YAKEEN NEET 2.0

2026

Ionic Equilibrium

Physical Chemistry | Lecture -07

By- Amit Mahajan Sir

Topics to be covered

1. Medics Test, Revision of Last Class
2. Salt Hydrolysis numericals
3. Solubility Product, Ionic Product
4. Magarmach Practice questions, Home work from modules

Rule to Attend Class

1. Always sit in a peaceful environment with headphone and be ready with your copy and pen.
2. Never ever attend a class from in between or don't join a live class in the middle of the chapter.
3. Make sure to revise the last class before attending the next class & always complete your home work along with DPP.
4. Never ever engage in chat whether live or recorded on the topic which is not being discussed in current class as by doing so u can be blocked by the admin team or your subscription can be cancelled.

Rule to Attend Class

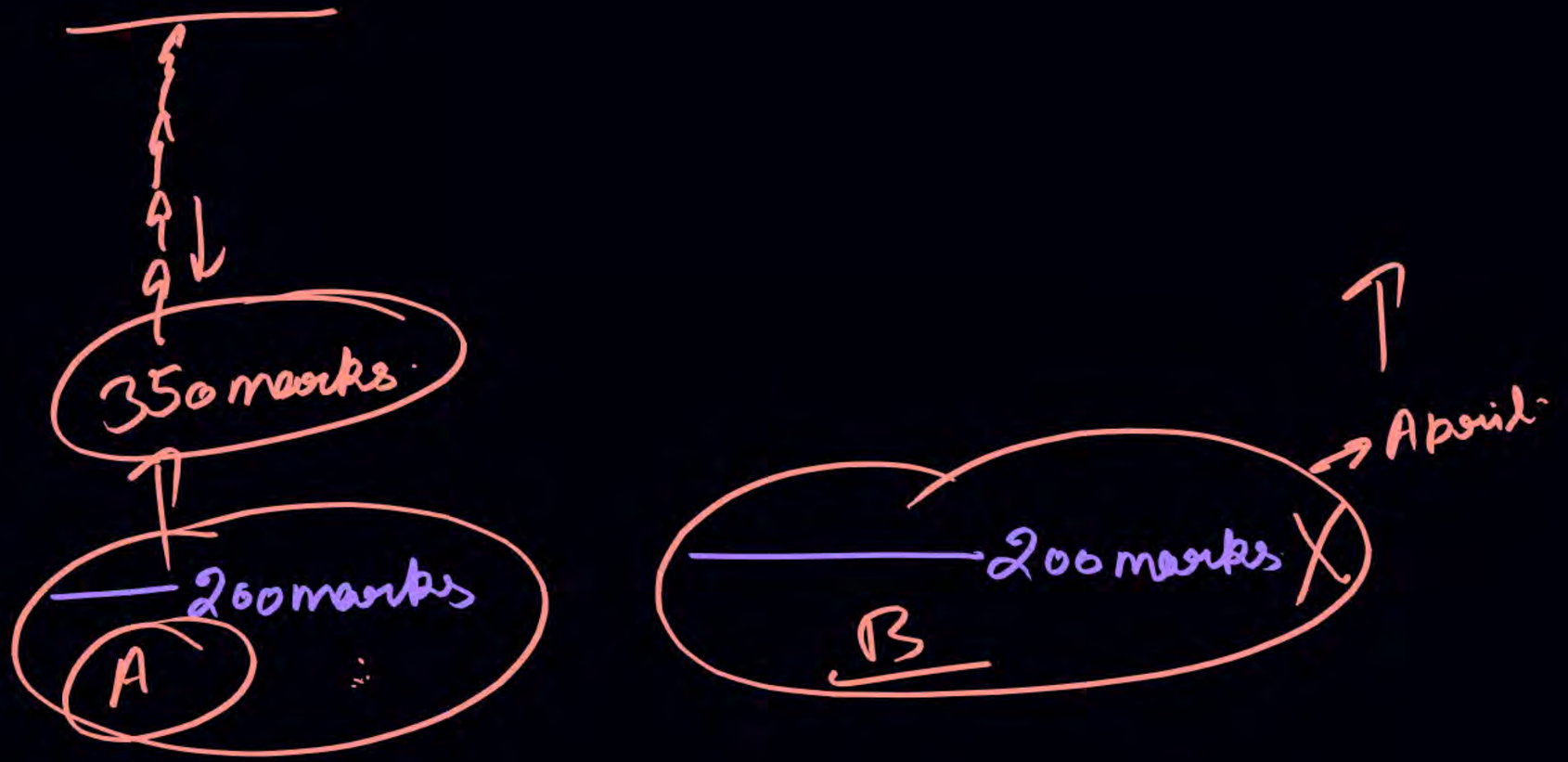
5. Try to make maximum notes during the class if something is left then u can use the notes pdf after the class to complete the remaining class.
6. Always ask your doubts in doubt section to get answer from faculty. Before asking any doubt please check whether same doubt has been asked by someone or not.
7. Don’t watch the videos in high speed if you want to understand better.


