2 is 2×10^{-30}. What will be the solubility in moles/litre?

1. $(1.85 \times 10^{-32})^{1/5}$
2. $\left(\frac{2 \times 10^{-30}}{108}\right)^{1/5}$
3. $\left(\frac{10-28}{5400}\right)^{1/5}$
4. All

$K_{sp} = x^x y^y (S)^{x+y}$ $\quad x = 3, y = 2$

$2 \times 10^{-30} = (3)^3 (2)^2 (S)^{2+3}$

$= 27 \times 4 \, (S)^5$

$\frac{2 \times 10^{-30}}{108} = S^5$

$S = \left(\frac{2 \times 10^{-30}}{108}\right)^{\frac{1}{5}}$

Ans. (2)

Question-

A salt M_2X_3 dissolves in water such that its solubility is x mole/litre. Its K_{SP} is

1. x^5
2. $6x^2$
3. $108x^5$
4. $6x^5$

$S = x$

$x = 2$

$y = 3$

$K_{sp} = x^x y^y (S)^{x+y}$

$= 2^2 3^3 (S)^{2+3}$

$= 108 (S)^5$

$= 108 x^5$

Ans. (3)

Question-

AgCl $\rightarrow$ S.S.S.

Solubility product of $\cancel{AlCl_3}$ is 2.8×10^{-10} at 25°C. Calculate solubility of the salt in 0.1M $AgNO_3$ solution

S.E.

1. 2.8×10^{-9} mole/litre
2. 2.8×10^{-10} mole/litre
3. 3.2×10^{-9} mole/litre
4. 3.2×10^{-12} mole/litre

$K_{sp} = 2.8 \times 10^{-10}$ $\quad$ $S = ?$

$AgCl + H_2O \rightarrow Ag^+ + Cl^-$
$\qquad\qquad\qquad\qquad S \qquad S$

$K_{sp} = [Ag^+]^1 [Cl^-]^1$

S.E.

$2.8 \times 10^{-10} = 10^{-1} \times [Cl^-]$

$[Cl^-] = 2.8 \times 10^{-9} M = S$

Ans. (1)

Question-

If s is the molar solubility of Ag_2SO_4, then

(1) $3\,[Ag^+] = s$

(2) $[Ag^+] = s$

(3) $[2Ag^+] = s$

(4) $[SO_4^{2-}] = s$

$$\underset{S}{Ag_2SO_4} + H_2O \rightarrow \underset{2S}{2Ag^+} + \underset{S}{1SO_4^{2-}}$$

$[Ag^+] = 2S$

$[SO_4^{2-}] = S$

Ans. (4)

Question-

The aqueous solution of which of the following sulphides would contain maximum concentration of S^{2-} ions.

1. MnS ($K_{sp} = 1.1 \times 10^{-21}$)
$x=1 \; y=1$
2. ZnS ($K_{sp} = 1.1 \times 10^{-23}$)
$x=1, y=1$
3. PbS ($K_{sp} = 1.1 \times 10^{-35}$)
$x=1, y=1$
4. CuS ($K_{sp} = 1.1 \times 10^{-30}$)
$x=1, y=1$

$S = [S^{2-}]$

$K_{sp} = x^x y^y (S)^{x+y}$

$K_{sp} = S^2$

$S = \sqrt[2]{K_{sp}}$

Ans. (1)

Question-

Which of the following salts has maximum solubility

all $x=1, y=1 \Rightarrow K_{sp} = S^2 \Rightarrow S = \sqrt{K_{sp}}$

1. HgS, $K_{sp} = 1.6 \times 10^{-54}$
2. $PbSO_4$, $K_{sp} = 1.3 \times 10^{-8}$
3. ZnS, $K_{sp} = 7.0 \times 10^{-26}$
4. $AgCl$, $K_{sp} = 1.7 \times 10^{-10}$

Ans. (2)

Question-

The necessary condition for saturated solution is $K_{ip} = K_{sp}$

1. Product of ionic concentrations = Solubility product
2. Product of ionic concentrations < solubility product
3. Product of ionic concentrations > solubility product
4. None of the above

Ans. (1)

Question-

Which of the following expressions shows the saturated solution of $PbSO_4$?

1. $K_{sp}\,(PbSO_4) = [Pb^{2+}]^1\,[SO_4^{2-}]^1$
2. $K_{sp}\,(PbSO_4) > [Pb^{2+}]\,[SO_4^{2-}]$
3. $K_{sp}\,(PbSO_4) = [Pb^{+}]\,[SO_4^{-}]$
4. $K_{sp}\,(PbSO_4) < [Pb^{2+}]\,[SO_4^{2-}]$

Ans. (1)

Question-

The correct relation between K_{sp} and solubility for the salt $KAl(SO_4)_2$ is

$x = 1$

$y = 1$

$z = 2$

(1) $4\,s^3$

(2) $4\,s^4$

(3) $27\,s^4$

(4) None

$$K_{sp} = x^x\, y^y\, z^z\, (S)^{x+y+z}$$

$$= (1)^1 (1)^1 (2)^2 (S)^{1+1+2}$$

$$K_{sp} = 4S^4$$

Ans. (2)

Question-

A precipitate of AgCl is formed when equal volumes of the following are mixed. [K_{sp} for AgCl = 10^{-10}]

1. 10^{-4} M $AgNO_3$ and 10^{-7}M HCl
2. 10^{-5}M $AgNO_3$ and 10^{-7}M HCl
3. 10^{-5}M $AgNO_3$ and 10^{-4}M HCl
4. 10^{-6}M $AgNO_3$ and 10^{-6}M HCl

10 Rs. 20 Rs

$\frac{10}{2} = 5$ $\frac{20}{2} = 10$

$K_{ip} > K_{sp} \Rightarrow$ sol^n p.p.t of AgCl

$K_{ip} = [Ag^+][Cl^-]$

$[Ag^+] = 10^{-5} = M_1$

$V_1 = V$ L

$V_2 = 2V$ L

$M_2 = ?$

$M_1 V_1 = M_2 V_2$

$M_2 = \frac{10^{-5} \times V}{2V} = \frac{10^{-5}}{V} = [Ag^+]$ final sol^n

$[Cl^-] = 10^{-4} = M_1'$

$V_1' = V$ L

$V_2' = 2V$ L

$M_2' = \frac{10^{-4} \times V}{2V} = \frac{10^{-4}}{2}$ M

$[Cl^-]$ final sol^n $= \frac{10^{-4}}{2}$

Ans. (3)

$$K_{ip} = \frac{10^{-5}}{2} \times \frac{10^{-4}}{2} = \frac{1}{4} \times 10^{-9} = 0.25 \times 10^{-9}$$

$$K_{ip} = \underline{2.5 \times 10^{-10}}$$

$$K_{sp} = 1 \times 10^{-10}$$

$K_{ip} > K_{sp} \Rightarrow$ sol^n is ppt.

Thank You...