

Weird Chemist

DPP-7 Solutions

Unit and Application of Equilibrium Constant

Chapter: Chemical Equilibrium

Master Formulae — DPP-7

1. K aur Product Stability:

- $K \gg 1 \Rightarrow$ Products zyada stable, forward reaction favored
- $K \ll 1 \Rightarrow$ Reactants zyada stable, backward reaction favored
- $K \approx 1 \Rightarrow$ Equal amounts of reactants and products

2. Unit of K_c :

$$\text{Unit of } K_c = (\text{mol L}^{-1})^{\Delta n_g} \quad \text{jahan } \Delta n_g = \sum (\text{product moles}) - \sum (\text{reactant moles})$$

3. Unit of K_p :

$$\text{Unit of } K_p = (\text{atm})^{\Delta n_g}$$

4. Reaction Quotient Q rule:

Condition	Direction
$Q < K$	Forward reaction (aur products banenge)
$Q > K$	Backward reaction (reactants wapis banenge)
$Q = K$	Equilibrium (koi net change nahi)

5. Standard Gibbs Energy & K:

$$\Delta G^\circ = -RT \ln K \quad \Rightarrow \quad K = e^{-\Delta G^\circ / RT}$$

Quick Answer Key — DPP-7 (28 Questions)

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	(3)	8	$K \approx 10$	15	(2)	22	(4)D
2	(1)	9	(2) M^2	16	(B)	23	(B)
3	(2)	10	(2) atm^{-2}	17	(3)C	24	(C)
4	(2)	11	(2)	18	(2)	25	(A)
5	(1)	12	(1)	19	(2)	26	(A)
6	(b) \uparrow ,(a) \downarrow	13	(2)	20	(3)	27	(2)
7	(3)	14	(2) atm^{-2}	21	(4)D	28	(2)

GROUP A — Stability / Direction of Equilibrium

Q1. In which of the following reaction product is more stable?

Explanation (Step-by-Step)

Yaar, product ki stability directly K ki value se pata chalti hai. Jitna bada K hoga, utna zyada product equilibrium pe milega, matlab product zyada stable hai.

Diye gaye reactions ki K values compare karo:

- $K_1 = 2.3 \times 10^{-2} = 0.023$ (NH₃ reaction — small K)
- $K_2 = 2 \times 10^2 = 200$ (NO reaction — large K)
- $K_3 = 294$ (HI reaction — **largest K !**)
- $K_4 = 1.4 \times 10^{-3} = 0.0014$ (XeO₂F₂ reaction — very small K)

Comparison: $K_3 = 294 > K_2 = 200 > K_1 = 0.023 > K_4 = 0.0014$

$\therefore K_3$ sabse bada hai $\Rightarrow \text{H}_2 + \text{I}_2 \rightarrow 2\text{HI}$ mein **HI product sabse stable** hai.

Approach (Kahan se start, kahan tak)

Start karo: Saare K values ko ek jagah note karo.

Karna kya hai: Largest K dhundho — wahi reaction ka product most stable hoga.

Pahuncho: $K_3 = 294$ sabse bada \Rightarrow Option (3).

Answer

Option (3): $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$; $K_3 = 294 \Rightarrow$ HI product sabse zyada stable hai.

Q2. Which Oxide of Nitrogen is most stable?

Explanation (Step-by-Step)

Pehle dhyan do: Yahan diye gaye saare reactions decomposition reactions hain! Matlab N₂ oxide toot ke N₂ aur O₂ ban raha hai (right side pe products wahi hain).