There is one big flaw in your Preparation that's name is Backlog ? What do we say to Backlog ?
NOT TODAY !!!

★ ★ ★ ★ ★ Trick

Next test → Ionic eq. + Electrochemistory

Tuesday Revise → Lec. 1 + Lec-2 → Ionic eq → MEDICS test
Tomorrow


350 marks
200 marks
A
200 marks
B
Absent

Revision of Last Class

Salt hydrolysis

QUESTION

Which of the following salts is the most basic in aqueous solution?

↓

Anion hydrolysis

(A) $Al(CN)_3$

(B) CH_3COOK

(C) $FeCl_3$

(D) $Pb(CH_3COO)_2$

QUESTION – (NEET 2014)

Which of the following salts will give highest pH in water?

highest pH → most Basic → Anionic hydrolysis

(A) $NaCl$ ✗

(B) Na_2CO_3 ✓

(C) $CuSO_4$ ✗

(D) KCl ✗

QUESTION

The pH of a 0.02 M NH_4Cl solution will be [Given $K_b(NH_4OH) = 10^{-5}$ and log2 = 0.301]

A 4.65

B 2.65

C 5.35

D 4.35

$C = 0.02\,M$ ↓ NH_4Cl ↓ Salt · SA + W · B

$HCl + NH_4^+OH$

$pK_b = -\log 10^{-5}$

$= 5 \log 10$

$= 5$

$pH = 7 - \frac{1}{2}(pK_b + \log C)$

$= 7 - \frac{1}{2}(5 + \log 2 \times 10^{-2})$

$= 7 - \frac{1}{2}(5 - 2 + 0.3)$

$= 7 - \frac{1}{2}(3.3) = 7 - 1.65 = 5.35$

$[H^+] = a \times 10^{-x}$

$pH = -\log [H^+]$

$pH = x - \log a$

$\log 2 \times 10^{-2}$

$-2 + \log 2$

QUESTION – (NEET 2021)

The pK_b of dimethylamine and pK_a of acetic acid are 3.27 and 4.77 respectively at T(K). The correct option for the pH of dimethylammonium acetate solution is:

A. 5.50

B. 7.75

C. 6.25

D. 8.50

$$pH = 7 + \frac{1}{2}(pK_a - pK_b)$$

$$= 7 + \frac{1}{2}(4.77 - 3.27)$$

$$= 7 + \frac{1}{2} \times 1.5 = 7.75$$

QUESTION

pH of 0.005 M calcium acetate (pK_a of CH_3COOH = 4.74) is

A 7.04

B 9.37

C 9.26

D 8.37

$pH = 7 + \frac{1}{2}(pK_a + \log C)$ → C = Conc. of ion which is hydrolyzed.

$= 7 + \frac{1}{2}(4.74 + \log 10^{-2})$

$= 7 + \frac{1}{2}(4.74 - 2)$

$= 7 + \frac{1}{2} \times 2.74$

$= 7 + 1.37 = 8.37$

$(CH_3COO)_2Ca \rightarrow 1Ca^{2+} + 2CH_3COO^-$

0.005 M

0.005×2

$= 0.01$

$= 10^{-2}$ M

QUESTION – (AIIMS 2007)

The pH of the solution obtained on neutralization of 40 mL 0.1 M NaOH with 40 mL 0.1 M CH_3COOH is:

A) 7

B) 8

C) 6

D) 3

$(pK_a = 4.74)$

$CH_3COOH + NaOH \rightarrow CH_3COO^-Na^+ + H_2O$

milli eq: $40 \times 0.1 \times 1$ $\quad$ $40 \times 0.1 \times 1$ $\quad$ 4

4 $\quad$ 4

$[CH_3COO^-Na^+] = [CH_3COO^-] = \frac{4}{80} = \frac{1}{20} = 0.05 = 5 \times 10^{-2}$

