



# DPP SOLUTION

- Subject – Physical Chemistry
- Chapter – Ionic Equilibrium

**DPP No.- 04**



**By – Amit Mahajan Sir**

## Question-



The solubility product of a salt having general formula  $\text{MX}_2$ , in water is  $4 \times 10^{-12}$ .

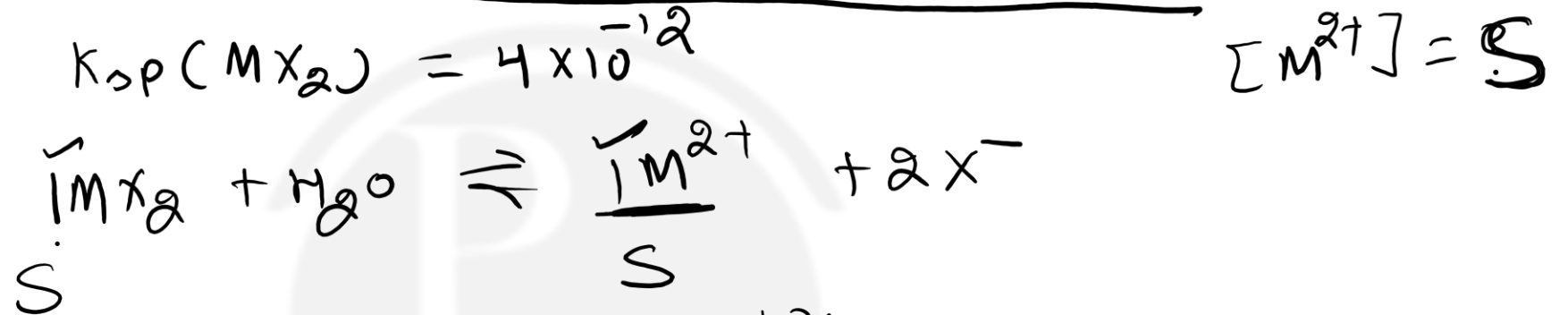
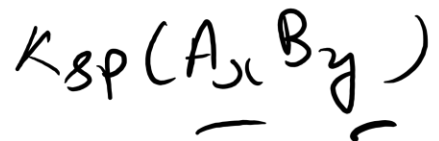
The concentration of  $\text{M}^{2+}$  ions in the aqueous solution of the salt is

①  $2.0 \times 10^{-6} \text{ M}$

✓ ②  $1.0 \times 10^{-4} \text{ M}$

③  $1.6 \times 10^{-4} \text{ M}$

④  $4.0 \times 10^{-10} \text{ M}$



$K_{sp}(\underline{\text{MX}_2}) = x^x y^y (\text{S})^{x+y}$

$x=1$   $y=2$

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

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

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

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

Ans. (2)

## Question-



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

~~1~~  $4x^3$

2  $108x^5$

3  $27x^4$

4  $9x$



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

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

$$= 4S^3$$

$$= 4x^3$$

Ans. (1)

## Question-



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

☒ 1  $4 \times 10^{-15}$

☐ 2  $4 \times 10^{-10}$

☐ 3  $1 \times 10^{-15}$

☐ 4  $1 \times 10^{-10}$

$$S = 10^{-5} \text{ M}$$

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

$$\underline{AB_2} = 4S^3 = 4(10^{-5})^3$$

$$x=1$$
$$y=2$$

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

Ans. (1)

## Question-



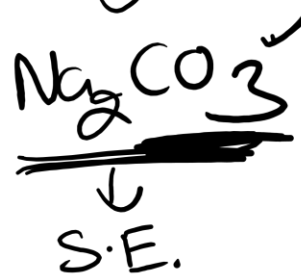
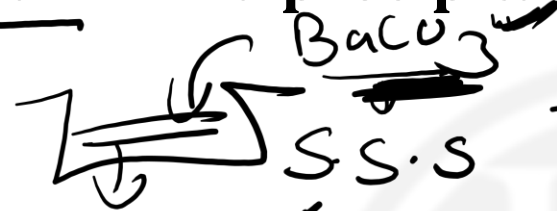
Solid  $\text{BaCO}_3$  is gradually dissolved in a  $1.0 \times 10^{-4} \text{ M}$   $\text{Na}_2\text{CO}_3$  solution. At what concentration of  $\text{Ba}^{2+}$  will a precipitate begin to form? ( $K_{sp}; \text{BaCO}_3 = 5.1 \times 10^{-9}$ )