Iska matlab:

- Bada $K \Rightarrow$ oxide easily toot jaata hai \Rightarrow oxide **unstable** hai
- Chota $K \Rightarrow$ oxide mushkil se toota \Rightarrow oxide **stable** hai

NO₂: $K = 6.7 \times 10^{16}$ \leftarrow **Sabse chota K**

NO: $K = 2.2 \times 10^{30}$

N₂O₅: $K = 1.2 \times 10^{34}$ \leftarrow Sabse bada K (most unstable)

N₂O: $K = 3.5 \times 10^{33}$

\therefore Smallest $K = 6.7 \times 10^{16}$ (Option 1, NO₂) \Rightarrow **NO₂ most stable oxide of nitrogen!**

Approach

Start karo: Pehle identify karo ye decomposition reactions hain.

Twist hai yahan: Most stable = Smallest K (zyada K matlab zyada toot gaya = unstable).

Pahuncho: Min $K = \text{NO}_2 \Rightarrow$ Option (1).

Common Mistake — Exam Trap!

Students directly sochte hain: Largest K = most stable. **GALAT!**

Yahan reactions ulta diya hai (decomposition). Toh rule bhi ulta hoga:

Smallest K = most stable (least decomposed) oxide.

Answer

Option (1): NO₂ is most stable ($K = 6.7 \times 10^{16}$ is smallest)

Q3. If $K = 1.6 \times 10^{12}$, at equilibrium system will contain?

Explanation

$K = 1.6 \times 10^{12}$ — yeh ek **bahut bada number** hai ($K \gg 1$).

$$K = \frac{[\text{products}]}{[\text{reactants}]} \gg 1 \Rightarrow [\text{products}] \gg [\text{reactants}]$$

∴ Equilibrium pe system mein mostly products honge.

Approach

3 cases yaad karo:

$K \gg 1 \rightarrow$ Mostly products $K \ll 1 \rightarrow$ Mostly reactants $K \approx 1 \rightarrow$ Similar amounts

Answer

Option (2): Mostly products

Q4. Equilibrium proceeds towards reactants, then K will be?

Explanation

Equilibrium reactants ki taraf shift hoga \Rightarrow products kam, reactants zyada.

$$K = \frac{[\text{products}]}{[\text{reactants}]} = \frac{\text{chota number}}{\text{bada number}} \ll 1$$

Approach

Direct rule: Backward/reactants ki taraf $\Rightarrow K \ll 1$. Seedha apply karo.

Answer

Option (2): $K \ll 1$

Q5. In which does the reaction go almost to completion?

Explanation

“Almost to completion” matlab saare reactants convert ho gaye products mein \Rightarrow Products **bahut zyada** hain $\Rightarrow K \gg 1$.

- $K = 10^4$ — **Bahut bada, almost complete!**
- $K = 10^{-3}$ — Bahut chota, barely reacts
- $K = 1$ — 50-50, completion nahi
- $K = 10^{-1}$ — Reactants dominant

Approach

Largest K dhundho $\Rightarrow K = 10^4 \Rightarrow$ Option (1).

Answer

Option (1): $K = 10^4$

Q6. Which goes almost to completion, which proceeds hardly at all?

Explanation

(a) $\text{N}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}(g); K_c = 2.7 \times 10^{-18}$

$K \ll 1 \Rightarrow$ **Proceeds hardly at all** (almost no products bante hain — yahi wajah hai atmospheric N_2 aur O_2 react kyun nahi karte normally!)

(b) $2\text{NO}(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}_2(g); K_c = 6.0 \times 10^{13}$

$K \gg 1 \Rightarrow$ **Goes almost to completion** (products bahut zyada bante hain).

Approach

$K \gg 1 \rightarrow$ Completion. $K \ll 1 \rightarrow$ Hardly reacts. Direct rule apply karo.

Answer

(b) goes almost to completion; (a) proceeds hardly at all.

Q7. When $K_c \gg 1$ for a chemical reaction,

Explanation

$$K_c = \frac{[\text{products}]}{[\text{reactants}]} \gg 1$$

\Rightarrow Numerator \gg Denominator \Rightarrow **products ki concentration \gg reactants ki concentration** at equilibrium.

