

Every Equilibrium Formula In One Visual Map

Mastering Chemical, Ionic, and
Phase Equilibrium for JEE

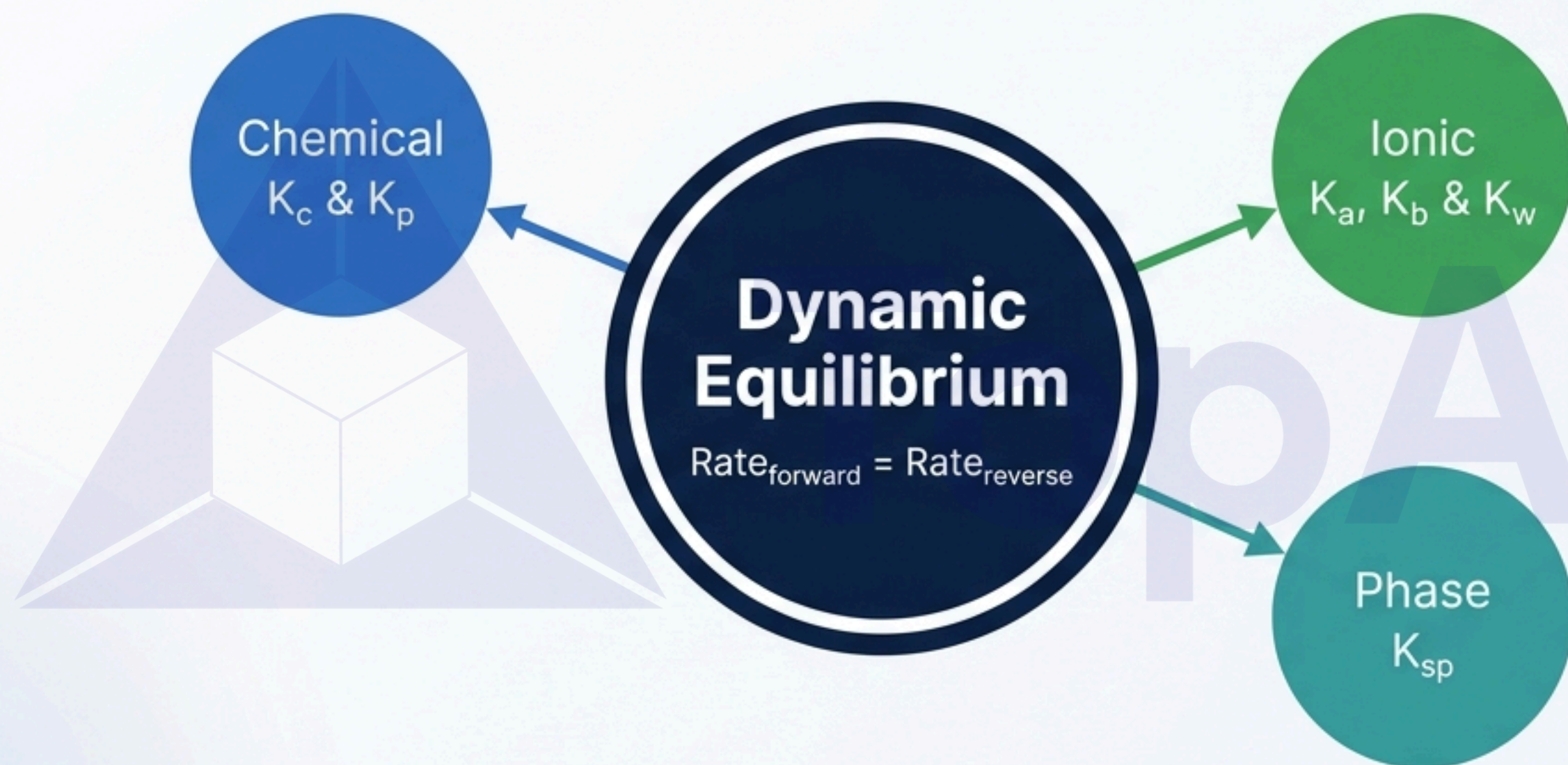


The Ultimate Cheat Sheet

- ✓ All K Constants
- ✓ pH Logarithmic Relations
- ✓ JEE Trap Alerts & Shortcuts

The Equilibrium Universe

One fundamental law, multiple manifestations.