$CH_3COO^-Na^+$

$pH = 7 + \frac{1}{2}(pK_a + \log C)$

$= 7 + \frac{1}{2}(4.74 + \log 5 \times 10^{-2})$

$= 7 + \frac{1}{2}(4.74 - 2 + 0.7)$

$= 7 + 1.72$

$= 8.72$

$4.74 + 7 + 5.44$

QUESTION – (NCERT Exemplar)

K_a for CH_3COOH is 1.8×10^{-5} and K_b for NH_4OH is 1.8×10^{-5}. The pH of ammonium acetate will be

A 7.005

B 4.75

C 7.0

D Between 6 and 7

QUESTION

HX is a weak acid ($K_a = 10^{-5}$). If forms a salt NaX (0.1 M) on reacting with caustic soda. The degree of hydrolysis of NaX is:

$$h = \sqrt{\frac{K_h}{C}} = \sqrt{\frac{K_w}{K_a \times C}} = \sqrt{\frac{10^{-14}}{10^{-5} \times 10^{-1}}} = \sqrt{10^{-8}} = 10^{-4}$$

$$\therefore \%\ h = h \times 100 = 10^{-4} \times 100 = 10^{-2}\ \%$$

(A) 0.01%

(B) 0.0001%

(C) 0.1%

(D) 0.5%

QUESTION – (AIPMT 2009)

The ionization constant of ammonium hydroxide is 1.77×10^{-5} at 298 K. Hydrolysis constant of ammonium chloride is:

(A) 6.50×10^{-12}

(B) 5.65×10^{-13}

(C) 5.65×10^{-12}

(D) 5.65×10^{-10} ✓

$$K_h = \frac{K_w}{K_b} = \frac{10^{-14}}{1.77 \times 10^{-5}} = \frac{1000}{177} \times 10^{-9} \times 100 = 5.65 \times 10^{-10}$$

QUESTION

From separate solutions of four sodium salts NaW, NaX, NaY and NaZ had pH 7.0, 9.0, 10.0 and 11.0 respectively, when each solution was 0.1 M, the weakest acid is:

(A) HW

(B) HX

(C) HY

(D) HZ

$A^- + H_2O \rightarrow H\text{-}A + OH^-$ ↑ pH ↑

Anion of w.A

HZ → weakest acid

QUESTION

What will be the pH and % α (degree of hydrolysis) respectively for the salt BA^{+-} of 0.1 M concentration? Given K_a for HA 10^{-6} and K_b for BOH^{+} = 10^{-6}.

h = α

pH = 7

$h = \sqrt{K_h} = \sqrt{\frac{K_w}{K_a \times K_b}} = \sqrt{\frac{10^{-14}}{10^{-6} \times 10^{-6}}}$

$= \sqrt{10^{-2}} = 10^{-1}$

% age $h = 10^{-1} \times 100 = 10\%$

(A) 5, 19%

(B) 7, 10%

(C) 9, 0.01%

(D) 7, 0.01%

QUESTION – (AIIMS 2006)

40 mL of 0.1 M ammonia solution is mixed with 40 mL of 0.1 M HCl. What is the pH of the mixture? (pK_b of ammonia solution is 4.74).

A. 4.74

B. 2.26

C. 9.26

D. 5.00

$pH = 7 - \frac{1}{2}(pK_b + \log C)$

$= 7 - \frac{1}{2}(4.74 + \log 5 \times 10^{-2})$

$= 7 - \frac{1}{2}(4.74 - 2 + 0.7)$

$= 7 - \frac{1}{2}(4.74 - 1.3)$

$= 7 - \frac{1}{2}(3.44) = 7 - 1.72 = 5.28$

$C = [NH_4^+] = \frac{M_0 \times 0.1 \times 1}{80}$

$= \frac{4}{80} = \frac{1}{20}$

$= 0.05$

$= 5 \times 10^{-2}$

QUESTION

$NH_4^+ CH_3COO^-$

A 100 mL 0.1 M solution of ammonium acetate is diluted by adding 100 mL of water. The pH of the resulting solution will be (pK_a of acetic acid is nearly equal to pK_b of NH_4OH):

$M_d = 0.05\ M$

(A) 4.9

(B) 5.0

(C) 7.0 ✓

(D) 10.0

Jan 23 2025

$C_2H_5NH_2$

$pOH = 5 \Rightarrow [OH^-] = 10^{-5} = C\alpha$

Q. If 1mM soln of ethylamine produces pH = 9 then $K_b = 10^{-x}$.

Value of x = ?