Options (1) aur (2) (speed ke baare mein) — yeh **galat hain**. K ki value equilibrium ki speed se koi lena dena nahi. Speed kinetics ka topic hai, thermodynamics ka nahi!

Common Mistake — Bahut Important!

“Bada K matlab reaction jaldi hogi” — BILKUL GALAT!

K sirf yeh batata hai ki equilibrium pe *kaun zyada hai* (products ya reactants). Reaction *kitni tezi se* equilibrium pe pahunchi — yeh K se pata nahi chalta, yeh activation energy aur rate constant pe depend karta hai.

Approach

Start: $K_c \gg 1$ ka meaning dekho.

End: Products \gg Reactants at equilibrium \Rightarrow Option (3).

Answer

Option (3): Product concentrations would be much greater than reactants at equilibrium

Q8. Benzene from acetylene — K should be about 0.01, 1, or 10?

Explanation

Commercial production ke liye **high yield** chahiye — matlab products zyada banne chahiye.

- $K \approx 0.01$: Products bahut kam ($K \ll 1$) \Rightarrow Commercially useless!
- $K \approx 1$: Products aur reactants equal \Rightarrow Sirf 50% yield, acceptable nahi
- $K \approx 10$: Products dominate ($K > 1$) \Rightarrow **Commercially useful!**

$K \approx 10$ sabse suitable hai — zyada products bante hain, commercially viable hai.

Approach

Start: Commercial production ki requirement = high yield.

End: High yield \Rightarrow Products dominate $\Rightarrow K > 1$. Sabse suitable: $K \approx 10$.

Answer

$K \approx 10$ — Most commercially useful (products dominate karte hain).

GROUP B — Unit of K_c / K_p

Q9. $\text{CH}_3\text{OH}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 2\text{H}_2(\text{g})$ — Unit of K_c ?

Explanation (Step-by-Step)

Step 1: Δn_g calculate karo:

$$\Delta n_g = (\text{product moles}) - (\text{reactant moles}) = (1 + 2) - 1 = +2$$

Step 2: Unit of $K_c = (\text{mol L}^{-1})^{\Delta n_g}$:

$$\text{Unit} = (\text{mol L}^{-1})^{+2} = \text{M}^2$$

Verify karo manually:

$$K_c = \frac{[\text{CO}][\text{H}_2]^2}{[\text{CH}_3\text{OH}]} = \frac{\text{M} \times \text{M}^2}{\text{M}} = \text{M}^2$$

Approach

Start: $\Delta n_g = \text{product moles} - \text{reactant moles} = 3 - 1 = +2$.

End: Unit = $\text{M}^{\Delta n_g} = \text{M}^2$.

Answer

Option (2): M^2

Q10. $\text{CS}_2(\text{g}) + 4\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) + 2\text{H}_2\text{S}(\text{g})$ — Unit of K_p ?

Explanation

Step 1: Δn_g calculate karo:

$$\text{Product moles} = 1 + 2 = 3$$

$$\text{Reactant moles} = 1 + 4 = 5$$

$$\Delta n_g = 3 - 5 = -2$$

Step 2: Unit of $K_p = (\text{atm})^{\Delta n_g}$:

$$\text{Unit} = (\text{atm})^{-2} = \text{atm}^{-2}$$

Approach

Start: Products = 3, Reactants = 5. $\Delta n_g = -2$.

End: Unit of $K_p = \text{atm}^{-2}$.

Common Mistake

H₂ ke 4 moles count karna bhul jaate hain! Reactants side mein CS₂ = 1 aur H₂ = 4, total = 5. Sirf 2 count kiya toh Δn_g galat nikalta hai!

Answer

Option (2): atm^{-2}

Q11. C₂H₄ + H₂ ⇌ C₂H₆ — Units of equilibrium constant?

Explanation

Step 1: Δn_g :

$$\Delta n_g = 1 - (1 + 1) = 1 - 2 = -1$$

Step 2: Unit of K_c :

$$\text{Unit} = \text{M}^{-1} = (\text{mol L}^{-1})^{-1} = \text{L mol}^{-1} = \text{dm}^3 \text{ mol}^{-1}$$

(Note: 1 L = 1 dm³, same cheez hai!)