①  $4.1 \times 10^{-5} \text{ M}$

②  $5.1 \times 10^{-5} \text{ M}$

③  $8.1 \times 10^{-8} \text{ M}$

④  $8.1 \times 10^{-7} \text{ M}$



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

$K_{sp}(\text{BaCO}_3) = [\text{Ba}^{2+}] [\text{CO}_3^{2-}]$

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

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

## Question-



Which is the correct representation of the solubility product constant of  $\text{Ag}_2\text{CrO}_4$



$$K_{sp} = [\text{Ag}^+]^2 [\text{CrO}_4^{2-}]$$

- ☒ 1  $[\text{Ag}^+]^2 [\text{CrO}_4^{-2}]$
- ☐ 2  $[\text{Ag}^+] [\text{CrO}_4^{-2}]$
- ☐ 3  $[2\text{Ag}^+] [\text{CrO}_4^{-2}]$
- ☐ 4  $[2\text{Ag}^+]^2 [\text{CrO}_4^{-2}]$

Ans. (1)

## Question-



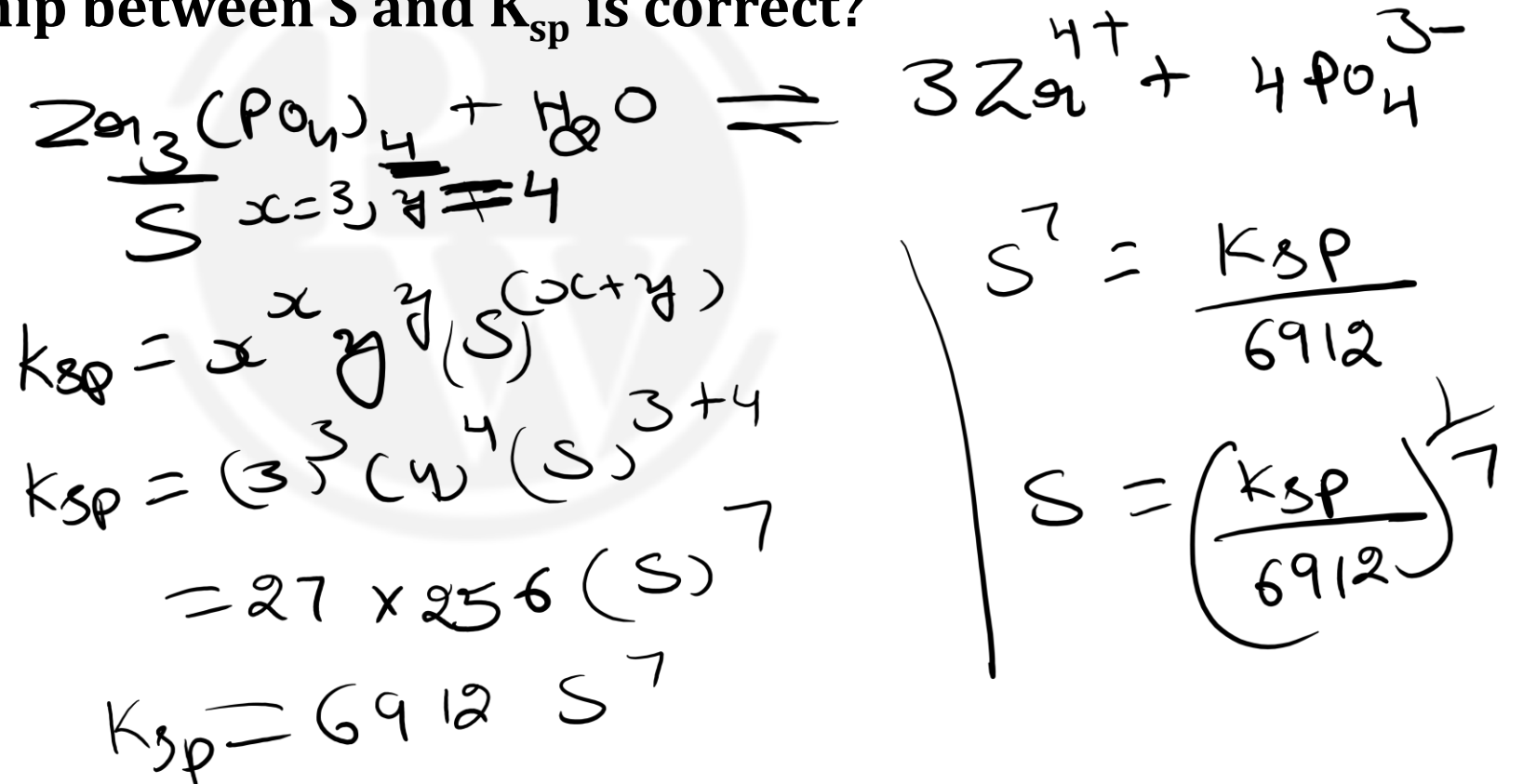
Zirconium phosphate  $[\text{Zr}_3(\text{PO}_4)_4]$  dissociates into three zirconium cations of charge +4 and four phosphate anions of charge -3. If molar solubility of zirconium phosphate is denoted by  $S$  and its solubility product by  $K_{sp}$  then which of the following relationship between  $S$  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  $S = \{K_{sp}/(6912)^7\}$