if $\alpha <<< 1$

Ans $C_2H_5NH_2 + H_2O \rightarrow C_2H_5NH_3^+ + OH^-$

$K_b = C\alpha^2$

$10^{-x} =$

Solubility Product (K_{sp})

Yakeen batch →

↓

Sparingly soluble salt (SSS)

for eg :- AgCl, $BaSO_4$, $Zn_3(PO_4)_2$, CaF_2

$$AgCl(s) + H_2O(l) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

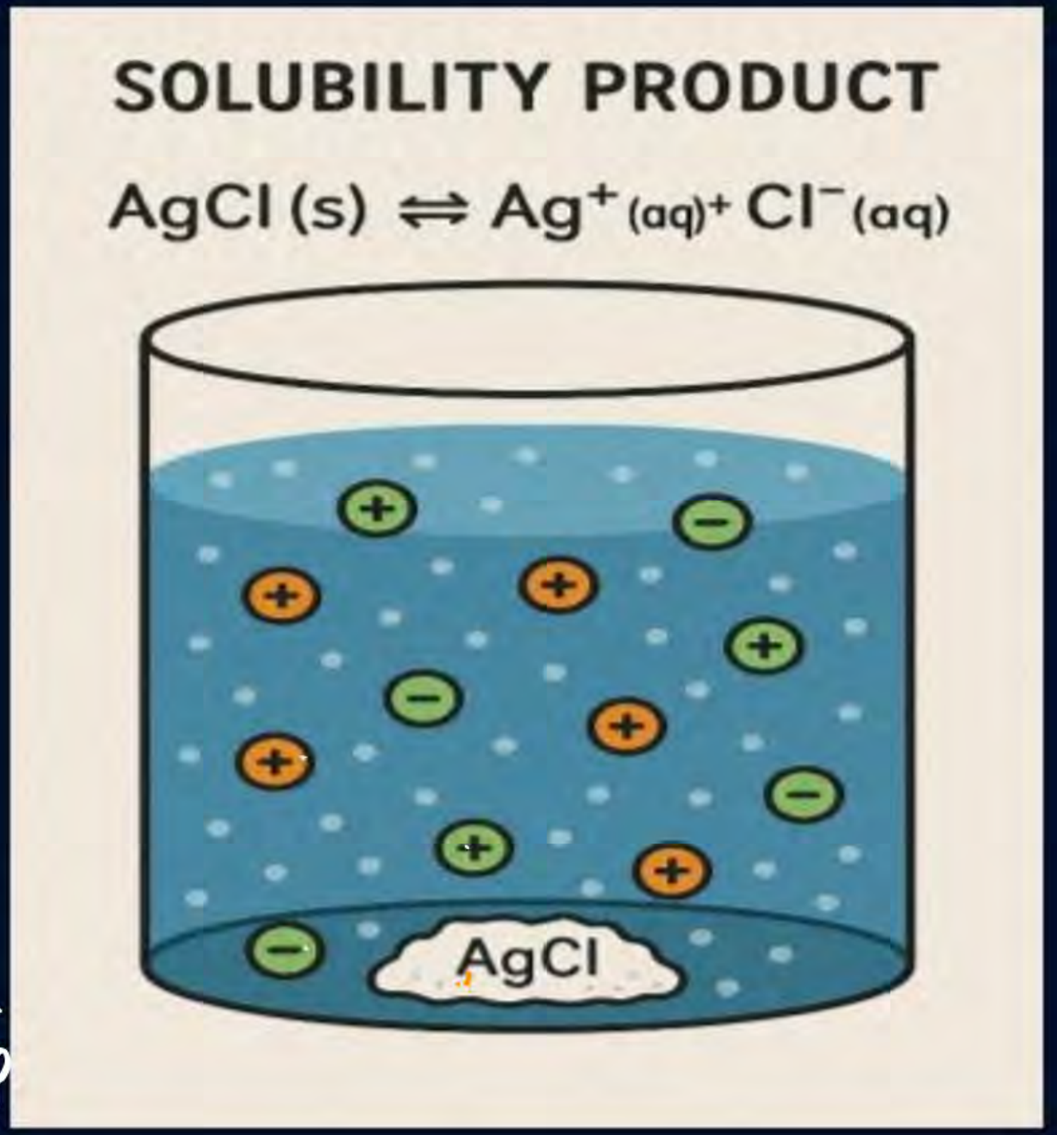
S = Solubility in moles/L

S S

$$K_c = \frac{[Ag^+][Cl^-]}{[AgCl][H_2O]}$$

$$K_c[AgCl][H_2O] = K_{sp} = [Ag^+][Cl^-] = (S)(S)$$

$$K_{sp} = S^2 \Rightarrow S = \sqrt{K_{sp}}$$



$$A_xB_y(s) + H_2O(l) \rightleftharpoons \underset{xs}{x}A^{y+} + \underset{ys}{y}B^{x-}$$