Approach

Start: $\Delta n_g = 1 - 2 = -1$.

End: $\text{M}^{-1} = \text{dm}^3 \text{ mol}^{-1} \Rightarrow$ Option (2).

Answer

Option (2): $\text{dm}^3 \text{ mol}^{-1}$

Q12. N₂ + 3H₂ ⇌ 2NH₃ — units of K_c and K_p ?

Explanation

Step 1: Δn_g :

$$\Delta n_g = 2 - (1 + 3) = 2 - 4 = -2$$

Step 2: Unit of K_c :

$$\text{Unit} = \text{M}^{-2} = (\text{mol L}^{-1})^{-2} = \text{mol}^{-2} \text{L}^2$$

Step 3: Unit of K_p :

$$\text{Unit} = (\text{bar})^{-2} = \text{bar}^{-2}$$

Approach

Start: $\Delta n_g = 2 - 4 = -2$.

End: K_c : $\text{mol}^{-2} \text{L}^2$; K_p : $\text{bar}^{-2} \Rightarrow$ Option (1).

Answer

Option (1): $\text{mol}^{-2} \text{L}^2$ and bar^{-2}

Q13. $4\text{A}(\text{g}) + 5\text{B}(\text{g}) \rightleftharpoons 4\text{X}(\text{g}) + 6\text{Y}(\text{g})$ — unit of K_c ?

Explanation

Step 1: Δn_g :

$$\Delta n_g = (4 + 6) - (4 + 5) = 10 - 9 = +1$$

Step 2: Unit of K_c :

$$\text{Unit} = \text{M}^{+1} = \text{mol L}^{-1} = \text{mole litre}^{-1}$$

Approach

Start: Dhyan se count karo: Products = $4 + 6 = 10$, Reactants = $4 + 5 = 9$.

End: $\Delta n_g = +1 \Rightarrow$ Unit = $\text{mole litre}^{-1} \Rightarrow$ Option (2).

Answer

Option (2): mole litre^{-1}

Q14. Same as Q10 — $\text{CS}_2(\text{g}) + 4\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) + 2\text{H}_2\text{S}(\text{g})$ — Unit of K_p ?

Explanation

Yeh Q10 ka exact repeat hai! $\Delta n_g = 3 - 5 = -2$, isliye unit of $K_p = \text{atm}^{-2}$.

Answer

Option (2): atm^{-2} (Same as Q10)

GROUP C — Comparing Equilibrium Constants

Q15. Highest concentration of reactants and products among given reactions?

Explanation

Saare reactions ki K values ek jagah likho:

Rxn	K value	Numerical	Status
(a) $x \rightleftharpoons y$	$K = 10^{-1}$	0.1	Largest K among all
(b) $y \rightleftharpoons z$	$K = 2 \times 10^{-2}$	0.02	—
(c) $P \rightleftharpoons Q$	$K = 3 \times 10^{-4}$	0.0003	Smallest K
(d) $R \rightleftharpoons S$	$K = 2 \times 10^{-3}$	0.002	—

Highest reactant concentration: Smallest K wali reaction mein \Rightarrow (c) has $K = 3 \times 10^{-4}$ (smallest)

Highest product concentration: Largest K wali reaction mein \Rightarrow (a) has $K = 0.1$ (largest)
 \therefore Highest reactants = (c); Highest products = (a)

Approach

Start: Saare K values compare karo numerically.

Rule: Smallest K = maximum reactants, Largest K = maximum products.

End: (c) has highest reactants, (a) has highest products \Rightarrow Option (2): c, a.

Answer

Option (2): (c) highest reactants, (a) highest products

Q16. Which reaction has the largest equilibrium constant? [NSEC-2002]

Explanation

Figure mein teen containers (boxes) diye gaye hain, har ek mein ek reaction ka equilibrium mixture dikhaya gaya hai.