- ✓ ALL constants depend ONLY on Temperature.
- ✓ ALL constants represent the ratio of Products over Reactants at standard states.

Chemical Equilibrium Constants

The foundational Law of Mass Action for $aA + bB \rightleftharpoons cC + dD$

K_c (Molarity)

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

[] = Molarity (mol/L) at equilibrium.

K_p (Partial Pressure)

$$K_p = \frac{(P_C)^c (P_D)^d}{(P_A)^a (P_B)^b}$$

P = Partial Pressure (bar or atm) at equilibrium.

⚠ JEE TRAP ALERT: Pure solids (s) and pure liquids (l) have a constant active mass of 1. Never include them in your K_c or K_p expressions!



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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Key Highlights

- » Free Study Material, Videos & Infographics
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- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Gas Equilibrium: The K_p & K_c Bridge

Converting between pressure and concentration using the Ideal Gas Law.



Formula Bank

$$K_p = K_c (RT)^{\Delta n}$$

R: Gas Constant
(0.0831 bar·L/mol·K)

T: Absolute
Temperature
(Kelvin)

Δn :
Moles of gaseous
products –
Moles of gaseous
reactants

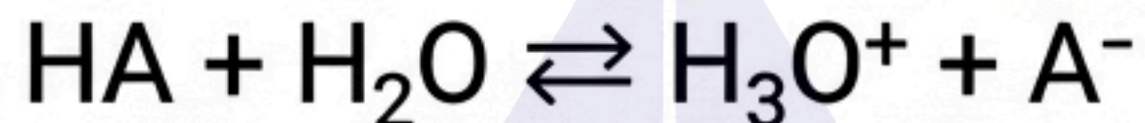
EXAM SNAPSHOT: The Δn Shortcuts

- $\Delta n = 0 \rightarrow K_p = K_c$
(e.g., $\text{H}_{2(g)} + \text{I}_{2(g)} \rightleftharpoons 2\text{HI}_{(g)}$)
- $\Delta n > 0 \rightarrow K_p > K_c$
(e.g., $\text{PCl}_{5(g)} \rightleftharpoons \text{PCl}_{3(g)} + \text{Cl}_{2(g)}$)
- $\Delta n < 0 \rightarrow K_p < K_c$
(e.g., $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}$)

Acid-Base Equilibrium

Ionization constants for weak electrolytes and their conjugate relationships.

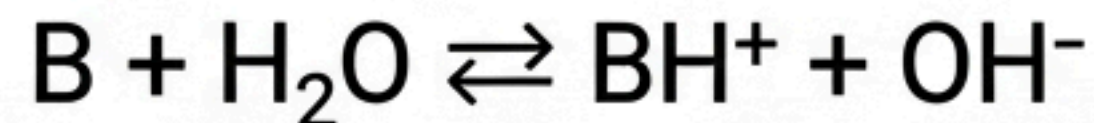
Weak Acid Ionization (K_a)



$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

Larger K_a = Stronger Acid

Weak Base Ionization (K_b)



$$K_b = \frac{[\text{BH}^+][\text{OH}^-]}{[\text{B}]}$$

Larger K_b = Stronger Base

Synthesis Bridge

The Conjugate Pair Relation: For any conjugate acid-base pair (e.g., NH_4^+ and NH_3):

$$K_a \times K_b = K_w$$

Water Equilibrium & pH Relations

The universal baseline and logarithmic scaling for aqueous solutions.