$$K_c = \frac{[A^{y+}]^x[B^{x-}]^y}{[A_xB_y]^1[H_2O]^1}$$

$$K_{sp} = [A^{y+}]^x[B^{x-}]^y$$

$$= (xs)^x(ys)^y$$

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

$$+xy - xy = 0$$

AB $\Rightarrow x=1, y=1$

$$K_{sp} = (1)^1(1)^1(s)^{1+1} = s^2 \Rightarrow s = \sqrt{K_{sp}}$$

A_2B $\Rightarrow x=2, y=1$

$$K_{sp} = (2)^2(1)^1(s)^{2+1} = 4s^3 \Rightarrow s^3 = \frac{K_{sp}}{4} \Rightarrow s = \left(\frac{K_{sp}}{4}\right)^{1/3}$$

AB_2 $\Rightarrow x=1, y=2$

$$K_{sp} = (1)^1(2)^2(s)^{1+2} = 4s^3 \Rightarrow s = \left(\frac{K_{sp}}{4}\right)^{1/3}$$

A_2B_3 $\Rightarrow x=2, y=3$

$$K_{sp} = (2)^2(3)^3(s)^{2+3} = 108s^5$$

$$s^5 = \frac{K_{sp}}{108} \Rightarrow s = \left(\frac{K_{sp}}{108}\right)^{1/5}$$

$AgCl$ $\Rightarrow$ $x=1, y=1$ $\Rightarrow$ $K_{sp} = s^2$ $\Rightarrow$ $s = (K_{sp})^{1/2}$

CuF_2 $\Rightarrow$ $x=1, y=2$ $\Rightarrow$ $K_{sp} = 4s^3$ $\Rightarrow$ $s = \left(\frac{K_{sp}}{4}\right)^{1/3}$

$Zn_3(PO_4)_4$ $\Rightarrow$ $K_{sp} = 6912(s)^7$ $\Rightarrow$ $s = \left(\frac{K_{sp}}{6912}\right)^{1/7}$

$x = 3$

$y = 4$

MIT

① K_{sp} = Solubility product

$A_xB_y + H_2O \rightleftharpoons xA^{y+} + yB^{x-}$

$\qquad\qquad\qquad\quad xS \quad yS$

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

x = no. of Cations in 1 molecule

y = ~~~ anion ~~~

$x+y$ = total no. of ions

S = Solubility in moles/L or M

② In Case of metallic bond don't dissociate in water.

$Hg_2Cl_2(s) + H_2O(l) \rightarrow Hg_2^{2+} + 2Cl^-$

$\qquad\qquad\qquad\qquad\quad S \qquad 2S$

$K_{sp} = (S)^1(2S)^2 = 4S^3$

③ If K_{sp} same

$S \propto$ (total no. of ions)

If total no. of ions same

$K_{sp} \propto S$

QUESTION

Solubility(s) of CaF_2 in terms of its solubility product is given as:

$x=1$
$y=2$

$K_{sp} = (1)^1 (2)^2 (s)^{1+2}$

$K_{sp} = 4s^3$

$s = \left(\frac{K_{sp}}{4}\right)^{1/3}$

A $s = (K_{sp})^{1/3}$

B $s = (K_{sp}/2)^{1/3}$

C $s = (K_{sp}/4)^{1/3}$

D $s = (K_{sp}/2)^{1/2}$

QUESTION JEE Advance PYQ

For a sparingly soluble salt A_pB_q, the relationship of its solubility product (L_s) with its solubility(S) is:

$x = p$

$y = q$

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

$L_s = p^p q^q (s)^{p+q}$

(A) $L_s = S^{p+q} \cdot P^p \cdot Q^q$

(B) $L_s = S^{p+q} \cdot P^q \cdot q^p$

(C) $L_s = S^{pq} \cdot P^p \cdot q^q$

(D) $L_s = S^{pq} \cdot (P \cdot q)^{p+q}$

QUESTION

JEE Mains

If solubility product of $Zr_3(PO_4)_4$ is denoted by K_{sp} and its molar solubility is denoted by S, them which of the following relations between S and K_{sp} is correct?