Reaction: $A_2 + X_2 \rightleftharpoons 2AX$ ($X = B, C, \text{ or } D$)

$$K = \frac{[AX]^2}{[A_2][X_2]}$$

Jis box mein product (AX) molecules **zyada** hain aur reactants (A_2, X_2) **kam** hain — usi ka K sabse bada hoga.

Figure dekhne pe, middle container ($A_2 + C_2 \rightleftharpoons 2AC$) mein product molecules (AC) ki sankhya reactants se clearly zyada hai compared to other two containers.

\therefore Largest K = Reaction (B):

Approach

Start: Figure mein products aur reactants ke molecules count karo har container mein.

End: Jis container mein product/reactant ratio highest hai \Rightarrow usi ka K sabse bada.

\Rightarrow Option (B).

Answer

Option (B): $A_2 + C_2 \rightleftharpoons 2AC$ — Largest equilibrium constant.

GROUP D — Reaction Quotient (Q) vs Equilibrium Constant (K)

Q17. Assertion–Reason: Q = K at equilibrium; catalyst changes Q?

Explanation

Assertion check karo:

“Q = K when reaction is in equilibrium” ⇒ **TRUE** (yeh equilibrium ki definition hai!)

Reason check karo:

“If catalyst is added, Q remains no longer equal to K” ⇒ **FALSE!**

Catalyst add karne se:

- Forward aur backward dono rates equally badhti hain
- Concentrations nahi badte (catalyst consume nahi hota)
- Na Q change hota hai, na K change hota hai
- System equilibrium pe hi rehta hai: $Q = K$ hi rehta hai!

Common Mistake

“Catalyst se equilibrium shift ho jaata hai” — **GALAT!**

Catalyst sirf us equilibrium tak *tezi se* pahunchata hai. Equilibrium position **SAME** rehti hai. Na K badhta, na Q badhta, na shift hota.

Approach

Start: Dono statements ko separately true/false decide karo.

End: Assertion = TRUE, Reason = FALSE ⇒ Option (C) ⇒ Option (3).

Answer

Option (3): C — Assertion TRUE, Reason FALSE.

Q18. $[H_2] = 2$, $[I_2] = 2$, $[HI] = 8$ mol/L; $K_c = 4$. Direction?

Explanation (Step-by-Step)

Reaction: $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Step 1: Q_c calculate karo (current concentrations se):

$$Q_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(8)^2}{(2)(2)} = \frac{64}{4} = 16$$

Step 2: Compare with K_c :

$$Q_c = 16 > K_c = 4$$

Step 3: $Q > K \Rightarrow$ System mein products zyada hain equilibrium se \Rightarrow **Backward reaction** hogi. HI toot ke H_2 aur I_2 banega jab tak $Q = K$ na ho jaaye.

Approach

Start: Q_c formula mein current concentrations daalo.

Middle: $Q_c = 16$, $K_c = 4$. Compare karo.

End: $Q > K \Rightarrow$ Backward direction \Rightarrow Option (2).

Answer

Option (2): Backward direction ($Q_c = 16 > K_c = 4$)

Q19. $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$; $K_p = 4.28 \times 10^{-5}$; $P(\text{N}_2) = 1$, $P(\text{H}_2) = 2$, $P(\text{NH}_3) = 3$ atm. Direction?

Explanation (Step-by-Step)

Step 1: Q_p calculate karo (partial pressures se):

$$Q_p = \frac{[P(\text{NH}_3)]^2}{P(\text{N}_2) \cdot [P(\text{H}_2)]^3} = \frac{(3)^2}{(1) \cdot (2)^3} = \frac{9}{8} = 1.125 \text{ atm}^{-2}$$

Step 2: Compare with K_p :

$$Q_p = 1.125 \gg K_p = 4.28 \times 10^{-5}$$

Step 3: $Q_p \gg K_p \Rightarrow$ Products bahut zyada hain \Rightarrow **Backward reaction.**

NH_3 toot ke N_2 aur H_2 banega.