Ans. (2)

# Question-



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

- 1  $2 + \log 2$
- 2  $2 - \log 2$
- ~~3  $12 + \log 2$~~
- 4  $12 - \log 2$

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

$$pH = ?$$

$$[H^+] = ?$$

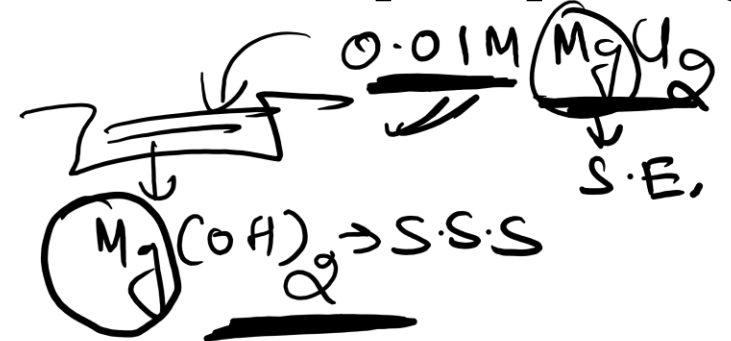
$$K_{sp} = [Mg^{2+}] [OH^-]^2$$

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

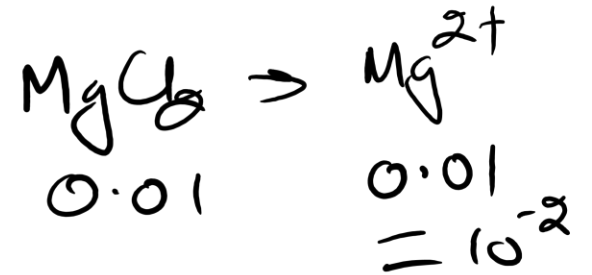
$$4 \times 10^{-4} = [OH^-]^2$$

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

$$pOH = (2 - \log 2)$$



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



$$pH = 14 - pOH$$

$$= 14 - 2 + \log 2$$

$$= 12 + \log 2$$

Ans. (3)