(A) $S = \left(\frac{K_{sp}}{144}\right)^{1/6}$

(B) $S = \left(\frac{K_{sp}}{216}\right)^{1/7}$

(C) $S = \left(\frac{K_{sp}}{929}\right)^{1/9}$

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

QUESTION – (Covid-2020)

The solubility product for a salt of the type AB is 4×10^{-8}. What is the molarity of its standard solution?

(A) 16×10^{-16} mol/L

(B) 2×10^{-16} mol/L

(C) 4×10^{-4} mol/L

(D) 2×10^{-4} mol/L ✓

$x = 1, y = 1$

$K_{SP} = 4 \times 10^{-8} = (1)^1 (1)^1 (S)^{1+1}$ (S)

$4 \times 10^{-8} = S^2$

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

QUESTION (JEE)

$S = 10^{-4}$ 2×10^{-6}

Two salts A_2X and MX have the same value of solubility product of 4.0×10^{-12}. The ratio of their molar solubilities i.e. (Round off to the nearest integer) (50)

A_2X $x=2, y=1$ $\Rightarrow K_{sp} = 4 \times 10^{-12} = 4S^3 \Rightarrow S = (10^{-12})^{1/3} = 10^{-4}\ M$

MX $x=1, y=1$ $\Rightarrow K_{sp} = 4 \times 10^{-12} = S'^2 \Rightarrow S' = (4 \times 10^{-12})^{1/2} = 2 \times 10^{-6}\ M$

$$\frac{S}{S'} = \frac{10^{-4}}{2 \times 10^{-6}} = \frac{100}{2} = 50$$

QUESTION – (AIIMS 2016)

The solubility product (K_{sp}) of the following compounds are given at 25°C.

Compound	K_{sp}
AgCl	1.1×10^{-10}
AgI	1.0×10^{-16}
$PbCrO_4$	4.0×10^{-14}
Ag_2CO_3	8.0×10^{-12}

The most soluble and least soluble compounds are respectively.

(A) AgCl and $PbCrO_4$

(B) AgI and Ag_2CO_3

(C) AgCl and Ag_2CO_3

(D) Ag_2CO_3 and AgI

QUESTION

Solubility product constant (K_{sp}) of salts of types MX, MX_2 and M_3X at temperature 'T' are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15}, respectively. Solubilities (mol dm^{-3}) of the salts at temperature 'T' are in the order:

(A) $MX > MX_2 > M_3X$

(B) $M_3X > MX_2 > MX$

(C) $MX_2 > M_3X > MX$

(D) $MX > M_3X > MX_2$

$4 \times 10^{-8} = S^2 \Rightarrow S = 2 \times 10^{-4}$ M

$32 \times 10^{-15} = 4S^3 \Rightarrow S = 2 \times 10^{-5}$ M

$27 \times 10^{-16} = 27 S^4 \Rightarrow S = 10^{-4}$ M

$MX > M_3X > MX_2$

QUESTION – (Delhi 2017)

Concentration of the Ag^+ ions in a saturated solution of $Ag_2C_2O_4$ is 2.2×10^{-4} mol L^{-1}. Solubility product of $Ag_2C_2O_4$ is:

(A) 5.3×10^{-12}

(B) 2.42×10^{-8}

(C) 2.66×10^{-12}

(D) 4.5×10^{-11}

$x=2,\ y=1$

$[Ag^+] = 2.2 \times 10^{-4}\ M$

$Ag_2C_2O_4 + H_2O \rightleftharpoons 2Ag^+ + C_2O_4^{2-}$

$S \qquad\quad 2S \qquad\ S$

$[Ag^+] = 2S = 2.2 \times 10^{-4}$

$S = 1.1 \times 10^{-4}$

$4(1.1 \times 10^{-4})^3 = K_{sp}$

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

$= 4S^3$

$= 4(1.1 \times 10^{-4})^3$

QUESTION – (AIIMS 2014)

K_{sp} of $M(OH)_2$ is 3.2×10^{-11}. The pH of saturated solution in water is:

x=1, y=2

A) 3.40

B) 10.30

C) 10.60

D) 3.70

$3.2 \times 10^{-12} = 4S^3$

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

$[OH^-] = 2S$

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

$pOH = 4 - \log 4$

$= 4 - 0.6$

$= 3.4$

$pH = 14 - 3.4 = 10.6$

$M(OH)_2(s) + H_2O \rightleftharpoons M^{2+} + 2OH^-$

S 2S

QUESTION

What is the molar solubility of $Fe(OH)_2$ ($K_{sp} = 8.0 \times 10^{-16}$) at pH 13.0?