Approach

Start: Q_p calculate karo with given partial pressures.

End: $Q_p = 1.125 \gg K_p = 4.28 \times 10^{-5} \Rightarrow$ Backward \Rightarrow Option (2).

Answer

Option (2): Backward ($Q_p \gg K_p$)

Q20. Which condition is in favour of forward reaction?

Explanation

Forward reaction tab hogi jab products aur banne chahiye, matlab abhi products kam hain (equilibrium se).

$$Q < K_c \Rightarrow \text{Products abhi equilibrium se kam hain} \Rightarrow \text{Forward reaction hogi}$$

Approach

Direct rule: $Q < K \Rightarrow$ Forward. $Q > K \Rightarrow$ Backward. $Q = K \Rightarrow$ Equilibrium.

Answer

Option (3): $Q < K_c$

Q21. A–R: K increases when concentration of reactants are increased?

Explanation

Assertion: “K badhta hai jab reactant concentration badhao” \Rightarrow **FALSE!**

K sirf **temperature** pe depend karta hai. Concentration se K nahi badlta — sirf Q badlta hai, phir system adjust karta hai.

Reason: “Reactant concentration badhane se equilibrium forward shift hota hai” \Rightarrow **TRUE.**

Le Chatelier’s principle ke anusaar, reactants badhaao \Rightarrow system forward shift karta hai products banana ke liye.

\therefore Assertion (A) is FALSE, Reason (R) is TRUE \Rightarrow **Option D**

Common Mistake — Exam Mein Bahut Aata Hai!

“Concentration badhao \Rightarrow K badhata hai” — KABHI NAHI!

K ek constant hai (fixed temperature pe). Concentration badhaoge $\Rightarrow Q$ change hoga \Rightarrow system shift karega taaki Q wapis K ke equal ho jaaye. Lekin K ki value SAME rehti hai!

Approach

Start: Assertion check — K concentration se badhta hai? No!

End: A = FALSE, R = TRUE \Rightarrow Option D \Rightarrow Option (4).

Answer

Option (4): D — Assertion FALSE, Reason TRUE.

Q22. A–R: Inert gas at constant volume shifts $A(g) + B(g) \rightleftharpoons AB(g)$ left?

Explanation

Assertion: “Constant volume pe inert gas add karne se equilibrium left shift karega” \Rightarrow **FALSE!**

Constant volume pe inert gas add karne par:

- Total pressure badhta hai
- Lekin A, B, AB ke **partial pressures** nahi badte! (Unke moles same hain, volume same hai)
- Q change nahi hota \Rightarrow **Koi shift nahi!**

Reason: “Partial pressures of A, B and AB decrease” \Rightarrow **FALSE!**

Constant volume pe inert gas add karne se A, B, AB ke partial pressures **SAME rehte hain**. Yeh decrease sirf constant pressure pe hoga.

\therefore A = FALSE, R = FALSE \Rightarrow **Option D**

Common Mistake — Top Exam Trap!

2 alag cases yaad karo:

Constant Volume pe inert gas: Partial pressures same \Rightarrow No shift!

Constant Pressure pe inert gas: Partial pressures decrease hoti hain \Rightarrow Shift hoga (towards more moles side).

Yeh distinction JEE mein direct poochha jaata hai!

Approach

Start: "Constant volume" condition notice karo.

End: Constant volume \Rightarrow Partial pressures unchanged \Rightarrow No shift.

Both A and R are FALSE \Rightarrow Option D \Rightarrow Option (4).

Answer

Option (4): D — Both Assertion and Reason are FALSE.