## Question-



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

1  $1 \times 10^{-2}$        $\text{pH Ba(OH)}_2 = 10$        $K_{sp} \text{ Ba(OH)}_2 = 10^{-9}$



3  $1 \times 10^{-1}$

4  $1 \times 10^{-5}$

$$\text{pOH} = 14 - \text{pH}$$
$$= 14 - 10 = 4$$

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

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

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

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

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

Ans. (3)

## Question-



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

$$K_{sp} = 1.6 \times 10^{-30}$$

$$S = ?$$

$$x = 1 \\ y = 3$$

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

$$1.6 \times 10^{-30} = (1)^1 (3)^3 (S)^{1+3}$$

$$1.6 \times 10^{-30} = 27 S^4$$

$$S = \left( \frac{1.6 \times 10^{-30}}{27} \right)^{\frac{1}{4}}$$

1  $\sqrt[2]{1.6 \times 10^{-30}}$

2  $\sqrt[4]{1.6 \times 10^{-30}}$

~~3  $\sqrt[4]{\frac{1.6 \times 10^{-30}}{27}}$~~

4  $\frac{1.6 \times 10^{-30}}{27}$

Ans. (3)

## Question-



The molar solubility (in mol L<sup>-1</sup>) of a sparingly soluble salt MX<sub>4</sub> is s. The corresponding solubility product is K<sub>sp</sub>. s is given in terms of K<sub>sp</sub> by the relation

$$S = ?$$

$$x=1, y=4$$

①  $s = \left(\frac{K_{sp}}{128}\right)^{1/4}$

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

~~②~~  $s = \left(\frac{K_{sp}}{256}\right)^{1/5}$

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

③  $s = (256 K_{sp})^{1/5}$

$$K_{sp} = 256 s^5$$

④  $s = (256 K_{sp})^{1/4}$

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

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

Ans. (2)

## Question-



The solubility of  $\text{CaF}_2$  in water at  $20^\circ\text{C}$  is  $15.6 \text{ mg per dm}^3$  solution. What will be the solubility product of  $\text{CaF}_2$ ?

①  $4.0 \times 10^{-4}$

$K_{sp} = ?$

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

$1 \text{ dm}^3$

$M_{\text{CaF}_2} = 40 + 2 \times 19 = 78$

②  $8.0 \times 10^{-8}$

$K_{sp} = x^x y^y (S)^{x+y} = \frac{15.6}{1000} \text{ g/L}$

③  $32.0 \times 10^{-12}$

$= (1) \cdot 2 (S)^{1+2} = \frac{15.6}{1000} \cdot 2 \text{ mol/L}$

④ None

$= 4S^3$   
 $= 4 \times (2 \times 10^{-4})^3 = 2 \times 10^{-4} \text{ M}$   
 $= 4 \times 8 \times 10^{-12}$   
 $K_{sp} = 32 \times 10^{-12}$

Ans. (3)

## Question-



Given the solubility product  $A_3B_2$  is  $2 \times 10^{-30}$ . 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

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

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

$$= \frac{27 \times 4}{108} (s)^5$$

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

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

Ans. (2)

## Question-



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

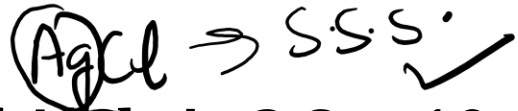
- ①  $x^5$
- ②  $6x^2$
- ☒ ③  $108x^5$
- ④  $6x^5$

$$\begin{aligned} S &= x \\ K_{sp} &= x^2 y^3 (S)^{2+3} \\ &= 2^2 3^3 (S)^{2+3} \\ &= 108 (S)^5 \\ &= 108 x^5 \end{aligned}$$

$$\begin{aligned} x &= 2 \\ y &= 3 \end{aligned}$$

Ans. (3)