Ionic Product of Water (K_w)

$$K_w = [H^+][OH^-]$$

At 298 K (25°C): $K_w = 1.0 \times 10^{-14}$

! Value changes with Temperature!
Do not assume 10^{-14} if $T \neq 298K$.

pH

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

pOH

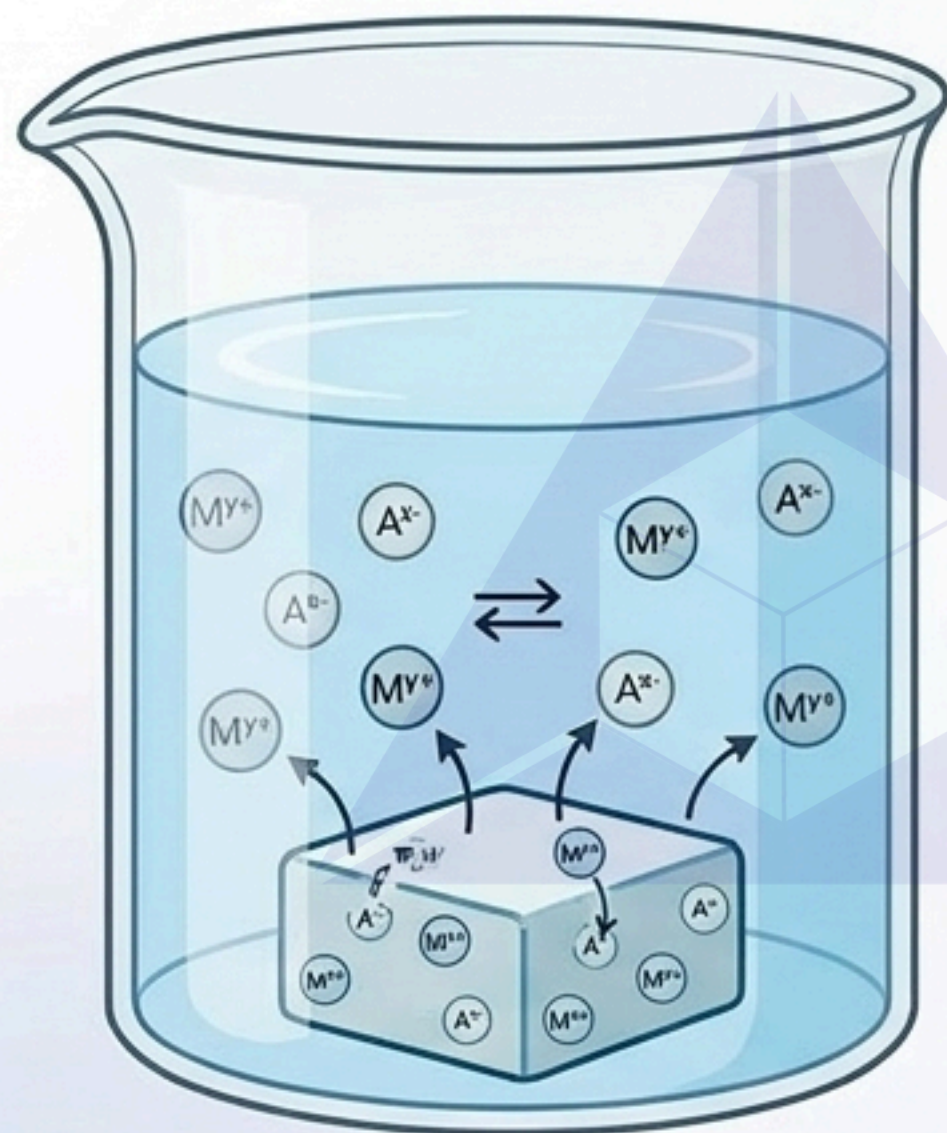
$$pOH = -\log[OH^-]$$

Key Takeaways

- ✓ The Master Rule (at 298K): $pH + pOH = 14$
- ✓ Because the scale is logarithmic, a 1-unit change in pH means a 10x change in $[H^+]$.