Q23. $2\text{HI}(g) \rightleftharpoons \text{H}_2(g) + \text{I}_2(g)$; $K_c = 0.020$; $[\text{HI}] = 2.0$, $[\text{H}_2] = 0.50$, $[\text{I}_2] = 0.10\text{M}$ [NSEC-2011]

Explanation (Step-by-Step)

Step 1: Q_c calculate karo:

$$Q_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} = \frac{(0.50)(0.10)}{(2.0)^2} = \frac{0.05}{4.0} = 0.0125$$

Step 2: Compare:

$$Q_c = 0.0125 < K_c = 0.020$$

Step 3: $Q < K \Rightarrow$ System mein abhi products equilibrium se kam hain \Rightarrow **Forward reaction hogi.**

More H_2 and I_2 will be produced.

Approach

Start: Q_c formula = $[\text{H}_2][\text{I}_2]/[\text{HI}]^2$.

End: $Q_c = 0.0125 < K_c = 0.020 \Rightarrow$ Forward \Rightarrow More H_2 and I_2 bante hain \Rightarrow Option (B).

Answer

Option (B): $Q_c < K_c$; more H_2 and I_2 will be produced.

Q24. $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$; Reaction will go backward when?

Explanation

Backward reaction tab hogi jab products equilibrium se zyada hain.

$$Q > K_c \Rightarrow \text{Backward reaction (reactants wapis banenge)}$$

Approach

Simple rule directly apply karo: $Q > K \Rightarrow$ Backward \Rightarrow Option (C).

Answer

Option (C): $Q > K_c$

Q25. $2\text{A} + \text{B} \rightleftharpoons 3\text{C}$; $K_c = 49$; 3L vessel: 2 mol A, 1 mol B, 3 mol C.

Explanation (Step-by-Step)

Step 1: Concentrations calculate karo (3L vessel mein):

$$[A] = \frac{2}{3} \text{ M}, \quad [B] = \frac{1}{3} \text{ M}, \quad [C] = \frac{3}{3} = 1 \text{ M}$$

Step 2: Q_c calculate karo:

$$Q_c = \frac{[C]^3}{[A]^2[B]} = \frac{(1)^3}{\left(\frac{2}{3}\right)^2 \cdot \left(\frac{1}{3}\right)} = \frac{1}{\frac{4}{9} \times \frac{1}{3}} = \frac{1}{\frac{4}{27}} = \frac{27}{4} = 6.75$$

Step 3: Compare:

$$Q_c = 6.75 < K_c = 49$$

Step 4: $Q < K \Rightarrow$ **Forward reaction!** Products aur bane chahiye.

Approach

Start: Moles \div Volume = concentration. (Yeh step miss karna common mistake hai!)

Middle: Q_c formula carefully apply karo.

End: $Q = 6.75 < K = 49 \Rightarrow$ Forward \Rightarrow Option (A).

Common Mistake

Directly moles use mat karo Q_c mein! Pehle concentrations mein convert karo: moles \div volume (in L) = molarity (M). Is step ko skip karna galat answer deta hai!

Answer

Option (A): Must proceed in forward direction ($Q_c = 6.75 < K_c = 49$)

Q26. A and B mixed to give C and D. Reaction quotient Q at initial stages? [JEE-2000]

Explanation

Reaction: $A + B \rightleftharpoons C + D$

Initial stage mein: Sirf A aur B hain. C aur D abhi bane hi nahi hain.

$$Q = \frac{[C][D]}{[A][B]}$$

$[C] = 0$ aur $[D] = 0$ initially:

$$Q = \frac{0 \times 0}{[A][B]} = \frac{0}{\text{some value}} = 0$$

Phir jaise-jaise reaction aage badhti hai, C aur D bante hain, Q badhta jaata hai, aur finally $Q \rightarrow K$ at equilibrium.

\therefore At initial stages, **Q is zero.**

Approach

Start: Initial mein products = 0.

End: $Q = \text{products/reactants} = 0/\text{something} = 0 \Rightarrow$ Option (A).