## Question-

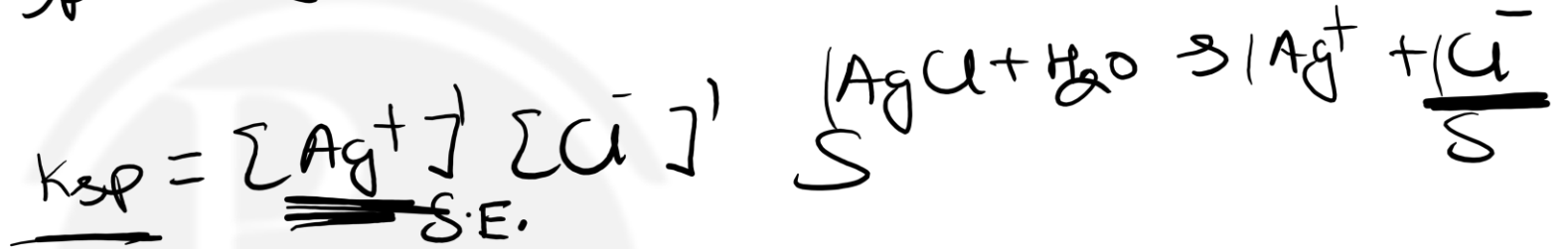


Solubility product of ~~AgCl~~ is  $2.8 \times 10^{-10}$  at  $25^\circ\text{C}$ . Calculate solubility of the salt in  $0.1\text{M AgNO}_3$  solution

S.E.

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

$$S = ?$$



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

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

- 1  $2.8 \times 10^{-9}$  mole/litre
- 2  $2.8 \times 10^{-10}$  mole/litre
- 3  $3.2 \times 10^{-9}$  mole/litre
- 4  $3.2 \times 10^{-12}$  mole/litre

Ans. (1)

## Question-



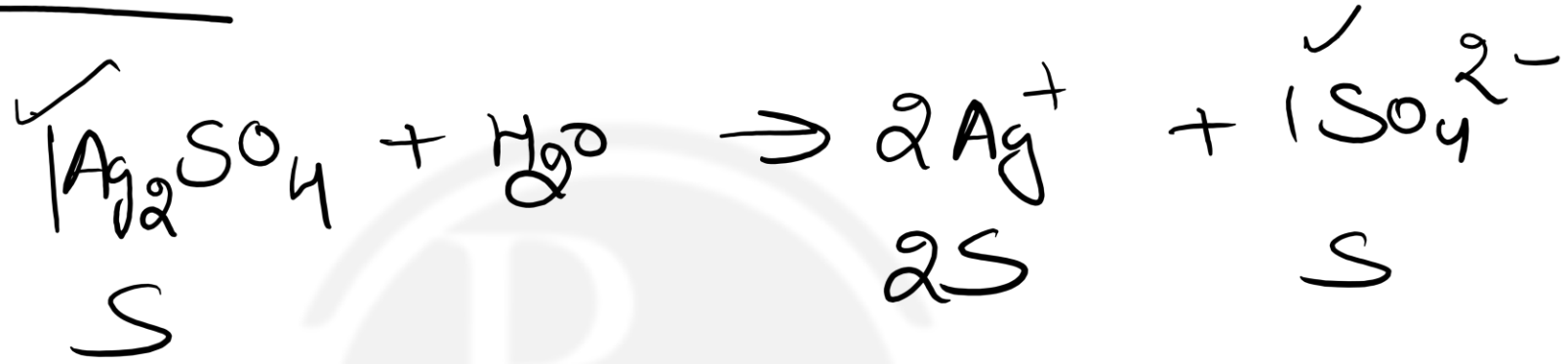
If  $s$  is the molar solubility of  $\text{Ag}_2\text{SO}_4$ , then