A 8.0×10^{-18}

B 8.0×10^{-15}

C 8.0×10^{-17}

D 8.0×10^{-14}

pOH = 1

$[OH^-] = 10^{-1}$ M.

$K_{SP} = 8 \times 10^{-16} = [Fe^{2+}][OH^-]^2$

$8 \times 10^{-16} = S(10^{-2})$

$S = 8 \times 10^{-14}$ M.

QUESTION

At 25°C, K_{sp} for $PbBr_2$ is equal to 8×10^{-5}. If the salt is 80% dissociated, what is the solubility of $PbBr_2$ in mol/litre?

A $\left[\frac{10^{-4}}{1.6 \times 1.6}\right]^{1/3}$

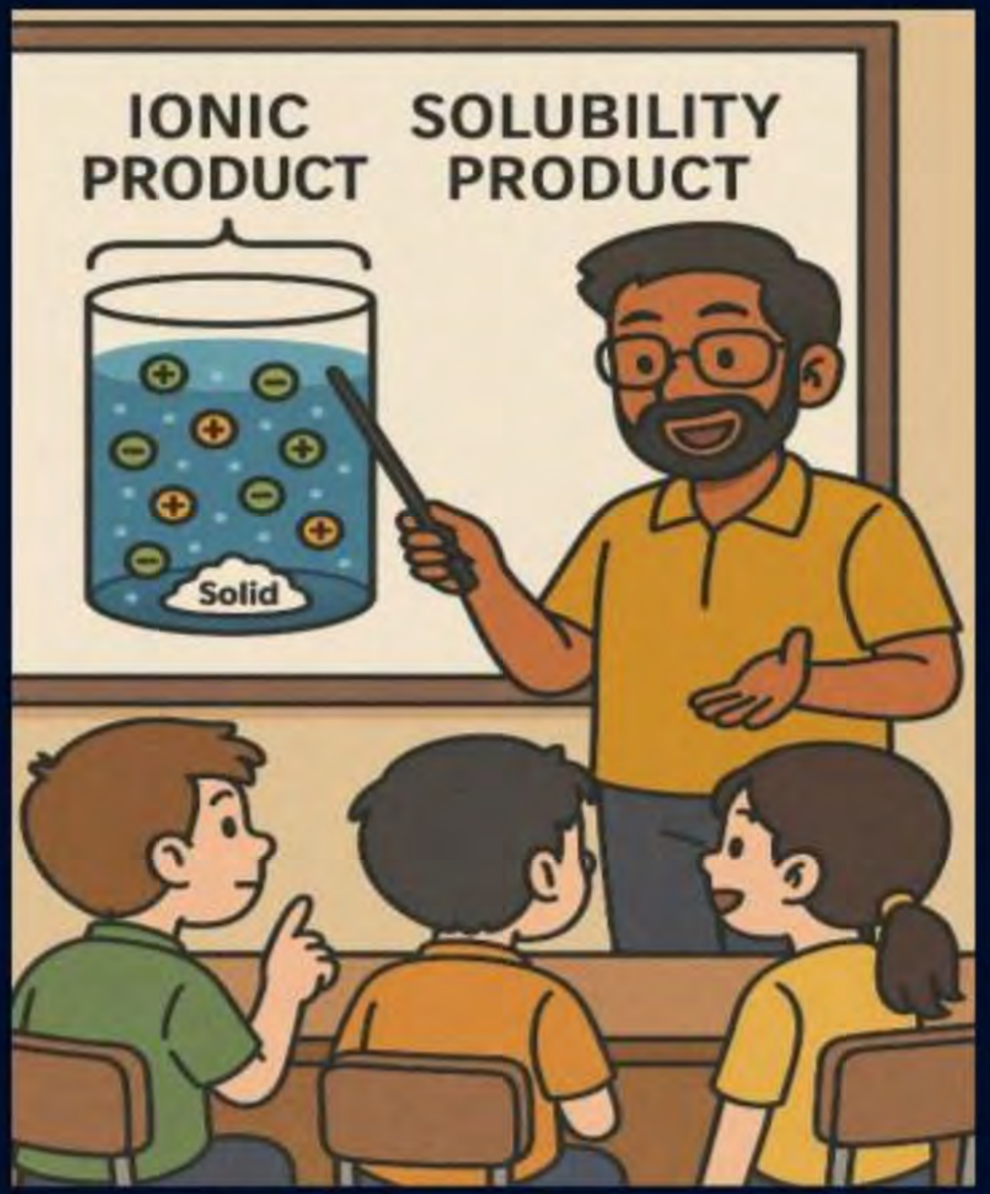
B $\left[\frac{10^{-5}}{1.6 \times 1.6}\right]^{1/3}$