Answer

Option (A): Q is zero at initial stages (products abhi bane nahi hain).

Q27. $\Delta G^\circ = 2494.2 \text{ J}$ at **300 K** for $2\text{A} \rightleftharpoons \text{B} + \text{C}$; $[\text{A}] = \frac{1}{2}$, $[\text{B}] = 2$, $[\text{C}] = \frac{1}{2}$. Direction? [JEE Main 2015]

Explanation (Step-by-Step)

Step 1: K nikalo from ΔG° :

$$\begin{aligned}\Delta G^\circ &= -RT \ln K \\ 2494.2 &= -(8.314)(300) \ln K \\ \ln K &= \frac{-2494.2}{8.314 \times 300} = \frac{-2494.2}{2494.2} = -1 \\ K &= e^{-1} \approx 0.368\end{aligned}$$

Step 2: Q_c calculate karo:

$$Q_c = \frac{[\text{B}][\text{C}]}{[\text{A}]^2} = \frac{(2) \left(\frac{1}{2}\right)}{\left(\frac{1}{2}\right)^2} = \frac{1}{\frac{1}{4}} = 4$$

Step 3: Compare:

$$Q_c = 4 > K_c = 0.368$$

Step 4: $Q > K \Rightarrow$ Reverse direction (backward reaction hogi).

Approach

Start: $\Delta G^\circ = -RT \ln K$ se K nikalo.

Middle: Q_c calculate karo given concentrations se.

End: $Q = 4 > K = 0.368 \Rightarrow$ Reverse direction \Rightarrow Option (2).

Common Mistake

$R = 8.314 \text{ J}/(\text{mol}\cdot\text{K})$ use karo (J mein, calories mein nahi), aur T Kelvin mein dena! Is question mein $RT = 8.314 \times 300 = 2494.2$, jo exactly ΔG° ke equal hai — toh $\ln K = -1$ aur $K = e^{-1}$ seedha nikal aata hai.

Answer

Option (2): Reverse direction because $Q > K_c$

Q28. $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$; $K = 100$; all initial = 1M. Equilibrium $[\text{D}] = ?$ [JEE Main 2016]

Explanation (Step-by-Step)

Step 1: ICE Table banao (x mol/L react kare):

	A	B	C	D
Initial	1	1	1	1
Change	$-x$	$-x$	$+x$	$+x$
Equilibrium	$1 - x$	$1 - x$	$1 + x$	$1 + x$

Step 2: K expression likho:

$$K = \frac{(1+x)^2}{(1-x)^2} = 100$$

Step 3: Dono sides ka square root lo (shortcut!):

$$\frac{1+x}{1-x} = \sqrt{100} = 10$$

Step 4: Solve karo:

$$1+x = 10(1-x) = 10 - 10x$$

$$11x = 9 \implies x = \frac{9}{11} \approx 0.818$$

Step 5: Equilibrium concentration of D:

$$[D]_{\text{eq}} = 1 + x = 1 + 0.818 = \mathbf{1.818 \text{ mol L}^{-1}}$$

Approach

Start: ICE table banao — carefully change column fill karo.

Middle: K expression mein substitute karo, phir **square root lo** (quadratic mat banao!).

End: $x = 9/11$, $[D] = 1 + 9/11 = 20/11 \approx 1.818 \implies$ Option (2).

Common Mistake — Smart Shortcut!

$\frac{(1+x)^2}{(1-x)^2} = 100$ ko seedha square root lo:

$\frac{1+x}{1-x} = 10$ (much faster!). Bahut students quadratic banate hain jo time waste hai. Jab bhi numerator aur denominator mein same power ho (both squared), seedha square root lo!

Answer

Option (2): 1.818 mol L^{-1} ($x = 9/11$, $[D] = 1 + 9/11 = 20/11 \approx 1.818$)

— End of DPP-7 Solutions —

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Chemical Equilibrium — Unit and Application of Equilibrium Constant