1  $3 [\text{Ag}^+] = s$

2  $[\text{Ag}^+] = s$

3  $[2\text{Ag}^+] = s$

~~4~~  $[\text{SO}_4^{2-}] = s$



$$\begin{aligned} [\text{Ag}^+] &= 2s \\ [\text{SO}_4^{2-}] &= s \end{aligned}$$

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 ( $K_{sp} = 1.1 \times 10^{-30}$ )  
 $x=1, y=1$

$$S = [S^{2-}] \quad K_{sp} = x^x y^y (S)^{x+y}$$

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

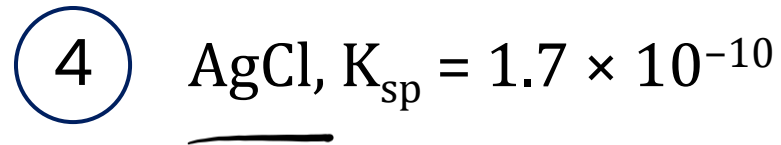
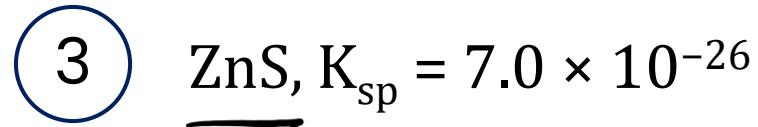
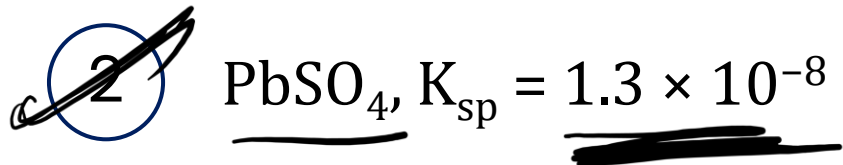
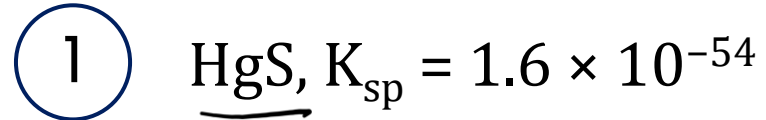
$$S = \sqrt{K_{sp}}$$

## Question-



Which of the following salts has maximum solubility

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



Ans. (2)

## Question-

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

- 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  $\text{PbSO}_4$ ?

✓ 1  $K_{sp} (\text{PbSO}_4) = \underline{[\text{Pb}^{2+}]} \underline{[\text{SO}_4^{2-}]}$

2  $K_{sp} (\text{PbSO}_4) > [\text{Pb}^{2+}] [\text{SO}_4^{2-}]$

3  $K_{sp} (\text{PbSO}_4) = [\text{Pb}^+] [\text{SO}_4^-]$

4  $K_{sp} (\text{PbSO}_4) < [\text{Pb}^{2+}] [\text{SO}_4^{2-}]$

Ans. (1)

## Question-

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

- 1  $4s^3$
- ✓ 2  $4s^4$
- 3  $27s^4$
- 4 None

$$x = 1$$

$$y = 1$$

$$z = 2$$

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

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

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

## Question-



A precipitate of AgCl is formed when equal volumes of the following are mixed.

[ $K_{sp}$  for AgCl =  $10^{-10}$ ]

- 1  $10^{-4} \text{ M AgNO}_3$  and  $10^{-7} \text{ M HCl}$
- 2  $10^{-5} \text{ M AgNO}_3$  and  $10^{-7} \text{ M HCl}$
- 3  $10^{-5} \text{ M AgNO}_3$  and  $10^{-4} \text{ M HCl}$
- 4  $10^{-6} \text{ M AgNO}_3$  and  $10^{-6} \text{ M HCl}$

10 Rs.  
 $\frac{10}{2} = 5$

20 Rs.  
 $\frac{20}{2} = 10$

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

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

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

$V_1 = V_L$

$V_2 = 2V_L$

$M_2 = ?$

$M_1 V_1 = M_2 V_2$

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

$[\text{Cl}^-] = 10^{-4} = M_1'$   
 $V_1' = V_L$

$V_2' = 2V_L$

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

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

Ans. (3)

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

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

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

$K_{ip} > K_{sp} \Rightarrow \text{sol}^n \text{ is p.p.t.}$





**Thank**

*You...*