C $\left[\frac{10^{-4}}{0.8 \times 0.8}\right]^{1/3}$

D $\left[\frac{10^{-5}}{1.6 \times 1.6}\right]^{1/2}$

Difference Between K_{ip} & K_{sp}

1 Page



QUESTION

A solution which is 10^{-3} M each in Mn^{2+}, Fe^{2+}, Zn^{2+} and Hg^{2+} is treated with10^{-16} M sulphide ion. If K_{SP} of MnS, ZnS and HgS are 10^{-15}, 10^{-23}, 10^{-20} and10^{-54} respectively, which one will precipitate first.

(A) FeS

(B) MgS

(C) HgS

(D) ZnS

QUESTION

When equal volume of $AgNO_3$ and NaCl solution are mixed, the precipitation of AgCl ($K_{sp} = 1.81 \times 10^{-10}$) will occur with:

A 10^{-3} M (Ag^+) and 10^{-10} M (Cl^-)

B 10^{-5} M (Ag^+) and 10^{-5} M (Cl^-)

C 10^{-6} M (Ag^+) and 10^{-5} M (Cl^-)

D 10^{-4} M (Ag^+) and 10^{-4} M (Cl^-)

QUESTION

At 25° C, the solubility product of Hg_2Cl_2 in water is 3.2×10^{-17} mol^3 dm^{-9}. What is the solubility of Hg_2Cl_2 in water at 25° C?

A 1.2×10^{-12} M

B 3.0×10^{-6} M

C 2×10^{-6} M

D 1.2×10^{-16} M

Common ion Effect

1 Page

*When a strong electrolyte is added to a solution of weak electrolyte having a common ion

Weak electrolyte :

QUESTION – (NEET 2020)

Find out the solubility of $Ni(OH)_2$ in 0.1 M NaOH. Given that the ionic product of $Ni(OH)_2$ is 2×10^{-15}.

(A) 2×10^{-8} M

(B) 1×10^{-13} M

(C) 1×10^{8} M

(D) 2×10^{-13} M

QUESTION – (AIIMS 2009)

The solubility of PbF_2 in water at 25 °C is $\approx 10^{-3}$ M. What is its solubility in 0.05 M NaF solution? Assume the later to be fully ionized.

A 1.6×10^{-6} M

B 1.2×10^{-6} M

C 1.2×10^{-5} M

D 1.6×10^{-4} M

QUESTION – (AIIMS 2017)

At 25°C, the solubility product of $Mg(OH)_2$ is 1.0×10^{-11}. At which pH will Mg^{2+} ions start precipitating in the form of $Mg(OH)_2$ from a solution of 0.001 M Mg^{2+} ions?

A 9

B 10

C 11

D 8

Home work from modules

Solve all questions of salt hydrolysis & Solubility product.

Magarmach Practice Questions (MPQ)

QUESTION

pK_a of a weak acid (HA) and pK_b of a weak base (BOH) are 3.2 and 3.4 respectively. The pH of their salt (AB) solution is:

A 7.0

B 1.0

C 7.2

D 6.9

QUESTION – (NCERT Exemplar)

Assertion (A): **Aqueous solution of ammonium carbonate is basic.**

Reason (R): **Acidic/basic nature of a salt solution of a salt of weak acid and weak base depends on K_a and K_b value of the acid and the base forming it.**

A. Both A and R are true and R is correct explanation of A.

B. Both A and R are true but R is not correct explanation of A.

C. A is true but R is false.

D. Both A and R are false.

QUESTION – (Covid-2020)

Which among the following salt solutions is basic in nature?

A. Ammonium sulphate

B. Ammonium nitrate

C. Sodium acetate

D. Ammonium chloride

QUESTION

Consider the following salts. Which one(s) when dissolved in water will produce a basic solution?

1. $RbClO_4$ 2. $NaNO_2$ 3. NH_4Cl 4. NaCl

(A) 1 and 3

(B) only 2

(C) 1 and 2

(D) 3 and 4

THANK YOU