Solubility Equilibrium

Phase boundaries for sparingly soluble salts: $M_xA_y(s) \rightleftharpoons xM^{y+}(aq) + yA^{x-}(aq)$



Solubility Product Constant (K_{sp})

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

(Where concentrations are at saturation)

Blue Exam Snapshot

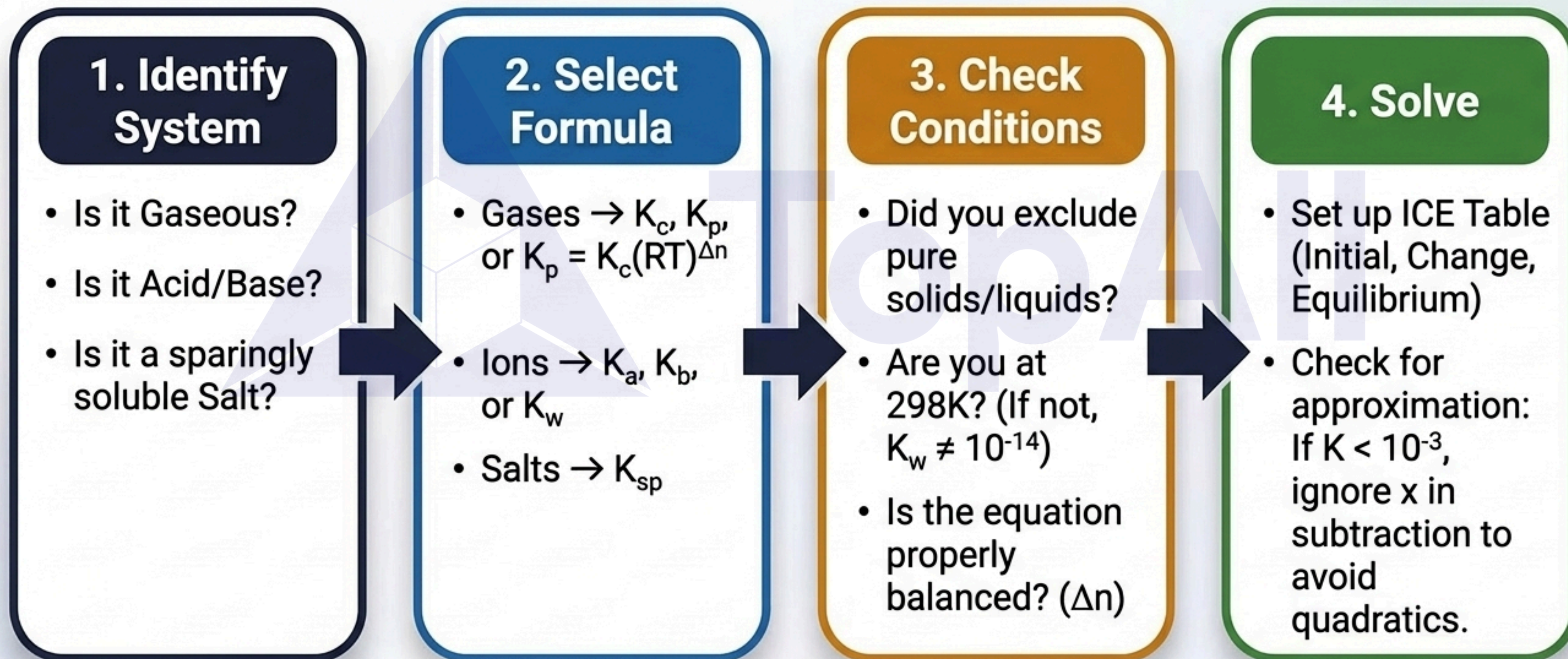
Precipitation Predictor (Q_{sp} vs K_{sp}):

- $Q_{sp} < K_{sp} \rightarrow$ **Unsaturated** (More solid can dissolve)
- $Q_{sp} = K_{sp} \rightarrow$ **Saturated** (Dynamic Equilibrium reached)
- $Q_{sp} > K_{sp} \rightarrow$ **Supersaturated** (Precipitation occurs)

! JEE TRAP ALERT: Do not confuse Solubility (S in mol/L) with Solubility Product (K_{sp}).
For an AB_2 type salt, $K_{sp} = (S)(2S)^2 = 4S^3$.

JEE Master Revision Map

The algorithmic approach to solving any Equilibrium numerical.





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